

Secondary Publication



Döbler, Niklas A.; Carbon, Claus-Christian

Does creating the perfect child mean enforcing or dismantling normative gender stereotypes? : Evidence from an interactive virtual genetic engineering exhibit

Date of secondary publication: 05.05.2025

Version of Record (Published Version), Article

Persistent identifier: urn:nbn:de:bvb:473-irb-1080134

Primary publication

Döbler, Niklas A.; Carbon, Claus-Christian (2025): Does creating the perfect child mean enforcing or dismantling normative gender stereotypes? : Evidence from an interactive virtual genetic engineering exhibit, in: Acta Psychologica, Amsterdam: Elsevier, Vol. 254, Nr. 104748, S. 1–23, doi: 10.1016/j.actpsy.2025.104748.

Legal Notice

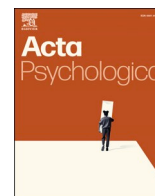
This work is protected by copyright and/or the indication of a licence. You are free to use this work in any way permitted by the copyright and/or the licence that applies to your usage. For other uses, you must obtain permission from the rights-holders.

This document is made available under a Creative Commons license.



The license information is available online:

<https://creativecommons.org/licenses/by/4.0/legalcode>



Does creating the perfect child mean enforcing or dismantling normative gender stereotypes? Evidence from an interactive virtual genetic engineering exhibit

Niklas A. Döbler^{*} , Claus-Christian Carbon 

Department of General Psychology and Methodology, University of Bamberg, Germany
 Research Group EPÆG (Ergonomics, Psychological Aesthetics, Gestalt), Germany
 Bamberg Graduate School of Affective and Cognitive Sciences (BaGrACS), University of Bamberg, Germany

ARTICLE INFO

Keywords:

Gender
 Genetic engineering
 Stereotypes
 CRISPR/CaS9
 Normativity

ABSTRACT

Genetic engineering of humans is a controversial practice with unknown societal effects. Gender constitutes an important evaluative background for human behavior and traits. This manifests within action-guiding normative gender stereotypes. This study investigates to which extent these stereotypes may influence the application of genetic engineering. After highlighting potential motivations to enact stereotypes biotechnologically, we propose two potential strategies. People may design future children in close accordance with contemporary gender stereotypes, e.g., to minimize their risk of being punished for non-confirmation, or may create individuals that counteract these stereotypes, e.g., to create a more gender-egalitarian future. To test these hypotheses, we analyzed a large-scale dataset (13,641 virtual children) from an interactive museum exhibit. Here, visitors could design their “perfect child.” Gender-dependent differences in designed Big-5-like personality traits and intelligence, musicality, creativity, and sportiness yielded evidence for behavior predicted by both strategies and were inconclusive regarding the dominance of one strategy. Confirming contemporary stereotypes, children deliberately chosen to be male were designed with lower sensibility but higher sportiness than those deliberately chosen to be female. These effects were accompanied by a relatively higher probability of decreasing sensibility and increasing sportiness of these male children. Non-differences among traits like sociality and conscientiousness disconfirmed normative stereotypes and suggested a more egalitarian design. Effect direction, strength, and certainty depended on whether gender was picked deliberately and other factors. Although the ecological setting and methodological limitations hinder a clear interpretation, we provide initial evidence on how genetically engineered children can “essentially” embody gender normativity.

Abbreviations and glossary

Good-GH: Good-Gender Hypothesis
 Eman-GH: Emancipating-Gender Hypothesis
 F: Female (Children who were deliberately chosen to be female)
 M: Male (Children who were deliberately chosen to be male)
 rF: random Female (Children whose randomly assigned female gender was not changed)
 rM: random Male (Children whose randomly assigned male gender was not changed)
 DGC: Deliberately gendered children (Children whose randomly assigned gender was changed – F/M)

RGC: Randomly gendered children (Children whose randomly assigned gender was not changed – rF/rM)

1. Introduction

Reproductive technologies require weighty decisions about whether and how to intervene in the “natural” processes of parenthood (Ihde, 1990). Prominently, this concerns prenatal diagnostics and the decision as to whether embryos with natural genetic defects should be carried to term. (e.g., Cunningham et al., 2015; Verbeek, 2011). Another decision pertains to choosing a specific sex for the child (e.g., Sharp et al., 2010). The selection of one embryo over the other practiced in this context is a

^{*} Corresponding author at: Markusplatz 3, 96047 Bamberg, Germany.
 E-mail address: niklas.doebler@uni-bamberg.de (N.A. Döbler).

broad measure. Yet, advancements in genetic engineering, like the DNA-cutting “genetic scissor” of CRISPR/Cas9, allow for the deletion or addition of genes with unprecedented accuracy (Redman et al., 2016).¹ CRISPR/Cas9 is already used for treating genetic diseases (Khalaf et al., 2020), but it could also influence the genetic basis of personality (Banazadeh et al., 2024). This technology has reignited the ethical debate about the decision to preemptively target embryonic genes in a health-promoting way (Calabrese et al., 2020) and create “perfect” children (Snure Beckman et al., 2019).

Arguments against such practice include the impression that one is “playing God” (Schönthaler et al., 2022, p. 363) or is “meddling with nature” (Pew Research Center, 2016, p. 5). One reason for this unease is so-called *genetic determinism*, i.e., the idea that genes are highly causally responsible for observable differences within humans (Resnik & Vorhaus, 2006). This is often accompanied by so-called genetic essentialism, the belief that our genes harbor a specific “essence,” that is not only *causally responsible* for shown behavior but “immutable, fundamental, homogeneous, discrete, [and] natural” (Dar-Nimrod & Heine, 2011, p. 801). Following this assumption, some people may see genetic engineering as either a reliable and direct way to modulate human capacities for good (Dar-Nimrod & Heine, 2011) or an interference with a defining aspect of our identity (Wilson, 2014). Suppose genetic engineering allows for the precise, direct, and highly consequential attainment of natural human features to human norms (Buchanan, 2011): which norms, other than health-related ones, should we adapt to? What “natural” features are a target for change, and what kind of humans are meant to be designed?

Closely linked to gene essentialism is so-called *gender essentialism*, i.e., the belief that the traditional categories of male and female and their related differences can be reduced to a definite biological and genetic makeup (Hendl, 2017; Saguy et al., 2021).² Endorsing genetic and gender essentialism can be empirically linked to affirming gender stereotypes (Keller, 2005; Meyer & Gelman, 2016; Nürnberger et al., 2016; Saguy et al., 2021; Weisgram & Bruun, 2018). Stereotypes concern personality, abilities, and behavior- and appearance-related factors (Koenig, 2018). Their content mirrors a normatively gendered, interaction-structuring environment in which deviation from one’s “essential” nature can have serious consequences (Butler, 1988; Saguy et al., 2021). Empirically, those who behave stereotype-non-conforming risk negative consequences, and those who issue these consequences may do so to maintain given gender relations (Rudman, Moss-Racusin, Glick, & Phelan, 2012). Stereotyped features like athletic, intellectual abilities and weight (Prentice & Carranza, 2002; Tang-Péronard & Heitmann, 2008) are well-recognized regarding their genetic basis (Willoughby et al., 2019). Given that convictions about gender can be highly naturalized and action-guiding (Butler, 1988; Butnor & MacKenzie, 2022; Saguy et al., 2021) and the manipulation of the human genome is thought to yield significant behavioral differences, normative gender stereotypes could influence which features of the latter are meant to be changed.

Following the call, to use any available knowledge to ensure the child’s well-being (Savulescu, 2001) and the beneficial outcomes of adhering to gendered ideals (Rudman, Moss-Racusin, Glick, & Phelan, 2012), targeting what is assumed to be the biological foundation of our behavior and personality may be a tempting strategy to enforce stereotypes and create a “perfect” boy/girl that is unlikely to experience the harsh consequences of gender deviant behavior. This stereotype-enforcing perspective is matched by positions that see emerging

biotechnology as the first step into a non-essentialist, gender-transcending society (Hughes & Dvorsky, 2008).

To our knowledge, no empirical study has investigated the link between genetic engineering and normative gender stereotypes. We mean to address this gap on a theoretical and empirical basis. Reflecting on the ethical intricacies of the phenomenon, we will develop two working hypotheses. One argues that parents may genetically engineer their children in accordance with a benign normative standard. Since gender stereotypes could be part of such a standard, we will review how parental actions already enforce or dismantle gender typicality and how these behaviors manifest in contemporary reproductive decisions. Hereafter, we will specify two testable hypotheses on whether people will use genetic engineering to either enforce or dismantle normative gender stereotypes. After discussing their implications, we will empirically test the hypotheses’ impact on hypothetical genetic engineering. For that reason, we analyzed data collected from an interactive museum exhibit, where visitors could genetically engineer their “perfect child” by designing gender, health, personality, and talents to their wishes. Given the prospect of emerging biotechnologies with unknown societal consequences, this paper aims to provide insight into the following question: *Suppose parents are interested in the well-being of their child, and gender is a consequential factor for the potential experience of social harm. How will normative conceptions about gender manifest when widespread and precise genetic engineering of humans becomes potentially available?*

2. Theory & hypotheses

Psychological research requires comprehensive theory-building and empirical testing. We hope the theoretical discussion here inspires future research, even if the subsequent investigation cannot address every proposition.

2.1. Working hypothesis A1: Adapting children for good

It should not be too controversial to state that parents are interested in the well-being of their children.³ Prenatally, pregnant women desire their children to be healthy and adjust their behavior in ways deemed beneficial for this goal (Bondas & Eriksson, 2001). The same study also showed that women were anxious about complications or their parenting abilities. Fathers reported similar worries (Dabb et al., 2023). In this context, the practical and theoretical possibilities of preimplantation/ natal diagnostics and reproductive techniques can inform, mitigate, or validate parental concerns about the child’s health (Cunningham et al., 2015; Hodgson & McClaren, 2018). However, availability and obtained information can yield pressure to make the “right” decision about the embryo’s fate (Cunningham et al., 2015). Moreover, parents may question their capacity to care for a disabled child and bemoan that the child has fewer opportunities in life (Hodgson et al., 2016). If parental motivations are reliably benign, should they not be interested in “select[ing] the child, of the possible children ... who is expected to have the best life, or at least as good a life as the others, based on the relevant, available information” (Savulescu, 2001, p. 415)? Savulescu (2001) originally formulated his “Principle of Procreative Beneficence” concerning preimplantation genetic diagnosis (PGD) and in-vitro fertilization (IVF) and contrasted those interventions against

¹ We will refer to interventions that alter the individual genome as genetic engineering

² E.g., “Every cell of the body and the entire body plan and form mark us as either male or female, and it is hard to imagine any more fundamental or essential characteristic of a person.” (President’s Council on Bioethics, 2003, p. 67)

³ Of course, there is child-harming behavior by parents, e.g., physical, sexual, or emotional abuse. Reasons for this conduct are complex. For instance, people who experienced abuse themselves reported more favorable attitudes toward abusing infants (Clemens et al., 2020). We do not want to defend these practices, yet emphasize that people may show objectively morally reprehensible conduct out of subjectively justified reasons. Moreover, for some, the act of genetically engineering children may fall under this category (e.g., Hendl, 2017; Sparrow, 2019). Demanding a nuanced investigation, a discussion of these topics is beyond the scope of this paper.

genetic alterations of a chosen embryo. Although it was explicitly meant to communicate a normative appeal, the principle's underlying reasoning seems to describe contemporary attitudes accurately. Parents express support for the idea of discarding genetically impaired embryos (Cunningham et al., 2015). Moreover, people support genetic engineering to enhance resistance against pathogenic agents or eliminate congenital disabilities (Jedwab et al., 2020). While the biotechnological reduction of harm associated with organismic "malfunctions" is far from uncontroversial (e.g., Padden & Humphries, 2020), people still consider these means to ensure their children can live as risk-free as possible.

If parents are generally concerned about their children's well-being, should they not be interested in selecting a child whose features comprehensively increase the probability of favorable outcomes? Indeed, Savulescu (2001) applied his principle not only concerning health but also with respect to characteristics he deems universally beneficial (e.g., intelligence). He even extended his position beyond the context of child selection and claimed that we are 'morally obliged' to employ genetic engineering to change personality traits that may impair human flourishing (Savulescu, 2005). Prima facie people seem not to concur with this reasoning. Instead, they are much more willing to endorse genetic engineering for treating and preventing medical conditions rather than targeting psychological features for improvement reasons (Jedwab et al., 2020). Compared to people with no children, parents are even more skeptical about genetically engineering human DNA (Jedwab et al., 2020) or interfering with children's characteristics by technological means (Wagner et al., 2018). However, parental motivations to care for their disabled children can manifest in the endorsement of therapeutic genetic manipulation (Snure Beckman et al., 2019). Moreover, a recent study revealed that 2.15 % – 5.75 % of participating U.S. parents have previously administered pharmacological substances without medical indication to their children to improve their cognitive capacities (Sattler et al., 2021). Additionally, general investigations into the attitudes toward genetic engineering (e.g., Marteau et al., 1995; Pew Research Center, 2016; Schönthaler et al., 2022) do not show universal rejection of this intervention. Scheufele et al. (2017) report that 26 % of respondents favored the application of hereditary genetic engineering for purposes other than treatment. A number rising to 39 % when beneficial effects would be non-hereditary. This is mirrored by a cross-country survey, indicating that around 30 % of participants affirmed the employment of genetic engineering for intelligence improvement (Jedwab et al., 2020). Furthermore, several scholars (e.g., Bostrom, 2003; Sorgner, 2015) have argued for this technology's beneficial impact. Despite prevalent ethical concerns, we can reasonably assume at least some support for using biotechnology to directly adapt children to maximize the chance for positive outcomes and minimize the chance of negative outcomes.

Still, genetic engineering is nothing that is taken lightly. Evolutionary-inspired arguments against large-scale interventions with the human gene pool fear the loss of protective variation within the same (Van Dijke et al., 2018; cf. Powell, 2012). However, there are claims that this practice must be implemented if we want to conserve a valued state of general health (Powell, 2015). The empirically observed importance of whether non-treatment interventions yield hereditary effects (Scheufele et al., 2017) and discussion about species-related negative effects (Van Dijke et al., 2018) suggests that people are considering evolutionary consequences. In general, the debate revolves around the idea that shaping individual genomes to a specific ideal may have far-reaching and generationally relevant negative societal, biological, and moral consequences (for an overview, see Van Dijke et al., 2018). This is most evident in the accusations that Savulescu's procreative beneficence re-endorses historical eugenic practices (Sparrow, 2007). This general concern – also mirrored in the genetic engineering debate – is that gene selection may reduce human diversity because decision-makers systematically eliminate features linked to potential individual and social harm (Garland-Thomson, 2020; Padden & Humphries, 2020; Sparrow, 2007; Van Dijke et al., 2018). Sparrow (2007) specifically argued that

the social forces that discriminate against different skin colors or sexual orientations pressure parents into selecting children that would swiftly realize a hetero-normative, ethnically homogenous society. Since some people would indeed use genetic engineering to prevent children's homosexuality (Marteau et al., 1995), empirical data supports Sparrow's concerns that the focus on the child's well-being may yield controversial decisions. Savulescu (2001) argued that his principle holds even if possibly entrenching negative social conditions, but emphasized the need for societal measures that mitigate discrimination. However, such policy-focused solutions may not immediately benefit one's child. Hence, it is not surprising that although parents of congenitally ill children feared that genetic engineering could lead to the diminished acceptance and subsequent extinction of humans with disabilities, some of them wanted to use every available means to help their child, even if this perpetuated discriminatory attitudes (Snure Beckman et al., 2019). Despite all valid ethical concerns about the solidification of stereotypes and wrongful societal norms (e.g., Hendl, 2017; Sparrow, 2007), let us approach this issue from the parents' perspective. If they are fundamentally concerned about the well-being of *their* child, and this already motivates a wide range of behaviors before birth: Is it not tempting to use the transformative power of genetic engineering to attune the child to a normative environment, rather than reshaping the environment to meet the child's needs (see Döbler & Carbon, 2024)?

This idea does not require explicitly following the dogma of procreative beneficence. If genetic engineering of humans becomes available, parents will likely contemplate whether their child's genes are adaptive and promote well-being in a given environment. In that case, we assume that the normative dogma and the goal of being good parents leads to the selection of genes that the designers believe will increase the likelihood of a good life for their children (see Bostrom, 2003; Weaver et al., 2020). Thus, people are believed to design children whose chosen features mirror a given value structure. This structure entails *normative* convictions about how children *ought* to be (prescription) or *ought not* to be (proscription) and assumed beneficence of adhering to these norms (see Koenig, 2018). As the cited evidence shows, this will likely eliminate devalued medical conditions and diseases. However, we have also reviewed the contentious idea that normative convictions extend toward psychological features whose potential consequences are deeply socially embedded. Thus, we formulate working hypothesis A1: *When designing a "perfect" child, designers align the configuration of the future child with normative convictions. They will do so to enable the child to live a good life. Most commonly, features like the predisposition of diseases are overwhelmingly eradicated. Less medically speaking, choices regarding traits like personality and talents should be related to common notions about the value of a specific level of feature expressions.*

Apart from the suggested focus on health, what other normative beliefs are so pressing and dominant that parents attune their behavior to them? What environment may they adapt their children to? One answer is a gendered one.

2.2. Working hypothesis A2: Gendered children

Our socio-material environment can be seen as structured in a way that reflects, enforces, and maintains an essence and biology dominated conception of gender and subsequently guides cognitive, behavioral, and social processes (Saguy et al., 2021). Butler (1988) pointed out how gender must be "performed" (p. 527) correctly and how doing so can be seen as adaptive strategic conduct to prevail in a normative social environment. According to her, shown behavior must concur with normative historicized expectations. One way to cultivate normative demands in a socio-material environment is through gender stereotypes (Saguy et al., 2021). Stereotypes about males and females are concerned with many features and are similarly descriptive and normatively pro- and prescriptive (Koenig, 2018; Prentice & Carranza, 2002). They have a pertinent influence on cognitive and social processes (Ellemers, 2018) and can rationalize mistreatment if individuals do not act accordingly

(Rudman, Moss-Racusin, Glick, & Phelan, 2012). Thus, people may be motivated to showcase stereotypical behavior to prevent negative consequences (Rudman, Moss-Racusin, Glick, & Phelan, 2012) and invest resources into complying with what they consider a stereotypical adult male or female (Sanchez & Crocker, 2005). This would be akin to “performing” gender in accordance with historized established norms (Butler, 1988).

Seeing gender stereotypes as cultivated psychological guardrails for successful adaptation, it becomes evident how gender-confirming behavior perpetuates their content (Butler, 1988; Butnor & MacKenzie, 2022; Rudman, Moss-Racusin, Glick, & Phelan, 2012). Crucially, this extends to external evaluators so that their negative or affirmative response to shown behavior may be motivated to reduce future deviation from the established script and maintain gender normativity (Rudman, Moss-Racusin, Glick, & Phelan, 2012). This is emphasized within the rich body of literature on how people are socially, economically, and physically punished if their appearance, personality, or behavior does not comply with contemporary gender stereotypes (e.g., Blondeel et al., 2018; Moss-Racusin et al., 2010; Rudman, Moss-Racusin, Glick, & Phelan, 2012; Rudman, Moss-Racusin, Phelan, & Nauts, 2012; Stotzer, 2009). Being overly agreeable, for instance, leads to lower income for males (Judge et al., 2012), who are expected to be more assertive and agentic (Koenig, 2018; Prentice & Carranza, 2002). For women, displaying agentic assertiveness in job-related contexts reduced likability (Rudman, Moss-Racusin, Phelan, & Nauts, 2012). Evident physical abuse against people who do not identify with their gender assigned at birth shows how peer reactions can be potentially life-threatening (Blondeel et al., 2018; Stotzer, 2009).

Interested in rendering the harsh consequences for non-stereotypical behavior less likely, parents could be inclined to attune children’s characteristics and behavior to a pre-given gendered normativity. Indeed, although some parents may report eased expectations about stereotypical behavior, they are unlikely to abandon traditionally gendered ideals completely (Kane, 2006). Moreover, deviations from the normative gender convictions were found to be reciprocally causally related to negative interactions between children and parents (Alanko et al., 2011), and there is evidence that experiencing high conformity with one’s assigned gender can be psychologically and socially beneficial (C. L. Martin, Cook, & Andrews, 2017). Parental attunement can manifest subtly in adapting to the environment according to gender stereotypes (Saguy et al., 2021). For instance, parental gender stereotype endorsement was shown to positively influence the children’s normative gender stereotypes and predicted furnishing the child’s bedroom in a stereotype-matching way (Sutfin et al., 2008). Moreover, it is highly desired for boys to play with gender-matched “masculine” toys but disfavored for them to play with “feminine” ones (Koenig, 2018). The action-guiding power of these stereotypes was shown by their predictive power upon people’s reluctance to buy gender atypical toys for children (Weisgram & Bruun, 2018). This shows how, apart from biological determinants, socio-material conditions and parental actions can significantly influence how gender is experienced and expressed by their children (Antoniucci et al., 2023; Davis & Greenstein, 2009). Growing up, children may internalize externally imposed parental and social demands so that they themselves become the pivotal authority for enforcing conformation with one’s assigned gender (Jackson et al., 2021).

We can locate the foundation for these processes prior to birth. The most common cases are pregnancy-related ultrasound examinations. Although merely exposing a *biological* feature, prenatal sex revelation may shape the expectations of parents according to *gendered* stereotypes (Browne, 2017). In this sense, these procedures prenatally turn biological sex into social gender (Verbeek, 2011). Imhoff and Hoffmann (2023) assessed which features parents desire within their children before and after their child’s sex was revealed this way. Results indicated that fathers shifted their preferred features in a stereotype-conforming direction. Although the effects were not strong and were conditional on

parent gender, the authors point out that even minor effects can contribute to a steady perpetuation of normative gender convictions. Parental beliefs about gender can become so decisive that people choose to terminate a pregnancy due to the expected child’s gender (Abrejo et al., 2009; Dubuc & Coleman, 2007). But even before the term starts, available technologies allow for the determination and selection of embryonic sex. Here, it was argued that the general practice of *sex selection* in its contemporary (e.g., PGD, IVF) and future manifestations meddles with the parental dogma of unrestricted affection (Hendl, 2017; President’s Council on Bioethics, 2003). On a more global scale, implementing such practices was also feared to turn individual benefits into societal disadvantages because it would distort the preferred sex distribution (President’s Council on Bioethics, 2003). Savulescu (2001) acknowledges that parents may be inclined to select the socially privileged sex. Yet, he rebutted that this conduct would quickly self-regulate because an uneven sex distribution would diminish the life quality of born men (cf. Sparrow, 2007). Nonetheless, so-called *sex selective abortion* led to an abundance of male children in many countries, including migrant communities in the United Kingdom (Dubuc & Coleman, 2007). In light of the empirical evidence of this practice and proposed arguments in favor of it, Hendl (2017) highlights how selecting for sex is built upon the normative convictions that characterize gender stereotypes. Moreover, she points out how doing so enforces essentialistic views about gender, which effectively undermine egalitarian relationships and constrain children’s independence. According to Hendl, this is because sex selection reduces projected behavioral and psychological differences to a genetic basis and, therefore, prenatally imposes parental demands upon the child to act in a stereotype-conforming way. In a similar vein, Browne (2017) accused proponents of sex selection of short-sightedness about systemic relationships and ethical implications. When asked directly for their reasons for pursuing clinical sex selection, couples expressed the hope that it would yield valued gender-related experiences, e.g., walking one’s daughter down the aisle as a father (Sharp et al., 2010). In the same study, couples seemed unworried about solidifying discriminative attitudes based on gender. Nonetheless, these results suggest that sex revelation and selection are deeply imbued by expectations regarding gender (Browne, 2017).

Fitzgerald (1997) warned against using gene engineering technology against transgender children to enforce gender conformity. However, sex selection does not inevitably lead to gender-stereotypical behavior (Hendl, 2017). To ensure the latter, one could exaggerate this practice and not only select the general chromosomes but the entire genetic makeup. Thus, application possibilities may reach beyond selecting a particular hoped-for gender identity and stretch toward precisely shaping it according to normative convictions. Under the impression that gender and our genes are highly consequential for our behavior and identity (Dar-Nimrod & Heine, 2011; Haslam & Whelan, 2008), why not implement proactive beneficence and equip the child with a set of features whose composition reflects valued male or female levels? Even if using transformative technological practices to adhere to gender stereotypes may maintain the harmful conditions that gave rise to them (Little, 1998): The motivation to minimize harm or have a “perfect” boy/girl may incline future parents to make controversial decisions. Why spend tiresome hours educating boys and girls on how or how not to behave and use genetic engineering to adapt the child to a gender-normative environment?

However, note the possibility of using this technology the other way around. Instead of enforcing them, people could design children as non-compliant with normative expectations (see Hughes & Dvorsky, 2008). Individuals who do so are called “vanguards” and have the potential to change stereotypes by empirically disproving them (Rudman, Moss-Racusin, Glick, & Phelan, 2012, p. 168). Indeed, parents can enact gender norms in an egalitarian way (Marks et al., 2009). Suppose future parents disvalue gender stereotypes: What better way to call them into question than by genetically establishing their falsification?

These thoughts yield working hypothesis A2: *Due to the evaluative*

dominance of gender, we suspect that perfect children are designed in relation to normative gender stereotypes. What demands further discussion is whether people will use genetic engineering to enact or dismantle normative gender stereotypes.

2.2.1. Enforcing stereotypes: Good-Gender Hypothesis (Good-GH)

Committed to ensuring that their children live as good a life as possible, people may use genetic engineering to design them in accordance with normative stereotypes. Following the benign-motivations reasoning (A1) and importance of gender (A2), this may be driven by the intention to preventively protect children against negative consequences that result from gender stereotype-violating behavior or personality traits (see Rudman, Moss-Racusin, Glick, & Phelan, 2012). Take the finding that agreeableness correlates negatively with income, especially for males (Judge et al., 2012). If parents do not want their male child to be economically punished, the logical choice is to make him not overly agreeable, even if this maintains the existing normative stereotypes that females shall display more agreeableness and males more assertiveness (see Prentice & Carranza, 2002). Even if enforced stereotypes are deemed unfair or untrue, one can still conclude that a child would be better off adhering to them.

Additional influences for enforcing stereotypes may be their cognition-scaffolding function, their perceived importance for structuring gender relations, the belief that they are societally justified (Ellemers, 2018), or one's interest in maintaining hierarchical gender relations (Rudman, Moss-Racusin, Glick, & Phelan, 2012). Preferring stereotypical characteristics within the child may also be linked to the designer endorsing the existence of a gender essence (see Broussard & Warner, 2019; Meyer & Gelman, 2016). Nonetheless, all these motivations converge to the attempt to create "good group member[s]," i.e., individuals whose behavioral and mental features are closely aligned with what is deemed quintessential for a gender (Ellemers, 2018, p. 287). This happens through the biotechnologically aided translation of the designer's stereotype knowledge to the child's genes. Although this may have "bad" societal consequences, children designed to align or even exaggerate contemporary normative gender stereotypes are "good" children in the most general sense: a proper representation of a normatively valued concept, idea, notion, etc.⁴ See Table 1 for an overview of identified normative gender stereotypes, whose enforcement specifies our working hypotheses to what we call the *Good-Gender Hypothesis (Good-GH)*.

2.2.2. Dismantling stereotypes: Emancipating-Gender Hypothesis (Eman-GH)

Schönthaler et al. (2022) report that around 50 % of their participants expressed worries that engineering the genome to improve mental capacities may negatively affect social equality. Although an impressive number, it is not a universally shared concern. Indeed, there is a lively academic debate about whether genetic engineering or other techniques to create "perfect" children will reduce or increase socio-economic issues (e.g., Bostrom, 2003; Singer, 2009; Sparrow, 2007; Thomas, 2022; Van Dijke et al., 2018). The academic debate extends to the question of gender. Some scholars proposed that biotechnology could pave the way toward a "postgender future," where each person's mental and physical configuration is up to their maximized self-determination and not bound to traditional gender lines (Hughes & Dvorsky, 2008, p. 13). Achieving this ideal is explicitly meant to overcome the traditional male/female binary and mitigate resulting oppression and suffering (Thweatt-Bates, 2016). Arguably a very abstract goal, note how members of the LGBTQ+

⁴ Categorizing genes and people as "good" is problematic because this implies the presence of a "bad" counterpart (Carbon, 2021). Hence, this naming refers to the logic of the stereotypes alone. Evaluation as "good" and "bad" in one context (for instance, in terms of terminal diseases) does not imply generalizability to other areas.

community already use drugs to discover novel ways to express their gender identity in a non-binary fashion (Pienaar et al., 2020).

Translated to our case, this would mean that people use technology to design children meant to dismantle gender stereotypes and contribute to increased gender equality (cf. Sparrow, 2007). Societally, this strategy would attempt to reform the socially unfavorable environment by explicitly designing vanguards. Instead of adapting the child to the environment, this strategy adapts the child in a way that creates friction to adapt the environment. This is not an unrealistic goal. Gender stereotypes have been proven to be time-dependent (Eagly et al., 2020; Zehnter et al., 2018) and are sensitive to frequency information about shown behavior (Diekmann & Eagly, 2000).

Arguably, this would put a significant burden on these children and introduce a profound strategic element to parents' reproductive decisions (Sparrow, 2007) that even Savulescu (2001) opposed. However, given that children are prone to adopting their parents' more egalitarian understanding of gender (Davis & Greenstein, 2009), the principle process described here is not new. For instance, male children with parents who hold gender egalitarian beliefs were more likely to also affirm them (Myers & Booth, 2002). Designing vanguard-like children may reflect the idea of using genetic engineering to create a better future where discrimination based on individual stereotype compliance is less prevalent. To-be-expected negative consequences for stereotype deviation (Rudman, Moss-Racusin, Glick, & Phelan, 2012) may be a burden parents are willing to place on their children. Targeting features crucial in preserving the current Western gender hierarchy may be particularly interesting here (see Rudman, Moss-Racusin, Glick, & Phelan, 2012). This entails high-status agentic traits which are more prescriptive for males (Rudman, Moss-Racusin, Phelan, & Nauts, 2012).

Such a strategy seems to favor positive societal consequences over individual ones. However, there is a long and recently renewed debate about the potential psychological and social adaptiveness of individual identification with typical male and female features (C. L. Martin, Andrews, et al., 2017; C. L. Martin, Cook, & Andrews, 2017).⁵ In light of the potential benefits of this so-called *psychological androgyny* (C. L. Martin, Cook, & Andrews, 2017), those who follow this design strategy should not be seen negatively. Their actions can still aim to ensure a good life for their children. Another reason for the creation of vanguards may be a strong prospective focus. People may anticipate a more gender egalitarian future (Diekmann & Eagly, 2000) and may attempt to adapt their children not to the contemporary but anticipated gender egalitarian stereotype landscape.

Assuming that contemporary stereotypes are perceived as non-favorable so that the child will be better off not adhering to them, *people can design emancipated children who, by their non-obedience to the gender stereotypes, can foster societal change and are prideful in doing so.* This derivation of our hypotheses is called the *Emancipating-Gender Hypothesis (Eman-GH)*.

2.3. Clarifying the implications and effects of Good- and Eman-GH

The following section will elaborate on psychological mechanisms that may foster adopting a strategy that orients at the Good-GH or Eman-GH. We will also discuss the consequences of these strategies, should they ever be implemented, and how people may react toward designed children.

Adopting an essentialistic perspective, males and females are conceived as natural, imperishable, biologically highly distinct categories (Haslam et al., 2000). If these categories are potentially explained by genetic factors (Dar-Nimrod & Heine, 2011), why would there be a need to interfere with processes that are assumed to occur naturally? Observing the characteristics whose allegedly distinct combination

⁵ Thanks to the anonymous reviewer for pointing out the theoretical link towards psychological androgyny

constitutes the assumed binary categories inevitably reveals variety within the underlying distributions. Even if individuals posit a high degree of distinctiveness between the overarching categories, some individuals may be more similar to the “perfect” male or female (see [Ellemers & Jetten, 2013](#)). The suitable strategy to create a “good” representation of one category demands aligning them with the mean of the gender feature distribution or pushing individual characteristics even further beyond. Assuming genetic determinism, genetic engineering of personality and other features may be seen as a means to locate traits at the desired level and maximize differences.

[Habermas \(2005\)](#) pointed out that designing children may interfere with the child’s self-determination if ever disclosed (see also [Hendl, 2017](#)). This is because the child has to cope with being purposefully designed and objectified ([Habermas, 2005](#)). Accordingly, biotechnological embryonic manipulations cut deeper than parenting or educational efforts ([Hendl, 2017](#); cf. [Sorgner, 2015](#)). Yet, [Resnik and Vorhaus \(2006\)](#) argue that concern about parents who overwhelm their children with autonomy-constraining expectations builds upon an *assumed* profound genetic determinism rather than actual empirical evidence. They claim that related parental misconceptions can be easily adjusted to the latter. In other words, if genes are less influential than thought, the intervention is far less controversial because it is less consequential. Resnik and Vorhaus correctly emphasize the power of personal beliefs. Yet, what matters here is not the precise empirical effect of genetic engineering (something we currently can only speculate about) but the fact that by granting the engineered genes *some* influence, one can claim limited justification for one’s expectations. After all, beliefs in genetic determinism are associated with more realistic heritability estimations of various traits, including personality ([Willoughby et al., 2019](#)). So, people may have a good intuition about the possibilities of the intervention. Even if attributing the majority of gender differences to environmental factors, parents may still contemplate whether they should not do everything possible to ensure that their children match their normative convictions.⁶ Furthermore, empirically unjustified expectations can still influence the parent-child interaction ([Browne, 2017](#)). Even without strong determinism, children may experience strain from the requirement to psychologically make sense of the fact that the genetic information inscribed into them reflects social conventions and beliefs imposed on them by others ([Habermas, 2005](#)). This is how sex selection may infringe upon the child’s autonomous development ([Hendl, 2017](#)).

However, possible interactions between (modified) genes and the environment render expression of the former uncertain ([Resnik & Vorhaus, 2006](#); [Sparrow, 2019](#)). Nonetheless, peers already evaluate the child’s biological makeup and scrutinize its observed gender identity and behavior regarding a potential overlap ([Abreu et al., 2019](#); [Brousard & Warner, 2019](#)). Instead of linking the reason for the child’s conduct to evident visual cues, people may also scrutinize its genetic makeup ([Hendl, 2017](#)). Even if unwarranted, people refer to genetic components as an irrevocable justification for stereotypes ([Dar-Nimrod & Heine, 2011](#); [Saguy et al., 2021](#)). If polycausal social differences between males and females are explained by an allegedly essential and deterministic biological reality ([Hoffman & Hurst, 1990](#)), social contexts that incentivize such argumentations are reinforced ([Saguy et al., 2021](#)). Hence, while assuming an inevitable genetic determinism is probably fallacious ([Resnik & Vorhaus, 2006](#)), arguments for overcoming such reasoning in general (e.g., [Resnik & Vorhaus, 2006](#)) and for gender in particular (e.g., [Saguy et al., 2021](#)) must acknowledge the appealing psychological function of assuming a solid genetic influence when trying to understand human behavior ([Dar-Nimrod & Heine, 2011](#)).

Using genetic engineering to alter and create the genetic foundation for these “essential” differences harbors a contradiction. Any assumed (genetic) essence is usually explicitly defined as *immutable* ([Dar-Nimrod](#)

& [Heine, 2011](#); [Neufeld, 2022](#)). Because they were changed, engineered genes cannot qualify as immutable carriers for our identity and thus cannot justify related stereotypes. Yet, if linked to genetic determinism, assumed immutability may not only refer to a chemical structure but may also concern an assumed causal relationship ([Dar-Nimrod & Heine, 2011](#)): “If the [engineered] genes are present, the outcome is expected” ([Dar-Nimrod & Heine, 2011](#), p. 802). However, we agree that seeing genetic engineering as a universal solution for social issues may stem from a biased perception of genetic influences ([Dar-Nimrod & Heine, 2011](#)). Nonetheless, we argue for the fundamental action-guiding effect of *assumed* technological capacities in interaction with what is *believed* to indicate a “perfect” woman/man. If people know that a child was designed in (dis)accordance with gender stereotypes, they are likely to respond to whether the designed human fulfills their (irrational) expectations. Gender and genetic essentialism are not meant to be philosophically sound. Instead, they are heuristic but consequential ways of explaining the variations within human gendered behavior ([Dar-Nimrod & Heine, 2011](#); [Saguy et al., 2021](#)). Once the information is inscribed, it can serve as the basis for stereotypes, rendering everybody who lacks the respective genes or, where the genes fail to manifest in behavior, a “bad” representation of their assigned gender. This directly evokes the problematic notion of “good” and “bad” genes (see [Carbon, 2021](#)) and emphasizes the enterprise to create children whose behavior aligns with what is “naturally” expected (see [Ellemers, 2018](#)).

If successfully manipulated, the child’s genetic code is shaped according to an external standard that values or devalues particular genes. If the gender-related attitudes of parents prenatally guide their behavior ([Browne, 2017](#); [Jack, 2020](#)), decisions in the genetic design process heavily depend on *parental* convictions about gender. The biological features do not merely inform parental expectations, but the expectations form the biological features. Similar to sex selection ([Hendl, 2017](#)) but far more radical, using genetic engineering in the way proposed in this paper may constrain the children’s participation in its gender development. Even if it never leads to tangible differences, genetic engineering is the unidirectional manifestation of parental expectations before birth. In that sense, the embryo cannot enact gender because it is unable to act: Gender is enacted upon it. Thus, enacting the Good-GH attunes a part of physical reality to social norms. In opposition, Eman-GH-children’s adaptation may necessitate questioning one’s stereotypes and possibly attuning them to physical reality. Inscribing the specific attitude toward these gendered ideals renders the child’s DNA an affirmative or dismantling embodiment of the stereotype content. Suppose the manipulated embryonic genes manifest in behavioral and psychological differences that match stereotype content. If so, Good-GH children do not only embody but also enact gender stereotypes. A self-experienced alignment between individual attributes and gender stereotypes can reinforce identification with one’s gender and subsequently inform in-group perception ([Tobin et al., 2010](#)). The same experience was associated with beneficial individual outcomes but can also negatively influence opposing gender interactions (C. L. [Martin, Andrews, et al., 2017](#)). However, it may also be possible that children who reliably disconfirm stereotypes develop a more relaxed understanding of gender categories ([Tobin et al., 2010](#)). If these children become parents, their attitudes can then be transmitted within their families ([Davis & Greenstein, 2009](#)).

This hints toward an intricate relationship between self-perception, stereotypes, and child-related preferences. As one of the anonymous peer-reviewers did, one could argue that parents are more interested in designing a child that corresponds to *their* characteristics rather than being aligned with some external standards. For instance, when adopting a child, parental decisions can be influenced by the desire to pick a child of the same race as theirs ([Ishizawa & Kubo, 2014](#)). Moreover, parents are motivated to impart their personally held values to their children ([Barni et al., 2017](#)). Noteworthy parental, benevolent sexist convictions predicted the extent to which they propagated values that entailed a traditional perspective on gender relations ([Barni et al.,](#)

⁶ Of course, there may be parents who are totally against the idea of genetically modifying their children.

2022). This adds to the findings that gender-relevant attitudes and self-perceptions are transmitted within a family (Antoniucci et al., 2023; Moen et al., 1997; Tenenbaum & Leaper, 2002). Possible reasons for these effects span from imitation learning over confirmation demands to genetic causes (Antoniucci et al., 2023) but should also be seen in light of the moderating influence of individual experiences and societal gender emancipation (Moen et al., 1997). In line with our working hypothesis A1, parents could elevate their qualities to a decision-guiding normative standard meant to ensure a good life. However, even if normative gender stereotypes may draw an exaggerated picture that does not necessarily correspond to how people describe themselves (Renström, 2024), parents are still confronted with the same gendered expectations as their future children. Hence, what they experience as important is not independent of societal forces. In that sense, the decision to design children with high similarity to oneself may still be influenced by stereotypes and converge with what is expected under the Good-GH or Eman-GH. Of course, there are normative frameworks other than gender to which the child can be adapted to. However, the point is that by being able to influence the children's characteristics, parents are urged to make critical decisions that align with some individual and social understanding of "right" and "wrong." The ubiquitous confrontation with the normative implications of gender (Butler, 1988; Saguy et al., 2021) makes it difficult to argue why this pivotal feature should not play at least some role when people are asked to design their perfect child.

Humans tend to generalize information about single individuals to validate and potentially change group evaluation (McIntyre et al., 2016). Eman-GH and Good-GH intuitively capitalize on this psychological phenomenon. Moreover, they are informed by a perceived present or desired future statistical norm of gender-associated features. The perceived statistical norm influences moral evaluation, so "normal" cases are perceived as more acceptable (Lindström et al., 2018; Martín et al., 2023). On a broader scale, empirical differences in performed social roles and activities are explained by assuming gender-related differences between the occupying individuals (Hoffman & Hurst, 1990). Hence, the success of both strategies may also depend on whether the intervention inclines/enables engineered individuals to enact (counter-)stereotypical roles.

However, the underlying dynamics can render once suitable alterations maladaptive (Döbler & Carbon, 2024). If the statistical norm changes, offspring created following the Good-GH may display gender-divergent features and may be more likely to experience the negative consequences initially meant to be prevented. At the same time, responding flexibly to contingent demands may be key to capitalizing upon the benefits of combining typical male and female traits (C. L. Martin, Cook, & Andrews, 2017). Designing children in a way that constricts their behavioral repertoire may yield the same maladaptive rigidity that could also characterize stereotype-conforming Good-GH children (see C. L. Martin, Cook, & Andrews, 2017). Evaluating this maladaptive genome against one that would be more adaptive could render the initial design "obsolete" (Sparrow, 2019, p. 7). According to Sparrow, this can have negative consequences for the child and demonstrates that dynamic developments put high pressure upon individuals to keep their genome 'up-to-date.' However, full support for related concerns presupposes viewing human behavior as significantly genetically predetermined (Resnik & Vorhaus, 2006).

Ascribing sufficient causality to our genes may tempt us to view engineering them as an alleged shortcut for social and individual issues (Dar-Nimrod & Heine, 2011). Following one of the proposed strategies further builds upon the action-guiding power of normative stereotypes. This may not only influence the behavior of the designing authority but also shape how children evaluate themselves and are evaluated by others. However, it is still unclear how design decisions will manifest. Having established a guiding theoretical framework, we will now address this issue by investigating whether the Good-GH or the Eman-GH dominates when people are allowed to create their perfect child.

3. The present study

Working hypothesis A1 suggests that people attune their behavior to normative convictions when designing their perfect child. Working hypothesis A2 adds that normative gender stereotypes are a critical source for these convictions. However, parents may have conflicting opinions on whether following (Good-GH) or dismantling (Eman-GH) these stereotypes is more beneficial. Because they are highly gender-specific (Koenig, 2018; Prentice & Carranza, 2002), our primary focus will concern the enactment of personality and talent-related stereotypes. For that purpose, we will empirically test whether the distribution of designed features of "perfect" children affirms or disconfirms present normative gender stereotypes.

4. Methods

4.1. Origin of the data: The exhibit

When discussing the hypothetical impact of genetic engineering, we inevitably face the problem of technological and ethical feasibility. We circumvented this issue by extracting existing data from an interactive exhibit about genetically designing perfect children, located in the "Deutsches Museum Nürnberg – Das Zukunftsmuseum." (Nuremberg, Germany - <https://www.deutsches-museum.de/en/nuernberg>). Across the museum, exhibits are meant to educate visitors about hypothetical future scenarios and disruptive technologies. Visitors can interactively explore the functioning of gene editing technologies like CRISPR/Cas9, be the human counterpart in a Turing test, or learn about concepts for space colonies. The museum recommends a minimum age of 12 years for visitors.

The exhibit is an interactive, physical screen in the "Body and Mind" section. The default language is German but can be switched to English. The English description of the exhibit reads: "Create your perfect child! You have €250,000 at your disposal. Weigh up which aspects are particularly important to you." (Perfect child = "Wunschkind. Literal translation: "wished-for-child"). At the introductory screen, visitors are told that "genetic scissors" (German: "Genschere") can be used to purposefully interfere with the genome, either by removing, disabling, or altering specific genes. After starting the program, visitors can manipulate randomly preset features of their virtual child. During the whole manipulation process the child is depicted as a toddler (Fig. 1).

Although the technology is not mentioned directly, the term "genetic scissors" refers to the pop-science description of CRISPR/Cas9. Moreover, some screens educate visitors about the genetic foundation of manipulatable features. In that sense, the mechanism of the intervention was reliably communicated. Behind the exhibit is another station where visitors can learn about the biotechnological "cutting" mechanism of CRISPR/Cas9.

4.2. Procedure

The authors were not involved in the programming of the exhibit. The first possible choice concerns gender. This feature is indicated via a plush toy lion, either with the male mane or without (female). The next screen concerns a possible manipulation of skin, hair, and eye color. Hereafter, removing or adding pre-existing genetic disease dispositions is possible. Then, five alterable personality dimensions are presented and briefly described. These traits closely follow the Big-5 personality model (see Costa Jr. & McCrae, 1992). Visitors could then manipulate traits framed as talents. They were told that besides genetics, social features and parental style are important influences, so not every talent will be used later in life. Fig. 1 shows a procedural overview, additional information and how personality dimensions were described to the visitor. After the manipulation, visitors are informed about the other visitors' most frequent choices (not grouped by children's gender). Visitors then see an animation of their child growing up. They are told

that different environmental processes influence the child's character in a way not predictable by genetic engineering alone. The exhibit briefly describes the child's life, with comments on their personality, appearance satisfaction, or if their designed talents have been manifested. Completing the exhibit takes approximately 2–10 min.

All children are initiated with randomized features. Changing one feature costs a fixed amount of money, independent of the range of change. Hence, eliminating a predisposition costs the same as manifesting it, and maximizing a feature is similarly as costly as minimizing it. Gender, predispositions, appearance, personality, and talent expression are confined to pre-determined probabilities (see Fig. 1 for the assumed distributions). An extremely high or low feature expression is only possible by monetary investment. Emphasizing the prospect of designing features above the norm, manipulation possibilities of traits and talents are presented on a slider scale ranging from 100 % to 100 % (−1; +1 in the data). Visitors can always navigate backward to revert a made change.

4.3. Obtained data

Written permission to use the data was granted by the museum. The university ethics committee further approved the data analysis. The retrieved dataset comprised $N = 13,643$ complete engagements with the exhibit, resulting in the same number of virtual children. The date range of extracted data was June 4th, 2021, to May 11th, 2022. During this period, anyone locally present in the museum could interact with the exhibit. The exhibit does not ask for personal information about the participants. Hence, we have no sociodemographic information about the people who used it. This may also minimize social desirability effects. We cannot determine if persons who engaged with the exhibit did so only once and cannot clarify if people were genuine museum visitors or employees, etc.

There were irregularities with the first two data points, both created on June 4th, 2021. Here, the value of the virtual slider that determined the RGB-color value of skin, hair, and eye color seemed to have used a different scale. For instance, an initial slider value of 0.4 created a skin color visually similar to what was represented as 0.92 among other children. These first two children were excluded from further analysis because we cannot ensure whether the other scales were also affected.

The third and fourth children were created on June 29th, 2021, with the following data collected on July 20th, 2021. We have no information on what caused the gap in the data. There is no evidence that they were created by a different data-generating process. 3.03 % ($n = 413$) of the children showed no alteration. It is conceivable that these children reflect a non-attentive engagement with the exhibit. However, it is also possible that the alterable features were irrelevant enough for the visitors or that they genuinely did not want to genetically engineer their children. The lack of background information calls for caution but does not justify the exclusion of specific data points, apart from the irregularities mentioned. The final dataset comprises $N = 13,641$ virtual babies designed by an unknown number of people. The supplement features additional information about the data preparation process.

4.4. Terminology

We will refer to values randomly assigned by the exhibit as $feature_N$, where N stands for “natural,” and those chosen by the visitors as $feature_C$ (C = choice). If nothing was changed, $feature_C$ is equal to $feature_N$.

In the default German description, openness [Offenheit], agreeableness [Verträglichkeit], and conscientiousness [Gewissenhaftigkeit] directly refer to the German translation of the respective Big 5 dimensions. Sociality [Geselligkeit] and sensibility [Sensibilität] do not have a semantic equivalent. The description of the traits suggests a close association with extraversion [Extraversion] and neuroticism [Neurotizismus]. Although not perfect representations, predictions will orient at this understanding.

The English setting of the exhibit asked to pick the child's sex. However, in the German settings, the first screen just asked to pick the *Geschlecht*, which is the translation for “sex” and “gender.” In the following, we will exclusively use the term gender. Apart from preventing a potentially confusing shift in terminology, where sex becomes gender after the first screen, this is because the matter of stereotypes and parental expectations closely tie reproductive organs to gender attributions (Browne, 2017). Given that a female/male plush toy indicated the child's sex and the prevalence of normative gender stereotypes about toys (e.g., Koenig, 2018), the exhibit reflects the connection between sex selection and gender stereotypes (see Browne, 2017). Even an essentialistic argumentation that refers to genetic sex differences usually merges biological and non-biological variables, thus evoking *gender essentialism* (Browne, 2017; Dar-Nimrod & Heine, 2011). The exhibit described potential choices as male [männlich] or female [weiblich]. We will retain this wording to describe the depicted child's gender and not use the more age-appropriate boy/girl distinction.

$gender_N$, as presented to the visitor on the first screen, can be *random Male* or *random Female*. Purposefully choosing a gender will result in $gender_C = Female/Male$. Visitors can also maintain the randomly initiated gender ($gender_C = gender_N$). For further differentiation, we include information about the gender selection decision. Hence, $gender_C$ is either *Male* (M), *Female* (F), *random male* (rM), or *random female* (rF). We will refer to these groups with their acronyms if not stated otherwise. If subsumed as the final gender, we will write out female/male with no further reference. We call children whose gender has been chosen deliberately *DGC* (Deliberately gendered children— M/F) and those whose $gender_N$ was maintained *RGC* (Randomly gendered children — rM/rF).

4.5. Methodological considerations

The present study draws from existing data gathered in a field setting. Because we were not involved in the exhibit's design, we could not influence confounding variables, participant selection/engagement, exhibit programming, etc. Nonetheless, we believe that the overall setting and the data size are suitable for assessing the action-guiding power of stereotypes and the hypothesized behavioral patterns. Even if only evoked virtually, the dogma of parental care and associated benign motivations should outnumber data of visitors who do not sincerely act upon their beliefs or did not engage earnestly. Regardless of size and certainty, any reported effects must be verified in a more controlled setting.

The framing of the exhibit is believed to have overruled skepticism if the presented features are indeed linked to genetic variation. Visitors were further left to believe that their manipulations would reliably change the features of their virtual child. Only after completing the exhibit were they told about the possible influence of environmental factors. Hence, assessing the motivating function of stereotypes is possible by analyzing the visitor's declaration of intention, i.e., the manipulations they hoped to manifest in their “perfect” child.

Starting at 18 months of age, humans increasingly obtain gender stereotype knowledge (Miller et al., 2006). So, we can reasonably assume that visitors had at least some stereotype knowledge.

4.6. Predictions

Both hypotheses predict a discernible effect of the chosen gender on the $feature_C$ distribution. Moreover, pre- and proscriptions should manifest in increased likeness to increase or decrease feature values. Table 1 contains respective predictions and exemplary literature references. Predictions were based on linking manipulatable features to the literature. While physically appearing in concurrence with one's assigned gender is among the most dominant stereotypes (Koenig, 2018), we refrained from assessing these factors due to the limited manipulation possibilities of the exhibit in this regard. The supplement

Table 1
Predictions.

		Predictions under:					
		Good-Gender Hypothesis (Good-GH)			Emancipating-Gender Hypothesis (Eman-GH)		
		Predicted differences	Change	Example evidence	Predicted differences	Change	Example evidence
	Gender distribution	No preference		Balanced preference for boys and girls in Germany (Carol & Hank, 2020)	No preference		Balanced preference for boys and girls in Germany (Carol & Hank, 2020)
	Money spent on all features	No prediction	–	Too little variation in cost; inconclusive evidence regarding gender-dependent spending behavior and limited generalizability to the given context	No prediction	–	Too little variation in cost; inconclusive evidence regarding gender-dependent spending behavior and limited generalizability to the given context
Appearance	Predispositions	Females > Males	Males are more likely to be relieved of predispositions	Parental dogma of being a good parent (Working hypothesis A1), but also male proscription not to be weak (Prentice & Carranza, 2002)	No difference		Parental dogma of being a good parent (Working hypothesis A1)
	Personality			Not in focus due to limited manipulation possibilities			
	Sensibility	Females > Males	Female values increased, male values reduced	Male proscription/ female prescription to be emotional (e.g., Rudman, Moss-Racusin, Phelan, & Nauts, 2012)	Females = Males	Female values reduced, no increase for males	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000)
	Sociality	Females < Males	No change in female values, increase in males	Agency proscribed for males, no female proscription per se (e.g., Bosson et al., 2022)	Females = Males	More increase for females, male values maintained	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000)
	Openness	No prediction for both		No differences in desirability found (Prentice & Carranza, 2002)	No prediction for both		No differences in desirability found (Prentice & Carranza, 2002)
	Agreeableness	Females > Males	Female values increased, male values reduced	Communality prescriptive for females (Bosson et al., 2022), males get punished for being overly agreeable (Judge et al., 2012)	Females >/= Males	Reduction for females and an increase for males	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000), but also status neutral and thus possibly less important (Rudman, Moss-Racusin, Phelan, & Nauts, 2012)
	Conscientiousness	Females < Males	Female values maintained, increase for male values	Facets linked to traits proscribed for males, not proscribed for females (Prentice & Carranza, 2002)	Females = Males	Increase for females, no overly decrease for males	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000)
Talents	Intelligence	Females < Males	Female values maintained, increase for male values	Male prescription to be intelligent, no female proscription (Koenig, 2018)	Females = Males	Increase for females and males	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000)
	Sportiness	Females < Males	Female values maintained, increase for male values	Male prescription, no female proscription (Prentice & Carranza, 2002)	Females = Males	Female values increased, less importance for males	Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000)
	Creativity	Difference exists	No prediction	Creativity less important for males than females (Prentice & Carranza, 2002) but associated with male-prescribed agency (Proudfoot et al., 2015)	No difference		Alignment of female and male stereotypes by attuning females to male stereotypes (Diekman & Eagly, 2000) but unclear stereotype direction.
	Musicality	No prediction for both		Musical ability linked to being psychologically androgynous (Kemp, 1985)	No prediction for both		Musical ability linked to being psychologically androgynous (Kemp, 1985)

Note. Example reference denotes one or two references that informed our prediction-building process. A comprehensive discussion of how predictions were justified can be found in the supplement.

contains a detailed rationale about prediction justification, which is not included here due to its extensive length. The direction of predictions concerns the final gender. However, to get a more nuanced perspective on the data and prevent overgeneralization, we will evaluate each prediction also concerning whether children’s randomly assigned gender was maintained or picked deliberately.

Good-GH-specific predictions were based on evidence of the existence of specific pre- and proscriptive gender stereotypes (e.g., Bosson et al., 2022; Koenig, 2018; Prentice & Carranza, 2002; Rudman, Moss-Racusin, Phelan, & Nauts, 2012). Predictions for the Eman-GH were mainly informed by Diekman and Eagly (2000), who assessed participants’ beliefs about gender stereotypes in the future (2050 CE). Results

indicated an alignment trend in stereotype content, mainly driven by females assumed to acquire male traits. This study is not ideal, as it merely measured descriptive stereotypes and reported various effects. Nonetheless, we used it for broad orientation. Still, together with cross-cultural, favorable opinions toward a more gender-equal society (International Women’s Day, 2019: Global Attitudes toward Gender Equality, 2019), and the more utopian vision of so-called "postgenderism" (Hughes & Dvorsky, 2008, p. 2), the Eman-GH predicts an alignment of features.

Predictions of the Eman-GH are meant as counterparts to the Good-GH and must be understood relative to the identified stereotypes and gender comparisons. Extrapolating the propositions of Diekman and

Exhibit overview

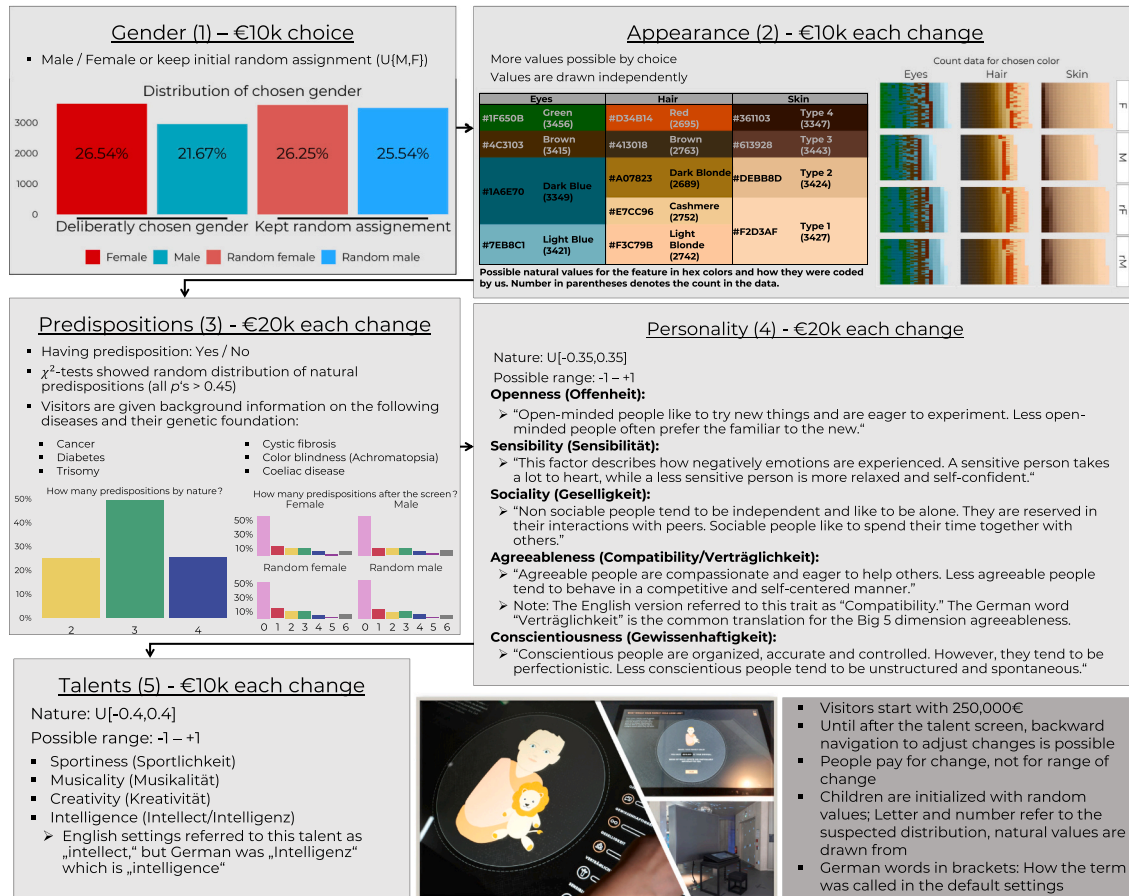


Fig. 1. Sequence of exhibit screens with additional information. Picture of the exhibit copyright: Deutsches Museum Nürnberg, Christian Illing.

Eagly (2000) about female stereotypes aligning with male ones and not vice versa, we propose the following exemplary mechanism: If the Good-GH predicts higher male values for sociality, driven by a one-sided increase due to the respective prescription, the Eman-GH predicts that a balance is driven by an attunement of female values to a level formerly only desirable for males. Eman-GH-related effects on the decision to increase or decrease a feature must be seen in the context of change and range of change. A higher likelihood to increase a feature does not tell us anything about the manifested level of feature_C. Hence, we must also consider the final designed values. Here, the Eman-GH predicts their manifestation in a way that counteracts stereotypes, while the Good-GH predicts their maintenance.

People may design their children in a way that does not endorse stereotypes yet reverts their content (e.g., more sensible males instead of equal levels). If results disconfirm the predictions of the Good-GH, this is not necessarily evidence of the Eman-GH.

5. Data analysis

We used the *brms* (Bürkner, 2017) package for R to calculate Bayesian regression models. Models ran for four chains with 10,000 iterations each (5000 warmup draws). Priors for predictor coefficients were uniformly set to be $N(0,1)$. Other settings retained the *brms* default.

For each personality and talent variable, we proceeded as follows: Employing multinomial logistic regression, we first modeled whether

the chosen value differed from the randomly assigned one and in which direction the change occurred (Decreased/No Change/Increased). Chosen gender and feature_N value were set as predictors. To control for budgeting effects, we included the proportion of money available on the respective screen as an additional predictor. To test possible differences, we also modeled interaction terms between the chosen gender and the other predictors.

The number of disease predispositions was modeled using an ordered logistic regression with the number of natural dispositions, the proportion of money available, and their interactions with chosen gender as predictors. Using logistic regression, we also modeled the decision to change a predisposition. Predictors were whether the disposition was present, proportion of money available, and the interactions with chosen gender.

Visual inspection of the data revealed that feature distribution did not follow a normal distribution but showed evident density bumps at the extrema (Supplement). To assess the range of change and eventually test for evidence of the dominance of one of the proposed strategies, we employed zero-one-inflated beta regression (ZOIB) to predict feature_C and the proportion of money spent. Instead of just a measure of central tendency, this method allows for modeling the entire distribution of the outcome (Heiss, 2021; Kneib et al., 2023). This method also accounts for 0 s and 1 s in the data by assuming that these values do not stem from beta but from two additional logistic distributions. That way, ZOIB combines three statistical models: one beta regression and two logistic regressions. Each model consists of the shape parameter of the beta

distribution (Mean: μ – logit scale; Precision: φ – log scale) and values that describe the zero-one-inflation (zoi: logit scale; coi: logit scale). We can use the latter two to estimate the proportion of zero-one-inflated values (zoi; $\frac{0|1}{All}$), the conditional proportion of these values being one (coi; $\frac{1}{0|1}$) and the percentage of $\frac{0}{All}$ or $\frac{1}{All}$. For a detailed explanation, we refer to two highly educative blog posts that served as primary instruction for this method and our explanation here (see Heiss, 2021; Vuorre, 2019). To suit the outcome to the beta regression, we rescaled feature_C values from -1 to +1 to 0–1. For interpretability, we reverted the rescaling to the values displayed at the exhibit. Because people paid for change, not range of change, assessing feature_C, gender_C was the single predictor for each parameter (μ , φ , zoi & coi).

Although one could interpret not changing feature_N as a legitimate expression of a desired value, including this data would mean introducing purely random and computational variance to the Feature_C. Moreover, detailed insights into the visitors' decision-making process are impossible. Thus, we do not know if the decision to maintain feature_N stems from not caring about this feature, inattention, or satisfaction. Hence, single ZOIB models for the five personality traits and four talents used only data from children whose features were modified and thus created more “actively” (Table 2). These values will be called designed values.

For the multinomial regression and ZOIB models, children with no money left when entering the respective screen were excluded ($n = 20$ for talents, $n = 0$ for all other screens).

Figs. 2 to 7 show the graphical analysis of the expected value of the posterior predictive distribution and the predictors' resulting average marginal component effect (see Heiss, 2023; McElreath, 2020). These distributions are created by building a counterfactual dataset with selected predictor values, feeding it into the fitted model, drawing from the resulting posterior, and then calculating the average of these draws (Heiss, 2022). This was done by the functions *epred_draws* and *compare_levels* from the R-package *tidybayes* (Kay, 2023). The latter calculates marginal effects by subtracting the averaged posterior draws of each group.

6. Results

Analysis of variance showed that neither initially assigned personality values nor talent values differed across Gender_C or Gender_N (all p 's $\geq 0.16/0.25$ – see Supplement).

6.1. Gender distribution

Gender_C is displayed in Fig. 1 and Table 3. Deviating from our predictions, visitors displayed a preference for female children (Final gender: 47.2 % male, 52.8 % female), $\chi^2(1) = 42.45$, $p < 0.001$. Considering the uniform distribution of gender_N (49.3 % rM, 50.7 % rF), $\chi^2(1) = 2.73$, $p = 0.098$, this difference was due to an imbalance within the 6576 (48.2 %) children whose gender has been deliberately chosen. (44.95 % M, 55.05 % F, $\chi^2(1) = 67.04$, $p < 0.001$). To determine the role of initiated gender on gender change, we ran a Bayesian logistic regression. The predictor was Gender_N, prior: $N(0,1)$. Gender_N = rM predicted a change of gender, i.e., a deliberately chosen female child ($OR = 1.30$, Credible Interval_{95%} (CI): 1.20–1.41, probability of direction (pd) = 100 %).⁷

As visible in Table 3, some visitors picked the final gender their baby was already initiated with. The child's gender was displayed by a plush toy lion, either with a typical male mane (male) or without (female). The mane disappeared when visitors switched gender, which rendered the meaning of the toy visible. Still, this depiction may have led to confusion

and identification difficulties. Visitors may not have understood that their choice was obsolete. Visitors may also have wrongfully assumed that the gender will be reassigned after the screen. In that case, selecting F while being assigned rF may display a safety strategy to ensure gender preference.

6.2. Disease predispositions and spent money

Results are shown in detail in the supplement. Having a predisposition was the best predictor for the decision to change (remove) it. For all gender, these effects were the strongest for diseases that may be commonly associated with severity, like cancer, cystic fibrosis, and trisomy. Across all diseases, M children were more likely to be given a predisposition than their F counterparts. This and other findings do not support the Good-GH, which predicts that males are more likely to be relieved of their predispositions due to proscribed weakness (see Prence & Carranza, 2002).

6.3. Personality traits and talents

Fig. 2 shows the results of the multinomial logistic regression on decision probability for personality traits and talent values. Fig. 3 and Fig. 4 show the respective marginal effects. These figures allow us to assess the presence and strength of pro- and prescriptions. Fig. 5 and Fig. 6 show the expected differences in the posterior predictive distribution as predicted by the Zero-one-inflated beta regression. Fig. 7 shows the expected total proportion of extreme values. These figures are meant to display the strength of stereotypes and relative gender effects. More detailed information on all regression coefficients and figures in large resolution can be found in the supplement or the OSF. Our models reveal an effect of the chosen gender on decision probability and designed feature values. The direction, strength, and certainty of effects shifted along the lines of the gender selection process and feature.

We found a consistent negative relationship between the probability of increasing a feature and its natural values. This was often matched by a positive relationship between the probability of maintaining or decreasing features and their natural values. Decision probabilities also depended on feature and available money. Concerning the differences among female and male children whose gender had been picked deliberately (DGC), differences in decision probability never fully supported the Good-GH's predictions, except for sportiness. Within this group and other features, we, nonetheless, found evidence for the predicted proscriptive male decrease but not the female prescriptive increase (e.g., sensibility, agreeableness). Predictions of the Eman-GH were also never fully supported among the DGC. If at all, values of F children were more likely to be maintained rather than increased (except for creativity, musicality, and, to some extent intelligence). The inconclusive and relatively uncertain differences among the DGC within the decision to manipulate intelligence and conscientiousness partially contradict the predictions of both hypotheses. Decision differences between randomly gendered children (RGC) were far less pronounced but failed to support one hypothesis comprehensively. Not evident differences in the decision probability to manipulate intelligence are in line with the prediction of the Eman-GH, while some of the effects concerning sensibility manipulation cautiously point toward the direction of the Good-GH.

When comparing DGC children with their RGC-opposite-gender-counterpart, an effect of available money on the decision to maintain and increase a value became evident. At higher budgets the DGC values were more likely to be increased. This difference shifted when fewer resources were available. This suggests that not spending money on gender is correlated with other factors (e.g., inattention, general frugality) that yield fewer changes.

With respect to the expected differences in designed values, differences among the DGC supported the Good-GH concerning sportiness, creativity, sensibility, and, to a certain extent, agreeableness. No evident differences between DGC in sociality, conscientiousness, and, to some

⁷ Probability of direction (pd) refers to the proportion of the coefficients posterior sharing the same algebraic sign as the median (Makowski, Ben-Shachar, Chen, & Lüdtke, 2019).

Table 2
Number and percentage of children whose values were changed.

		Female (3620)	Male (2956)	Random female (3581)	Random male (3484)	n in ZOIB
Personality	Agreeableness	2458 (67.90 %)	2134 (72.19 %)	2162 (60.37 %)	2112 (60.62 %)	8866
	Conscientiousness	2595 (71.69 %)	2231 (75.47 %)	2325 (64.93 %)	2218 (63.66 %)	9369
	Openness	2646 (73.09 %)	2262 (76.52 %)	2316 (64.67 %)	2260 (64.87 %)	9484
	Sensibility	2267 (62.62 %)	1983 (67.08 %)	1973 (55.10 %)	1936 (55.57 %)	8159
Talents	Sociality	2574 (71.10 %)	2265 (76.62 %)	2245 (62.69 %)	2199 (63.12 %)	9283
	Creativity	2747 (75.88 %)	2261 (76.49 %)	2465 (68.84 %)	2476 (71.07 %)	9949
	Intelligence	2865 (79.14 %)	2394 (80.99 %)	2762 (77.13 %)	2716 (77.96 %)	10,737
	Musicality	2475 (68.37 %)	2088 (70.64 %)	2216 (61.88 %)	2204 (63.26 %)	8983
	Sportiness	2780 (76.80 %)	2403 (81.29 %)	2520 (70.37 %)	2505 (71.90 %)	10,208

Note. ZOIB models that predicted differences between chosen personality and talent values only used children whose values were changed (n in ZOIB). Percentages refer to proportions within the gender group. ZOIB = Zero-one-inflated beta regression. Number behind gender refers to total number in data.

Predicted probability for change decision: Personality (A-E) and talents (F-I)

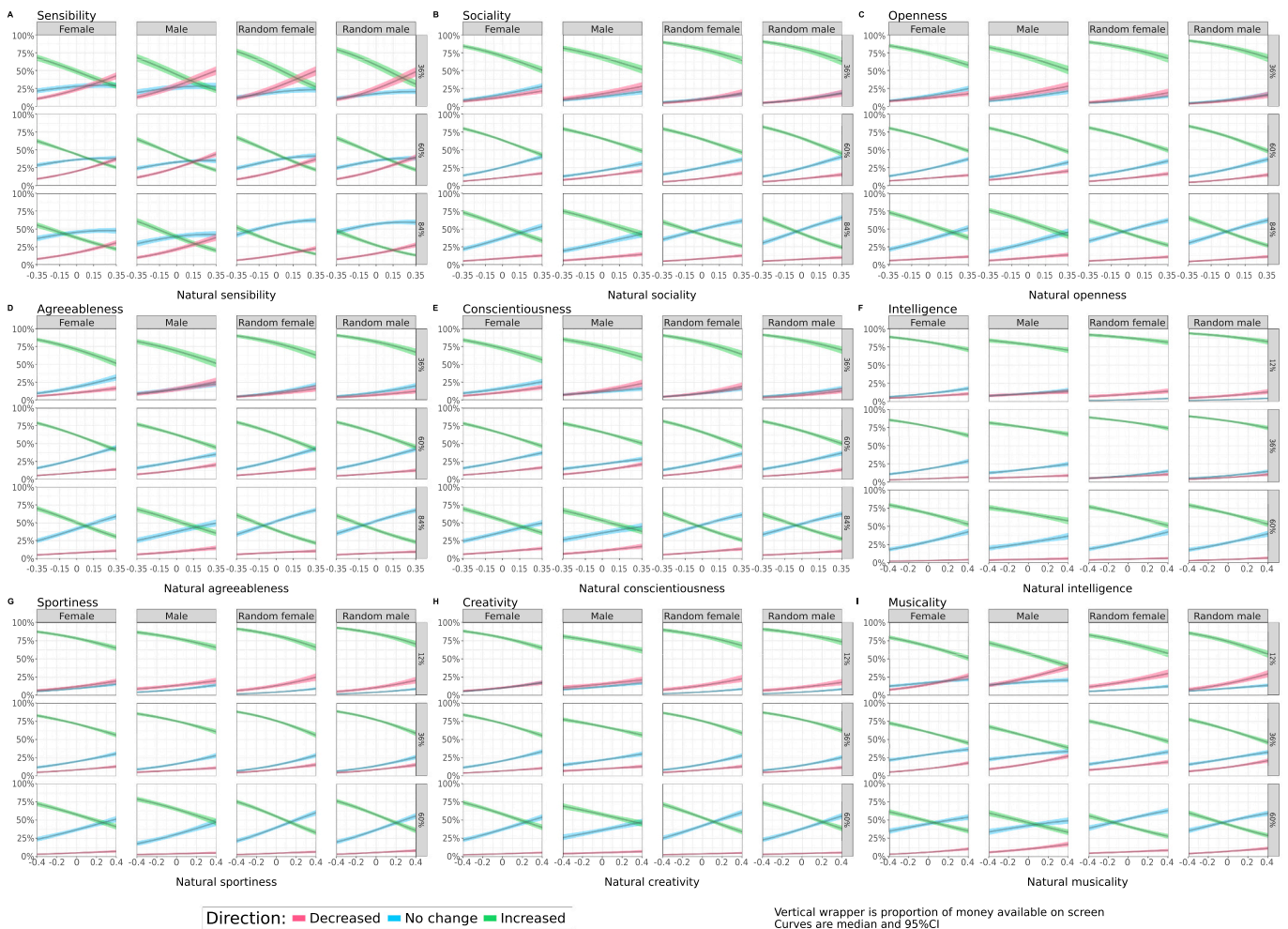


Fig. 2. Decision probability for personality traits and talents. X-axis is the natural value as randomly initiated by the exhibit. Y-axis is probability. Each colored lineribbon refers to the probability curve of the change direction (Median and 95 % credible interval). Horizontal wrappers are the chosen gender, vertical ones are exemplary proportions of money on the screen. Their values were chosen based on the data’s predictor range and frequency. Model coefficients and the figure in large resolution are on the OSF. Panels indicate features.

extent, intelligence falsified the Good-GH and supported the predictions of the Eman-GH. Interestingly, differences within these features among the RGC and between rF and M children leaned toward the Good-GH. Some designed differences among RGC contradicted the Good-GH and seemed to support (sportiness) or contradict (agreeableness) the Eman-GH.

Concerning extreme values, visitors preferred feature maximization

over minimization. Chosen gender again modulated these effects. The highest proportion of extreme values, in general, and minimized and maximized ones, in particular, were often found in M children.

6.4. Assessing evidence

Even the most certain differences in designed values were arguably

Marginal effect of chosen gender on change decision: Personality

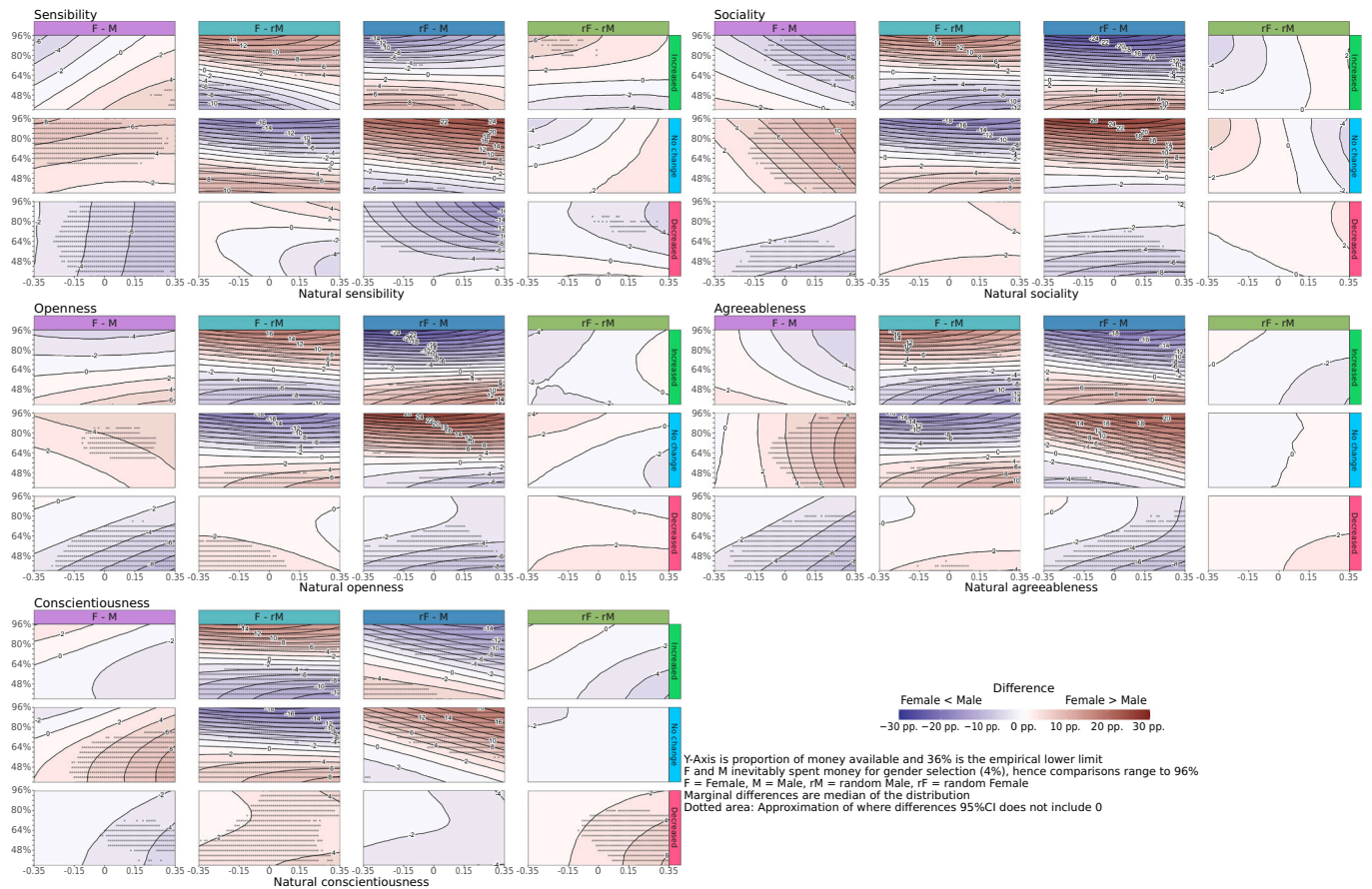


Fig. 3. Marginal effects of chosen gender on decision probability for changing personality traits (see Fig. 2). Pp. = percentage points. All comparisons, the used median, credible intervals, and additional comparisons between the same gender and the figure in large resolution can be found in the OSF. Y-axis is available money on the screen. X-axis is the natural value as randomly initiated by the exhibit. Contours and numbers within the figure are differences in decision probability for the decision (horizontal wrapper). Comparisons are made so that positive numbers (reddish) indicate a higher probability for F or rF children compared to M/rM children, while blueish contours and negative numbers indicate higher probabilities for M/rM children. For each predictor combination, several samples were drawn from the posterior. These were aggregated and examined whether the 95 % credible interval contains zero. If not, this predictor combination is marked by a dot. This is a more conservative way to assess certainty because all other possible intervals are treated similarly although they express a different degree of certainty. Panels indicate features.

small. To better understand their meaningfulness, Bayes factors (BF) were calculated to assess evidence for a) any difference and b) predicted direction of the Good-GH over distributions that assumed no differences. The Eman-GH implies that the median and mean of the difference distribution is 0. However, the standard deviation of a respective distribution is unclear. Using the *bayestestR* package (Makowski, Ben-Shachar, & Lüdtke, 2019) and orientating at the suggested procedure (Makowski, Ben-Shachar, Chen, & Lüdtke, 2019), BF was calculated as follows: Employing different SD-magnitudes, we specified a so-called *Region Of Practical Equivalence* (ROPE = $\pm 1/2 SD$). This is the region in which a difference is seen as trivial. We then calculated the ratio between the predicted difference distributions of our models in the area outside the ROPE and the respective area for the assumed difference Eman-GH distribution. Therefore, a BF of 3 means that the odds that the predicted distribution of differences contains a value outside ROPE is three times as large as for the Eman-GH distribution of comparison (for more detail, see Makowski, Ben-Shachar, & Lüdtke, 2019). Findings are shown in Fig. 8, where two ROPE specifications are displayed: Either symmetrically in every direction (evidence for any difference) or reflecting the Good-GH prediction. Here, ROPE ranges from infinity to one or two standard deviations in the direction of prediction. Evidence against the Good-GH does not automatically mean evidence for the Eman-GH. This would only be the case if the found difference is ~ 0 and,

direction wise, does not oppose the hypotheses predictions (e.g., F/rM differences in intelligence).

As shown in Fig. 8, our results partially support the Good-GH. However, the strength of the evidence is conditional on the assumed characteristics of comparison distribution and the gender selection process. The clearest evidence for the Good-GH among all groups is found within sensibility, and the strongest evidence in terms of the Bayes factor was within F/M differences in sportiness.

7. Discussion

This study analyzed data from a museum context to evaluate potential strategies when designing a “perfect” child. It was hypothesized that people who can genetically design their perfect (virtual) child do so with benign motivations relative to present normative convictions. The dominating behavior to eliminate genetic disease disposition supports this working hypothesis A1 and the idea that a “perfect” child should live a healthy, i.e., good life (see Bondas & Eriksson, 2001).

However, normative convictions also pertain to gender-related attributes (Koenig, 2018). Against the consequential and action-guiding backdrop of normative gender stereotypes, we proposed the dominance of one of two main strategies. One comprises the attempt to enact contemporary normative gender stereotypes to minimize friction and

Marginal effect of chosen gender on change decision: Talents

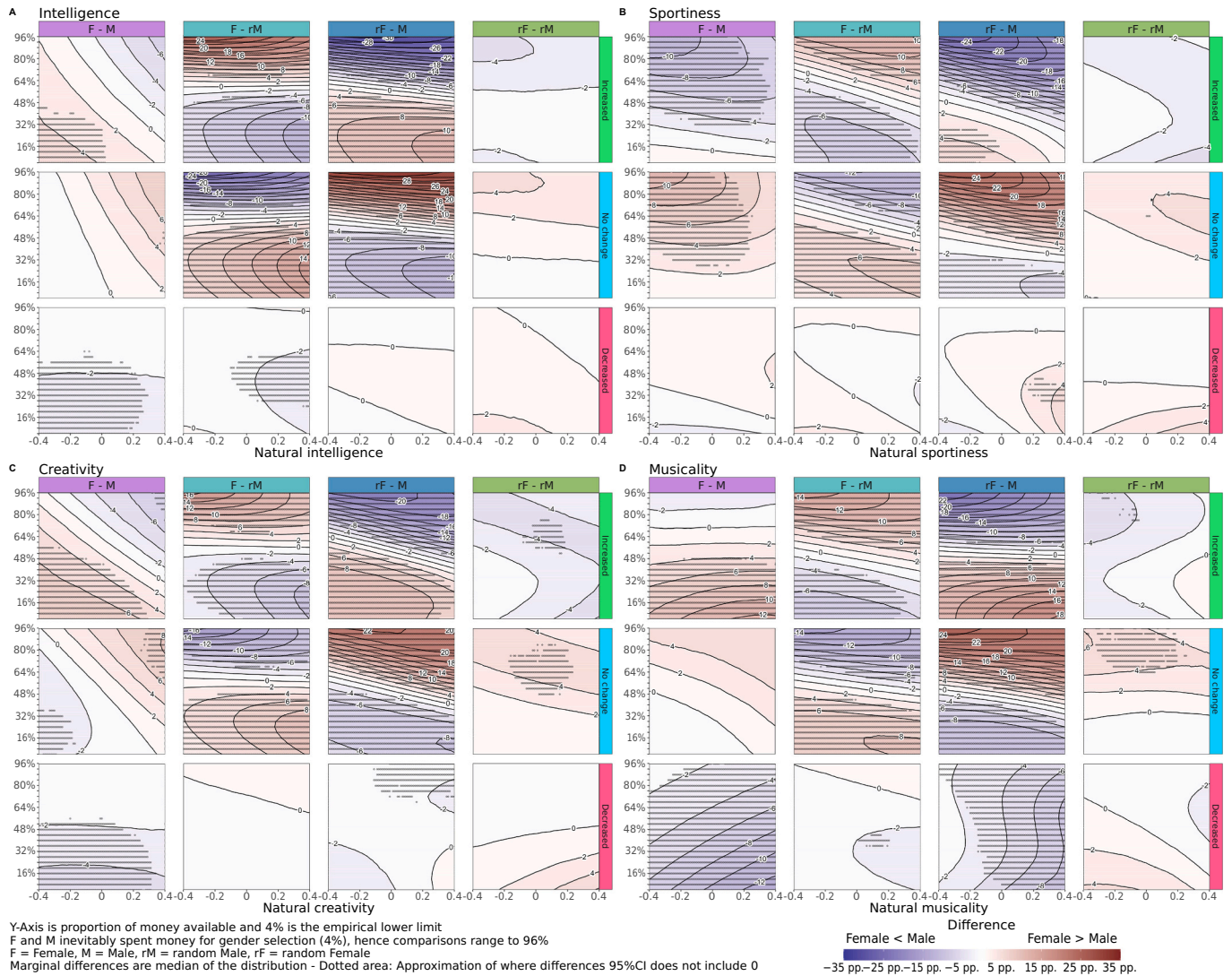


Fig. 4. Marginal effects of chosen gender on decision probability for changing talents (see Fig. 2). Pp. = percentage points. For all comparisons, the used median, credible intervals, and additional comparisons between the same gender and the figure in large resolution can be found in the OSF. Y-axis is available money on the screen. X-axis is the natural value as randomly initiated by the exhibit. Contours and numbers within the figure are differences in decision probability for the decision (horizontal wrapper). Comparisons are made so that positive numbers (reddish) indicate a higher probability for F or rF children compared to M/rM children, while blueish contours and negative numbers indicate higher probabilities for M/rM children. For each predictor combination, several samples were drawn from the posterior. These were aggregated and examined as to whether the 95 % credible interval contains zero. If not, this predictor combination is marked by a dot. This is a more conservative way to assess certainty because all other possible intervals are treated similarly although they express a different degree of certainty. Panels indicate features.

potential negative consequences for their child (see Rudman, Moss-Racusin, Glick, & Phelan, 2012). This adapts one’s child directly to the environment and creates “good boys/girls” (Good-Gender Hypothesis - Good-GH). Drawing on a study by Diekmann and Eagly (2000) that showed that gender stereotypes of males and females are predicted to align in an egalitarian way and the idea that biotechnology can ease oppressive gender relations (Hughes & Dvorsky, 2008), we also suggested that people may try to adapt the environment through an adaptation of their children into a more gender egalitarian direction (Emancipating-Gender Hypothesis – Eman-GH). Although we could not assess visitors’ motivation directly, their design behavior led to data patterns that partially aligned with both hypotheses’ predictions. Thus, our findings suggest that people may at least partially orient on a present gender-related value structure when designing their perfect child. Evidence that differed across features was dependent on the gender

selection process, i.e., designing the child deliberately as Male/Female (DGC: M/F) or maintaining the randomly assigned gender (RGC: random Male/random Female — rM/rF). However, ambiguous effects hinder a decisive interpretation. The following discussion will focus on those findings that allow for a clearer interpretation and on differences between children whose gender has been picked deliberately. This is not meant to withhold equivocalities but to provide the first step for future research in more controlled settings.

While possible values for all features ranged from -1 to 1, expected values across all features grouped at the positive side of the scale. Relative to the largest differences possible (± 2), marginal effects were small. This is not an inevitable contradiction since the Good-GH and Eman-GH predict relative rather than absolute differences. Moreover, people paid for change and not for range. Hence, there was no economic reason not to maximize a specific value. This supports the

Personality: Marginal effects of gender on expected posterior values and their extreme values

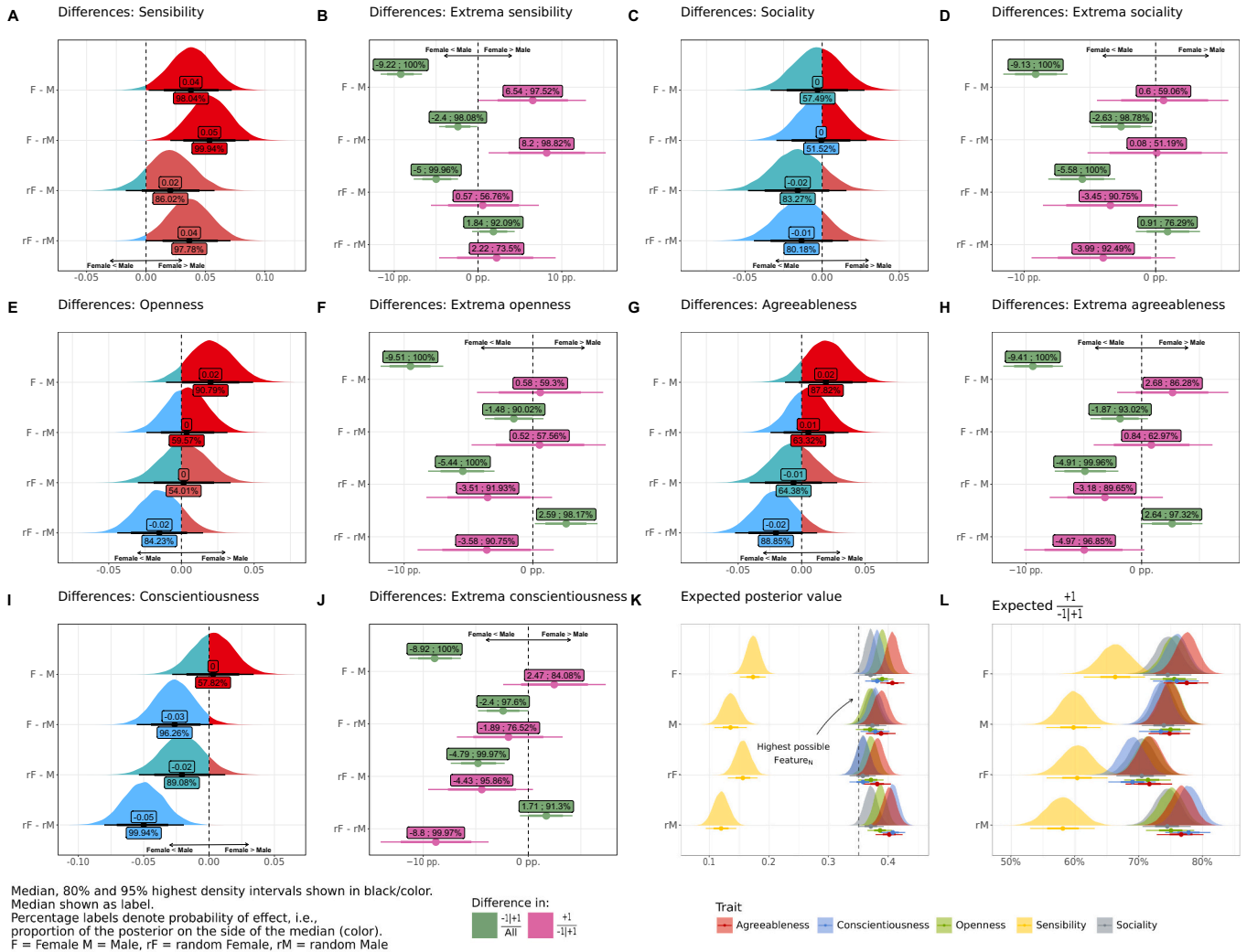


Fig. 5. X-Axis in panel A – J: Comparisons, each structured so that blueish color indicates higher values for M/rM children and reddish ones indicate higher values for F/rF children. X-axis in panels K – L refers to chosen gender. Panels entitled “Differences: [Feature]” are the marginal differences in expected posterior value across gender. Values underlying these comparisons are seen in panel K. Panels entitled “Differences: Extrema [Feature]” are marginal differences in the proportion of extreme values (Green) and conditional proportion of extreme positive ones (pink, see also panel L). All distributions show the median (dot and label in panel A - J) and 80/95 % credible intervals (thick and thin line). See the OSF for detailed comparisons and the large-resolution figure. Model coefficients are in the supplement. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

meaningfulness of identifiable differences.

Greater differences were found concerning the proportion of extreme M and F values. For instance, within designed creativity and intelligence, M children’s values surpassed F ones by around ten and twelve percentage points, respectively. As noted by one of the anonymous peer-reviewers, this aligns with the so-called *variability hypothesis*. The basic idea is that the distribution of psychological characteristics among males tends to be more diverse and potentially more extreme than among females (Shields, 1982). Meta-analyses found no conclusive or strong evidence for the hypothesis concerning general creativity (Taylor et al., 2024) and intelligence (Giofrè et al., 2022). If proven effective, genetic engineering could influence any feature distribution and create a hypothesized effect that nature could not provide.

7.1. Personality: Sensibility

As predicted by the Good-GH, M children’s sensibility was more likely to be decreased than those of F counterparts. However, opposing our predictions, F values were likelier to be maintained and not likelier

to be increased. Nonetheless, we attribute these differences to the prescription for females to express emotions and be compassionate and the proscription for males to be emotional (e.g., Koenig, 2018; Prentice & Carranza, 2002). Consistent with general findings (e.g., Koenig, 2018), the male proscription seemed stronger than the female prescriptions. Sensibility was the only feature in which all gender differences among designed values pointed toward the predicted direction and thus provided clear support for the Good-GH.

Designed and maximized values of sensibility were the lowest of all features. This hints toward a specific devaluation of associated qualities. However, this and the findings on gender-specific effects do not mean that sensibility, in general, is seen as unfavorable (see Prentice & Carranza, 2002). While a rise in sensibility_N consistently increased the probability of decreasing it, low natural values also predicted an increase. Note that similar to gender (A. E. Martin & Mason, 2022), showing emotions is a critical aspect of being seen as human (Phillips, 2022). This may support the parental dogma hypothesis of creating favorable outcomes for their child. An overly accentuated sensibility may render the child more emotionally vulnerable, while

Talents: Marginal effects of gender on expected posterior values and their extreme values

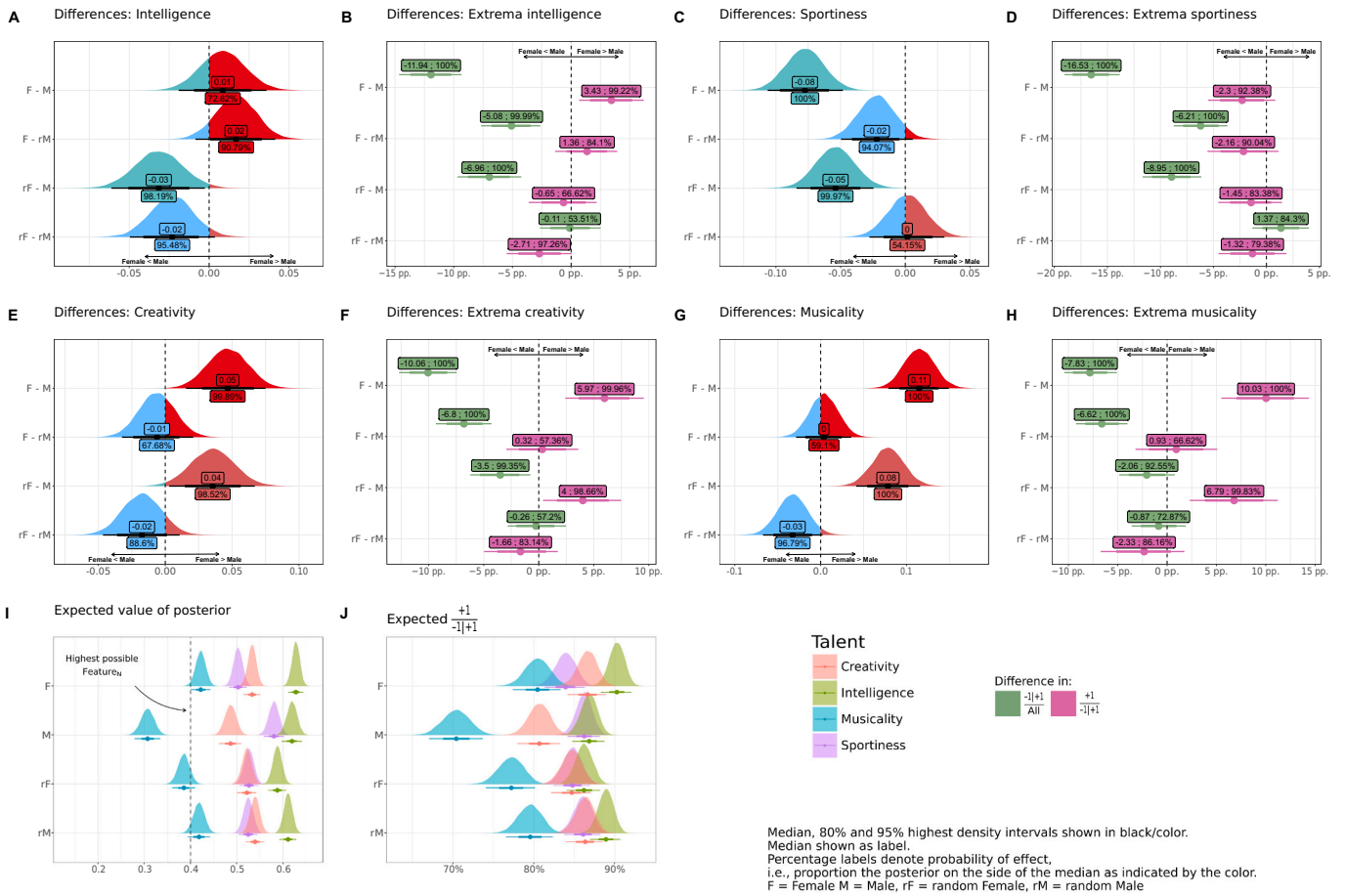


Fig. 6. X-Axis in panel A – H: Comparisons, each structured so that blueish color indicates higher values for M/rM children and reddish ones indicate higher values for F/rF children. X-axis in panels I – J refers to chosen gender. Panels entitled “Differences: [Feature]” are the marginal differences in expected posterior value across gender. Values underlying these comparisons are seen in panel I. Panels entitled “Differences: Extrema [Feature]” are marginal differences in the proportion of extreme values (Green) and conditional proportion of extreme positive ones (pink, see also panel J). All distributions show the median (dot and label in panel A - H) and 80/95 % credible intervals (thick and thin line). See the OSF for detailed comparisons and the large-resolution figure. Model coefficients are in the supplement. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

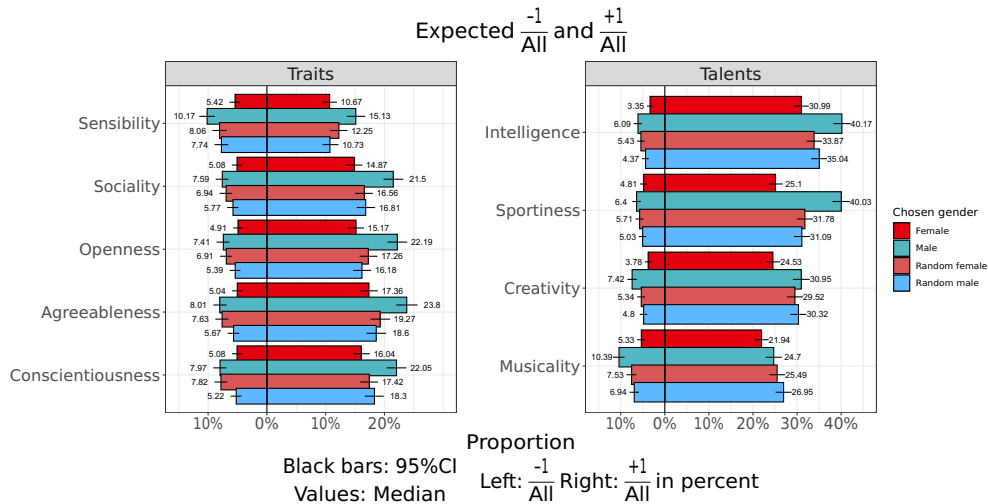


Fig. 7. Proportion of minimized (left) and maximized (right) values relative to all designed values for each feature. See OSF for detailed values and the large-resolution figure.

Table 3
Overview of frequency of natural and chosen gender.

	Natural gender		Overall (N = 13,641)
	Random female (n = 6917)	Random male (n = 6724)	
	Chosen gender		
Female	1823 (26.4 %)	1797 (26.7 %)	3620 (26.5 %)
Random female	3581 (51.8 %)	0 (0 %)	3581 (26.3 %)
Male	1513 (21.9 %)	1443 (21.5 %)	2956 (21.7 %)
Random male	0 (0 %)	3484 (51.8 %)	3484 (25.5 %)
Gender changed to opposite?			
Yes	1513 (21.9 %)	1797 (26.7 %)	3310 (24.3 %)
No	5404 (78.1 %)	4927 (73.3 %)	10,331 (75.7 %)

Note. If the chosen gender is random female/male, the natural gender was maintained, and no money was spent on gender selection.

underdeveloped emotional capabilities may deprive the child of valuable experiences. Despite the many children with extreme values, the general understanding of personality traits may be positive. Still, extreme expression may be associated with more clinical phenomena like personality disorders or accentuations and are thus incompatible with a “perfect” child.

However, previous research showed that people see emotional capabilities as a key component of personal identity and are less willing to manipulate identity-constituting features within themselves or their child (Riis et al., 2008; Wagner et al., 2018). This could explain why

sensibility was the trait least likely to be changed.

7.2. Personality: Sociality

We linked sociality to extraversion, agency, and the normative expectations for males to showcase assertiveness, dominance, no shyness, independence, and general agency (Bossion et al., 2022; Doey et al., 2014; Koenig, 2018; Rudman, Moss-Racusin, Phelan, & Nauts, 2012). Still, comparisons among DGC suggested little to no differences. Conditional marginal effects on decision probability partially supported a male prescription but also yielded ambiguous results inconsistent with our predictions. Found evidence favoring the Good-GH may be due to the assumed properties of the comparison distribution rather than meaningful differences. Assuming no differences aligns with what is expected under the Eman-GH and may clarify findings by Prentice and Carranza (2002), who found no gender-specific desirability differences in showing extroversion.

Apart from supporting the Eman-GH, non-evident differences among the DGC may be explained by an ambiguous understanding of “sociality.” When formulating our predictions, we acknowledged that traits associated with this term could be similarly desired for males and females. However, we decided that the link to agency justifies assuming a male prescription (Supplement). Yet, psychometric facets of extraversion are named *warmth* and *positive emotions* (Costa Jr. & McCrae, 1992), qualities that can be linked to female prescriptions concerning displaying warmth, wholesomeness, and cheerfulness (Prentice & Carranza, 2002). Moreover, being overly social could undermine the male prescription of assertiveness. This would render decreasing male sociality values a sufficient strategy under the Good-GH. This would also explain

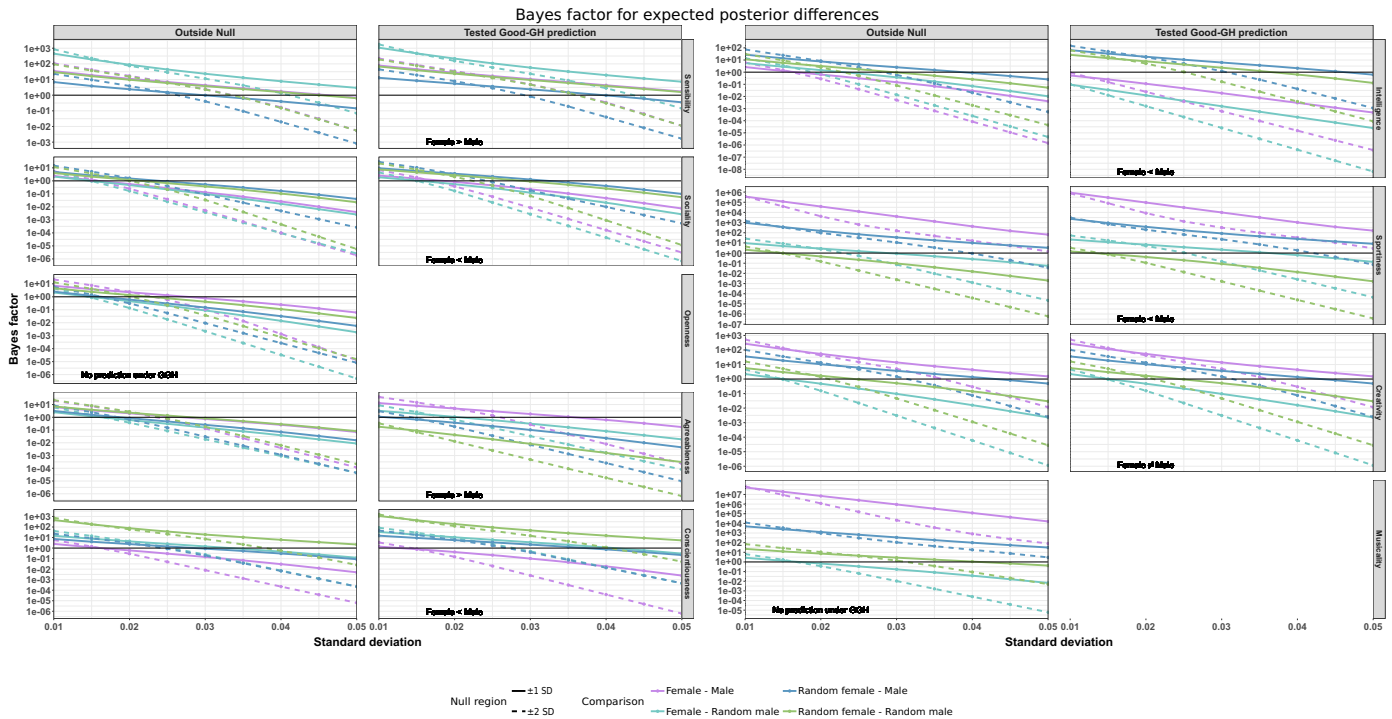


Fig. 8. Y-axis: Bayes factor (calculated on a logarithmic scale; translated for readability). X-axis: used standard deviation for comparison distribution. Comparison distribution was always $N(0, SD)$. Between columns defined, ROPE changed and was either non-directed (Outside Null) or directed (Evidence for Good-GH prediction). In the latter case, ROPE ranged from $-\infty$ to 1 (solid line) to 2 (dashed line) SD or $1/2$ SD to ∞ , depending on predicted direction. In cases where the Good-GH did not make any predictions, we refrained from showing the same graph twice. Exception: “Creativity” to highlight that the Good-GH assumed unspecific differences. A file with all values and additional comparisons between the same gender and the figure in large resolution can be found in the supplement and the OSF. Given that a distribution of $N(0,0.01)$ is very narrow, comparison with the predicted difference distribution still yields evidence even though the probability of effect is uncertain and small (e.g., sociality).

why M children's sociality was partially more likely to be decreased and increased and why the proportion of extreme values is highest among M children. More research is needed to determine how people understand "sociality" concerning normative gender stereotypes. Subsequent results could also clarify to what extent we may have over- or underweighted existing stereotypes.

7.3. Personality: Openness

Building on previous findings that, for example, suggested no differences in normative open-mindedness (Prentice & Carranza, 2002), none of the hypotheses yielded any prediction on openness. Differences suggest a trend toward more open F than M children, which may be driven by a male proscription.

7.4. Personality agreeableness

Partially concurring with findings on the female prescription to be communal (e.g., Bosson et al., 2022; Koenig, 2018), results suggest a trend for less agreeable M children than F children. An interpretation favoring the Good-GH is also supported by probability differences, which indicate that among DGC, M children's agreeableness was conditionally more likely to be decreased. Yet, agreeableness for F children was maintained rather than increased. Expected differences among the RGC pointed in the opposite direction and were thus inconsistent with the predictions of both hypotheses.

7.5. Personality: Conscientiousness

Linking psychometric facets of conscientiousness (e.g., being achievement focused) to male prescriptions like being ambitious (see Costa Jr. & McCrae, 1992; Rudman, Moss-Racusin, Phelan, & Nauts, 2012), our models found little evidence for the predicted male increase. Although we also found no conclusive evidence for the Eman-GH prediction that female values will be increased, the non-existing F/M differences may support the idea that female mental profiles approximate male ones (see Diekmann & Eagly, 2000). However, all other gender differences seemed to support the Good-GH.

7.6. Talents: Intelligence

Only differences in designed values among the rF and rM supported the Good-GH's prediction that males ought to be more intelligent (e.g., Koenig, 2018). Found differences in decision probability and expected differences among DRC counteract the Good-GH and partially supported the Eman-GH.

Concerning intelligence, models yielded the greatest proportion of maximized children and the highest predicted values. Intelligence is often implicitly and explicitly linked to achievement and performative excellence, so associated skills are highly desirable in Western societies (Cocodia, 2014; Sternberg & Grigorenko, 2004). Although less prescriptive for females, it is desired for all gender (Prentice & Carranza, 2002). Thus, high designed intelligence may reflect Savulescu's (2001) proposition that this feature is pivotally beneficial for future children and human well-being. Nonetheless, there were some gender differences. M children showed the highest absolute proportion of maximized and minimized children. Possibly, visitors found amusement in creating a not-very-intelligent child. But it remains unclear why this was more pronounced for M than F children.

7.7. Talents: Sportiness

Besides the found evidence within designed values and decision probability for the Good-GH among DGC, Sportiness was the only feature where extreme M children were likelier to have maximized values than F ones. Moreover, expected sportiness values and the total

proportion of maximized children among M matched the respective intelligence values. M children were the only group where sportiness and not intelligence was the most modified feature. Alongside effects in sensibility, differences in sportiness among the DGC provided the strongest evidence for the Good-GH. The stereotype of highly valued male and moderately valued female athleticism (Prentice & Carranza, 2002) is enforced.

7.8. Talents: Creativity

Probably driven by the decision to rather decrease M children's creativity_N and increase the values of F counterparts, the latter children were designed to be more creative. This aligns with the observation that creativity is not as important for males as it is for females (Prentice & Carranza, 2002) while challenging the notion that creativity is a male prescription due to its connotation with traits indicating agency (see Proudfoot et al., 2015). The DGC-related insight may be used to adjust the prediction of the Good-GH from unspecific differences in creativity toward the expectation that females ought to be more creative than males, which is driven by a mixture of pre- and proscriptions.

7.9. Talents: Musicality

Relative to other talents, musicality seemed devalued among M children. The overall trend of decreasing this talent at higher levels was especially pronounced for M children. Nonetheless, F children were more likely to get an increase, contributing to the evident differences in expected value. Neither Good-GH nor Eman-GH made any predictions regarding musicality. Recent evidence suggests that being musical is equally desired for men and women (Hudson & Ghani, 2024). Yet, our findings may hint toward the presence of normative gender stereotypes and urge further inquiry if musicality is as psychologically androgynous as suggested (see Kemp, 1985).

7.10. Critically evaluating Eman-GH and Good-GH for future research

The setting from which we extracted our data constrains the certainty with which we can generally affirm or discard our hypotheses. Due to ambiguous findings and differences contradicting both hypotheses, we now critically revisit our predictions and modeling choices and make suggestions for future research in more controlled settings.

Since our findings are limited in mapping individual motivation, explanations and motivational concerns other than those suggested by the Good-GH and Eman-GH must be considered. Our working hypothesis A1 should be a good starting point for deriving gender-unrelated normative reference frames that can influence design behavior.

Assuming that differences emerged based on gender, we hypothesized that our predictions would hold regardless of the gender selection process. Yet, differences among the children whose randomly assigned gender was retained often pointed in the opposite direction than differences among children with deliberately chosen gender (e.g., creativity, musicality, intelligence, openness). The former differences were often more uncertain, less pronounced but sometimes supported an opposite hypothesis. Files on the OSF feature marginal effects between M and rM as well as F and rF. Found differences within the same final gender suggest that the gender selection process played a greater role than initially hypothesized and emphasize the need for further research concerning the salience of gender in the design process.

The deliberate choice for one over the other gender prevents identification difficulties and may render associated stereotypes more available. From a Good-GH perspective, this may explain why gender differences were more pronounced among DGC than RGCs. One could further argue that the deliberate decision for one gender indicates a particular emphasis on gender in general. In this case, the following design process may orient more toward a gender-specific value structure than if gender is randomly assigned. Recall how desired child qualities

can shift after sex revelation (Imhoff & Hoffmann, 2023). This may suggest that people who opted for deliberate gender choice may design a perfect *gendered* child. In contrast, people who retain the random assignment may be more concerned about a perfect child regardless of gender. However, although differences among RGC were small and sometimes relatively uncertain, they often tended toward higher values for rM children. Future study settings could address this issue by shifting the gender selection process to the end of the procedure or eliminating it altogether. Additionally, information on the importance or prevalence of stereotypes may also be manipulated.

The study by Imhoff and Hoffmann (2023) did not show a relevant shift in mothers' attitudes following the revelation of their child's sex. The authors discuss this by referring to research on gender-dependent stereotype strength influencing the evaluation of fathers. However, they point out that there was no interaction effect on preferred qualities with gender attitudes in general. Nonetheless, we should contemplate the possible influence of the visitor's gender, age, and psychometric traits (e.g., essentialistic beliefs, self-concept, stereotype endorsement, attitudes toward genetic engineering, and personality). Since we have no information about the visitors, we cannot confirm whether personal characteristics yielded more pronounced enforcement or dismantling of stereotypes. Hence, we must postpone any related inquiry to future research.

One anonymous peer-reviewer noted that the initial instruction to "Create your perfect child!" could have been understood as a request for designing a perfect child in terms of what is *generally* and not individually associated with this term. However, a task-reminding question heading all screens of the exhibit read: "What would your perfect child look like?" ["Wie sieht dein Wunschkind aus?"]. The German word "Wunschkind" can be translated as "wished-for-child" and has a strong individual connotation. When designing a general "perfect" child, values should align with whatever feature expression is generally desired. This may yield no differences and thus yield results as predicted by the Eman-GH. Even if stereotypes conjoin both reference frames, future study designs may explicitly vary individualization of the instruction (e.g., personal, societal, other's "perfect" child). Here, one could also manipulate information about the expected societal and evolutionary consequences of one's decision. This could elucidate what societal costs people are willing to bear to ensure the benefit of their child and clarify the moral intricacies of our hypotheses. Researchers could vary the type of cost, e.g., highlighting a maladaptive effect upon genetic or social diversity. To investigate the scope people consider in their decision-making process, consequences may be communicated to occur differently on various scales, such as family, country, or humanity as a whole. Besides focusing on the decisions within the design process, the decision to conduct or reject genetic engineering should also be in focus. The motivations mentioned are likely to influence both decisions.

Abstracting from the concrete motivation of the visitors, we must critically ask if the notion of a gender-egalitarian future propagated by the Eman-GH manifests in the decision to nullify any differences. This inquiry should also question the assumed mechanisms regarding decision probability and the idea that females align with males (see Diekmann & Eagly, 2000). We must also ask if desiring or anticipating a "post-gender future" (Hughes & Dvorsky, 2008) is so prevalent that it can outweigh other design strategies. We suggested that traits that are linked to the current gender hierarchy, i.e., those related to agency and high status (Rudman, Moss-Racusin, Glick, & Phelan, 2012; Rudman, Moss-Racusin, Phelan, & Nauts, 2012) may be an important target for manipulation following the Eman-GH. The uncertain differences in sociality, intelligence, and conscientiousness among DGC support this idea. This interpretation demands further inquiry and is challenged by the finding that among RGC, differences in intelligence and conscientiousness support the Good-GH. These differences also contradict the interpretation that among RGC, Eman-GH-associated processes are at work, while DGC children are designed in closer accordance with what the Good-GH. Future research could explicitly prime participants with a

related goal (maintaining or overcoming stereotypes) and investigate the design outcomes. Reflecting the reality of gender, additional variations could inform people that their child's gender identity may not match the one assigned at birth or will be interpreted fluently by their offspring during different phases of their life. In line with previous findings (e.g., C. L. Martin, Andrews, et al., 2017), designers may also be informed about the potential benefits of a less strict interpretation of gender identity.

Effect sizes by Koenig (2018) suggest that the female prescription for communality is stronger than the male prescriptions to be emotional or showcase weakness. However, our findings provide more evidence for the enforcement of the latter. This is more in line with recent evidence that acting according to existing pre- and proscriptions is seen as more important for males than females (Bosson et al., 2022). Another possible explanation could be that the wording of the exhibit suggested a strong association between sensibility and traits that are proscriptive for males, while features like agreeableness may not have been directly linked to the female communality prescription. This comprehension-hypothesis could also explain the strong differences in sportiness but fails to account for the non-existing differences in intelligence. Because we were not involved in the exhibit's programming, we had to attune our predictions to the pre-defined setting instead of tailoring the study setting to our hypotheses in the most effective way. Even if the hypotheses' general mechanisms are untouched by this, description and selection of manipulatable features in future research should orient heavily on the existing literature to ensure that they match the common understanding of what is expected by males and females. Related efforts should also explore domains that we could not address. Given their relative strength and emphasis on the female body shape (Koenig, 2018), normative expectations regarding gendered appearance should be put in focus. This would allow us to compare designed children with prevailing beauty stereotypes (see Little, 1998).

Apart from group differences, gender and feature-related variation in stereotype strength and importance (Koenig, 2018; Prentice & Carranza, 2002) may have influenced feature manifestation within the same gender. For simplicity reasons and because every feature expression cost the same, we did not consider intra-gender stereotype variation when formulating our predictions. Interpreting designed values related to stereotype strength, approximation of designed sportiness, and intelligence in M children is in line with other studies (e.g., Hudson & Ghani, 2024; Prentice & Carranza, 2002). Although theoretically and methodologically defensible, not including data from people who retained natural value when comparing differences may have resulted in some nuances in the data not being considered. Hypotheses were tested on a macro-scale, which may neglect micro-scale effects. Future research should focus on identifying and comparing sub-groups within children. This may be done using clustering methods like latent profile analysis. Another possibility that would also address stereotype strength would be employing methods that model the feature variance within single children. This way, we could get a more individualized understanding and address the suggested benefits of modest stereotype divergences (Prentice & Carranza, 2002) and psychological androgyny (C. L. Martin, Cook, & Andrews, 2017). Testing the enforcement of pre- and proscriptions may be easier if values are pre-set instead of randomly assigned.

Our suggestions could be addressed in quantitative and qualitative studies. Besides an empirical approach, scholars and the public should comprehensively discuss the potential societal impacts of the Good-GH and Eman-GH. Even if concluding that the phenomena we discussed here are technologically infeasible, this can create insights into how social conventions manifest into physical reality and elucidate the desirability of such processes.

8. Limitations

The most evident limitation is the absence of any information (e.g.,

socio-demographic data, psychometrical, attention checks) about the visitors who engaged with the exhibit. The exhibit was not designed as a psychological experiment. Owing to the ecological setting, we neither know if every child is linked to exactly one visitor nor the average number of children single visitors created. The gamified characteristic of the exhibit in the museum may be a double-edged sword. It inclines engagement but can lead to a shallower, non-earnest, or inattentive engagement with the exhibit. Being primarily fun-orientated or wanting to explore multiple design possibilities are additional factors that may have influenced how people engaged with the exhibit.

The exhibit's programming may not be aligned with how humans make decisions or how economic choices commonly occur (e.g., paying for change, not range of change). Preselection of traits and talents may have influenced how normative stereotypes could be expressed and hindered the certainty of formulated predictions. Effects were often small and ambiguous. Even if predictions did not reflect the found role of the gender selection process, we consider this particular falsification of our hypotheses as an important insight for future research.

There may be various sources of selection bias concerning the composition of people who interact with the exhibit. Although the museum is open to international visitors, we cannot exclude the possibility of a German/Western bias. This extends to many studies we cited when formulating our hypotheses and predictions. Still, gender stereotypes cross-culturally align on the dimensions of prescriptive female community and male agency (Bosson et al., 2022; Kosakowska-Berezecka et al., 2022). An additional source of bias concerns the socio-demographic variables of museum visitors (e.g., Kircheng, 1996), which further confines generalizability.

Selection bias can also stem from local behavior within the museum. People may not have engaged with the exhibit due to being inattentive, distracted, uninterested, bored, and other currently unknown variables. At the level of individual attitudes, uses other than therapeutic ones increase the reluctance to use genetic engineering (e.g., Marteau et al., 1995; Rabino, 2003; Scheufele et al., 2017). Those who reject the notion of designing a perfect child and are generally skeptical of genetic engineering may not appear in the data because they do not engage with or finish the exhibit. Even if we interpret children who were not modified as being related to such an attitude, our findings only elucidate the prioritization process *after* affirming the intervention. They can neither address the public attitude toward human genetic engineering per se nor how this attitude is justified.

Chosen skin color was not included in our models. Given the recent evidence on the relationship between normative gender stereotypes and ethnicity (Hudson & Ghani, 2024), modeling a respective interaction could explain additional variance. This also pertains to stereotype differences based on the target's sexual preferences, ethnicity, and gender (Hudson & Ghani, 2024). Although the former was not communicated to visitors, future research should explore these interactions. This could also elucidate the role of stereotypes beyond the traditional heteronormative male/female boundaries.

The exhibit imposed a traditional male-female binarity of sex and gender onto the visitors. This distinction made it possible to link and analyze the data relative to previous research on normative gender stereotypes but undercuts the rich psychological and medical debate on the accuracy of this binary understanding and its genetic basis (e.g., Hyde et al., 2019). In contexts where gender is conceptualized as more diverse, the generalizability of our analysis is limited. This also pertains to the beliefs of the visitors about the accuracy of gender as binary.

9. Conclusion

We presented a comprehensive theoretical discussion on the relationship between biotechnology and action-guiding stereotypes. We further pointed out potential consequences and behavioral strategies that emerge from this relationship. Our results support the idea that people will genetically engineer their children according to good

intentions. They also provide evidence for the hypothesis that genetic engineering will be embedded into a given socio-material context in which contemporary normative gender stereotypes influence the task of designing a "perfect child." Revealed evidence supports the possibility that this may happen by strategically imposing the respective content on offspring to minimize potential negative consequences of stereotype violation. At the same time, findings also support the idea that people may use transformative biotechnology to dismantle stereotypes. Although being an initial step into a promising field, evident limitations within the data-generating setting and the absence of psychometric data hinder a definitive conclusion regarding these hypotheses' extent and precise character. Further research in more controlled settings and additional theoretical work are needed.

The fact that some of our results could be considered controversial underscores the importance of educational facilities like the one we obtained the data from. Not only because people are given a learning opportunity but also because policy decisions can be mutually informed by the scientific analysis of data gathered within these more informal settings. Even if discarding the widespread feasibility of targeted human genetic engineering, our findings contribute to the present corpus on normative gender stereotypes and elucidate their action-guiding effect. How people *would* use genetic engineering provides crucial insights into the enactment of gender and the role attributed to biotechnology in the gendered performance.

Following the action-guiding rules of normative gender stereotypes can self-fulfillingly lead to the empirical manifestation of their content (Ellemers, 2018), which then solidifies the belief in the presence of some gender "essence" (Butler, 1988). This was highlighted concerning gender-specific adaptations of the environment (Saguy et al., 2021; Sutfin et al., 2008), but may also apply to more controversial adaptations of children. Positive correlations between self- and external ratings with descriptive stereotypes suggest partial veracity of gender stereotypes about personality (Löckenhoff et al., 2014). Under the presumption of technological feasibility, our findings provide initial evidence that genetic engineering of children could solidify this correlation and extend it to other qualities. However, gender stereotypes could also be unverified by the biotechnological alteration and societal reception of genetic reality. In both cases, the alleged imperishable essence of our identity is subjected to deliberate manipulation. Thus, genetic engineering has the potential to technologically enforce the essentialist notion of gender while also dismantling its foundation.

CRedit authorship contribution statement

NAD: Conceptualization; Hypotheses; Data analysis; Figure preparation; Writing original draft; Writing revision **CCC:** Conceptualization; Supervision; Writing - Review & Editing.

Ethics statement

This study was reviewed and approved by the Ethics Committee of the University of Bamberg, Germany (Dossier number 2023-07/31).

Funding

No funding involved.

Declaration of competing interest

The authors have no competing interest to declare.

Acknowledgments

We thank the *Deutsches Museum Nürnberg – Das Zukunftsmuseum* for their open-minded and helpful cooperation. Many thanks to Jasmin Della Guardia for helping prepare the dataset. Special thanks to Dr.

Alexander “Sasha” Pastukhov for methodological advice and Don Watson and Marlene Compton for their proofreading. NAD wants to thank Thomas Kollmann and Jonah Lutz for their philosophical input and Dorothee Busch for her emotional support. Many thanks to the anonymous reviewers for their constructive and valuable feedback.

Appendix A. Supplementary data

The supplement contains additional information about the data and its preparation. Further resources are files with the model coefficients and detailed information about the marginal effects. It can also be found at the OSF: <https://osf.io/5g3rf/> – DOI 10.17605/OSF.IO/5G3RF. There, we also provide access to all figures. Supplementary data to this article can be found online at <https://doi.org/10.1016/j.actpsy.2025.104748>.

Data availability

Given the agreement of our cooperation partner, data will be made available upon reasonable request. This decision was made due to ongoing research and data sharing policy of the museum. After our projects have finished, data is likely to be made public. Requests for validation of published findings or those under review will always be accepted for this purpose alone. Permission to analyze the presented data was kindly granted by the *Deutsches Museum Nürnberg – Das Zukunftsmuseum*, Nuremberg, Germany.

References

- Abrejo, F. G., Shaikh, B. T., & Rizvi, N. (2009). ‘And they kill me, only because I am a girl’... a review of sex-selective abortions in South Asia. *The European Journal of Contraception & Reproductive Health Care*, 14(1), 10–16. <https://doi.org/10.1080/13625180802518231>
- Abreu, R. L., Rosenkrantz, D. E., Ryser-Oatman, J. T., Rostosky, S. S., & Riggle, E. D. B. (2019). Parental reactions to transgender and gender diverse children: A literature review. *Journal of GLBT Family Studies*, 15(5), 461–485. <https://doi.org/10.1080/1550428X.2019.1656132>
- Alanko, K., Santtila, P., Salo, B., Jern, P., Johansson, A., & Sandnabba, N. K. (2011). Testing causal models of the relationship between childhood gender atypical behaviour and parent–child relationship. *British Journal of Developmental Psychology*, 29(2), 214–233. <https://doi.org/10.1348/2044-835X.002004>
- Antonucci, C., Portengen, C., & Endendijk, J. J. (2023). Like parent, like child: General and specific associations between Parents’ and Children’s binary gender identity in a gender egalitarian context. *Sex Roles*, 88(5–6), 225–239. <https://doi.org/10.1007/s11199-023-01356-y>
- Banazadeh, M., Abiri, A., Poortaheri, M. M., Asnaashari, L., Langarizadeh, M. A., & Forootanfar, H. (2024). Unexplored power of CRISPR-Cas9 in neuroscience, a multi-OMICs review. *International Journal of Biological Macromolecules*, 263, Article 130413. <https://doi.org/10.1016/j.ijbiomac.2024.130413>
- Barni, D., Fiorilli, C., Romano, L., Zagrean, I., Alfieri, S., & Russo, C. (2022). Gender prejudice within the family: The relation between Parents’ sexism and their socialization values. *Frontiers in Psychology*, 13, Article 846016. <https://doi.org/10.3389/fpsyg.2022.846016>
- Barni, D., Ranieri, S., Donato, S., Tagliabue, S., & Scabini, E. (2017). Personal and family sources of Parents’ socialization values: A multilevel study. *Avances En Psicología Latinoamericana*, 35(1), 9. <https://doi.org/10.12804/revistas.urosario.edu.co/apl/a.3468>
- Blondeel, K., Vasconcelos, S., García-Moreno, C., Stephenson, R., Temmerman, M., & Toskin, I. (2018). Violence motivated by perception of sexual orientation and gender identity: A systematic review. *Bulletin of the World Health Organization*, 96(1), 29–41. <https://doi.org/10.2471/BLT.17.197251>
- Bondas, T., & Eriksson, K. (2001). Women’s lived experiences of pregnancy: A tapestry of joy and suffering. *Qualitative Health Research*, 11(6), 824–840. <https://doi.org/10.1177/104973201129119415>
- Bosson, J. K., Wilkerson, M., Kosakowska-Berezecka, N., Jurek, P., & Olech, M. (2022). Harder won and easier lost? Testing the double standard in gender rules in 62 countries. *Sex Roles*, 87(1–2), 1–19. <https://doi.org/10.1007/s11199-022-01297-y>
- Bostrom, N. (2003). Human genetic enhancements: A transhumanist perspective. *The Journal of Value Inquiry*, 37(4), 493–506.
- Broussard, K. A., & Warner, R. H. (2019). Gender nonconformity is perceived differently for cisgender and transgender targets. *Sex Roles*, 80(7–8), 409–428. <https://doi.org/10.1007/s11199-018-0947-z>
- Browne, T. K. (2017). Why parents should not be told the sex of their fetus. *Journal of Medical Ethics*, 43(1), 5–10. <https://doi.org/10.1136/medethics-2015-102989>
- Buchanan, A. E. (2011). *Beyond humanity?: The ethics of biomedical enhancement*. Press: Oxford Univ.
- Bürkner, P.-C. (2017). Brms: An R package for bayesian multilevel models using Stan. *Journal of Statistical Software*, 80(1). <https://doi.org/10.18637/jss.v080.i01>
- Butler, J. (1988). Performative acts and gender constitution: An essay in phenomenology and feminist theory. *Theatre Journal*, 40(4), 519–531.
- Butnor, A., & MacKenzie, M. (2022). Enactivism and gender performativity. In K. Maitra & J. McWeeny (Eds.), *Feminist philosophy of mind* (1st ed., pp. 190–C10.P77). Oxford University Press New York. doi:<https://doi.org/10.1093/oso/9780190867614.003.0011>.
- Calabrese, C., Ding, J., Millam, B., & Barnett, G. A. (2020). The uproar over gene-edited babies: A semantic network analysis of CRISPR on twitter. *Environmental Communication*, 14(7), 954–970. <https://doi.org/10.1080/17524032.2019.1699135>
- Carbon, C.-C. (2021). Good, bad and ugly genes? Science matters, also in terms of terminology and word usage. *Open. Psychology*, 3(47–49). <https://doi.org/10.1515/psych-2020-0109>
- Carol, S., & Hank, K. (2020). Natives’ and Immigrants’ gender preferences for children in Germany. *European Journal of Population – Revue Européenne de Démographie*, 36(2), 235–246. <https://doi.org/10.1007/s10680-019-09527-y>
- Clemens, V., Berthold, O., Witt, A., Brähler, E., Plener, P. L., & Fegert, J. M. (2020). Childhood adversities and later attitudes towards harmful parenting behaviour including shaking in a German population-based sample. *Child Abuse Review*, 29(3), 269–281. <https://doi.org/10.1002/car.2623>
- Cocodia, E. A. (2014). Cultural perceptions of human intelligence. *Journal of Intelligence*, 2(4), 180–196. <https://doi.org/10.3390/jintelligence2040180>
- Costa, P. T., Jr., & McCrae, R. R. (1992). The five-factor model of personality and its relevance to personality disorders. *Journal of Personality Disorders*, 6(4), 343–359.
- Cunningham, J., Goldsmith, L., & Skirton, H. (2015). The evidence base regarding the experiences of and attitudes to preimplantation genetic diagnosis in prospective parents. *Midwifery*, 31(2), 288–296. <https://doi.org/10.1016/j.midw.2014.09.010>
- Dabb, C., Dryer, R., Brunton, R. J., Yap, K., & Roach, V. J. (2023). Paternal pregnancy-related anxiety: Systematic review of men’s concerns and experiences during their partners’ pregnancies. *Journal of Affective Disorders*, 323, 640–658. <https://doi.org/10.1016/j.jad.2022.11.092>
- Dar-Nimrod, I., & Heine, S. J. (2011). Genetic essentialism: On the deceptive determinism of DNA. *Psychological Bulletin*, 137(5), 800–818. <https://doi.org/10.1037/a0021860>
- Davis, S. N., & Greenstein, T. N. (2009). Gender ideology: Components, predictors, and consequences. *Annual Review of Sociology*, 35(1), 87–105. <https://doi.org/10.1146/annurev-soc-070308-115920>
- Diekmann, A. B., & Eagly, A. H. (2000). Stereotypes as dynamic constructs: Women and men of the past, present, and future. *Personality and Social Psychology Bulletin*, 26(10), 1171–1188. <https://doi.org/10.1177/0146167200262001>
- Döbler, N. A., & Carbon, C.-C. (2024). Adapting ourselves, instead of the environment: An inquiry into human enhancement for function and beyond. *Integrative Psychological and Behavioral Science*, 58(2), 589–637. <https://doi.org/10.1007/s12124-023-09797-6>
- Doey, L., Coplan, R. J., & Kingsbury, M. (2014). Bashful boys and coy girls: A review of gender differences in childhood shyness. *Sex Roles*, 70(7–8), 255–266. <https://doi.org/10.1007/s11199-013-0317-9>
- Dubuc, S., & Coleman, D. (2007). An increase in the sex ratio of births to India-born mothers in England and Wales: Evidence for sex-selective abortion. *Population and Development Review*, 33(2), 383–400. <https://doi.org/10.1111/j.1728-4457.2007.00173.x>
- Eagly, A. H., Nater, C., Miller, D. I., Kaufmann, M., & Sczesny, S. (2020). Gender stereotypes have changed: A cross-temporal meta-analysis of U.S. public opinion polls from 1946 to 2018. *The American Psychologist*, 75(3), 301–315. <https://doi.org/10.1037/amp0000494>
- Ellemers, N. (2018). Gender Stereotypes. *Annual Review of Psychology*, 69, 275–298. <https://doi.org/10.1146/annurev-psych-122216-011719>
- Ellemers, N., & Jetten, J. (2013). The many ways to be marginal in a group. *Personality and Social Psychology Review*, 17(1), 3–21. <https://doi.org/10.1177/1088868312453086>
- Fitzgerald, W. A. (1997). Engineering perfect offspring: Devaluing children and childhood. *Hastings Constitutional Law Quarterly*, 24(4), 833–861.
- Garland-Thomson, R. (2020). How we got to CRISPR: The dilemma of being human. *Perspectives in Biology and Medicine*, 63(1), 28–43. <https://doi.org/10.1353/pbm.2020.0002>
- Giofre, D., Allen, K., Toffalini, E., & Caviola, S. (2022). The impasse on gender differences in intelligence: A Meta-analysis on WISC batteries. *Educational Psychology Review*, 34(4), 2543–2568. <https://doi.org/10.1007/s10648-022-09705-1>
- Habermas, J. (2005). *Die Zukunft der menschlichen Natur: Auf dem Weg zu einer liberalen Eugenik? [The future of human nature: on the road to liberal eugenics?]* *Erweiterte Ausgabe (5. Auflage)*. Suhrkamp. (Original work published 2002).
- Haslam, N., Rothschild, L., & Ernst, D. (2000). Essentialist beliefs about social categories. *British Journal of Social Psychology*, 39(1), 113–127. <https://doi.org/10.1348/014466600164363>
- Haslam, N., & Whelan, J. (2008). Human natures: Psychological essentialism in thinking about differences between people. *Social and Personality Psychology Compass*, 2(3), 1297–1312. <https://doi.org/10.1111/j.1751-9004.2008.00112.x>
- Heiss, A. (2021). *A guide to modeling proportions with Bayesian beta and zero-inflated beta regression models* [other]. *Socialsciences*. <https://doi.org/10.59350/7p1a4-0tw75>
- Heiss, A. (2022, September 26). Visualizing the differences between Bayesian posterior predictions, linear predictions, and the expectation of posterior predictions. *Andrew Heiss’s Blog*. <https://doi.org/10.59350/xge39-emt86>
- Heiss, A. (2023). *The ultimate practical guide to conjoint analysis with R* [other]. *Socialsciences*. <https://doi.org/10.59350/xgwjy-dyj66>

- Hendl, T. (2017). A feminist critique of justifications for sex selection. *Journal of Bioethical Inquiry*, 14(3), 427–438. <https://doi.org/10.1007/s11673-017-9797-6>
- Hodgson, J., & McClaren, B. J. (2018). Parental experiences after prenatal diagnosis of fetal abnormality. *Seminars in Fetal and Neonatal Medicine*, 23(2), 150–154. <https://doi.org/10.1016/j.siny.2017.11.009>
- Hodgson, J., Pitt, P., Metcalfe, S., Halliday, J., Menezes, M., Fisher, J., Hickerton, C., Petersen, K., & McClaren, B. (2016). Experiences of prenatal diagnosis and decision-making about termination of pregnancy: A qualitative study. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, 56(6), 605–613. <https://doi.org/10.1111/ajog.12501>
- Hoffman, C., & Hurst, N. (1990). Gender stereotypes: Perception or rationalization? *Journal of Personality and Social Psychology*, 58(2), 197–208. <https://doi.org/10.1037/0022-3514.58.2.197>
- Hudson, S. T. J., & Ghani, A. (2024). Sexual orientation and Race Intersectionally reduce the perceived gendered nature of normative stereotypes in the United States. *Psychology of Women Quarterly*, 48(1), 56–79. <https://doi.org/10.1177/03616843231187851>
- Hughes, J. J., & Dvorsky, G. (2008). *Postgenderism: Beyond the gender binary*. Institute for Ethics and Emerging Technologies.
- Hyde, J. S., Bigler, R. S., Joel, D., Tate, C. C., & Van Anders, S. M. (2019). The future of sex and gender in psychology: Five challenges to the gender binary. *American Psychologist*, 74(2), 171–193. <https://doi.org/10.1037/amp0000307>
- Ihde, D. (1990). *Technology and the lifeworld: From garden to earth*. Indiana University Press.
- Imhoff, R., & Hoffmann, L. (2023). Prenatal sex role stereotypes: Gendered expectations and perceptions of (expectant) parents. *Archives of Sexual Behavior*, 52(3), 1095–1104. <https://doi.org/10.1007/s10508-023-02584-9>
- International women's day 2019: *Global attitudes towards gender equality*. (2019). Ipsos; The Global Institute for Women's leadership; King's College London. <https://www.kcl.ac.uk/giwl/assets/iwd-giwl-main.pdf>.
- Ishizawa, H., & Kubo, K. (2014). Factors affecting adoption decisions: Child and parental characteristics. *Journal of Family Issues*, 35(5), 627–653. <https://doi.org/10.1177/0192513X13514408>
- Jack, A. (2020). The gender reveal party: A new means of performing parenthood and reifying gender under capitalism. *International Journal of Child, Youth and Family Studies*, 11(2), 82–93. <https://doi.org/10.18357/ijcyfs112202019520>
- Jackson, E. F., Bussey, K., & Myers, E. (2021). Encouraging gender conformity or sanctioning nonconformity? Felt pressure from parents, peers, and the self. *Journal of Youth and Adolescence*, 50(4), 613–627. <https://doi.org/10.1007/s10964-020-01387-8>
- Jedwab, A., Vears, D. F., Tse, C., & Gyngell, C. (2020). Genetics experience impacts attitudes towards germline gene editing: A survey of over 1500 members of the public. *Journal of Human Genetics*, 65(12), 1055–1065. <https://doi.org/10.1038/s10388-020-0810-2>
- Judge, T. A., Livingston, B. A., & Hurst, C. (2012). Do nice guys—And gals—Really finish last? The joint effects of sex and agreeableness on income. *Journal of Personality and Social Psychology*, 102(2), 390–407. <https://doi.org/10.1037/a0026021>
- Kane, E. W. (2006). “No way my boys are going to be like that!": Parents' responses to Children's gender nonconformity. *Gender & Society*, 20(2), 149–176. <https://doi.org/10.1177/0891243205284276>
- Kay, M. (2023). *Tidybays: Tidy data and Geoms for Bayesian models (version v3.0.6)*. [Computer software]. Zenodo. <https://doi.org/10.5281/ZENODO.1308151>
- Keller, J. (2005). In genes we trust: The biological component of psychological essentialism and its relationship to mechanisms of motivated social cognition. *Journal of Personality and Social Psychology*, 88(4), 686–702. <https://doi.org/10.1037/0022-3514.88.4.686>
- Kemp, A. E. (1985). Psychological androgyny in musicians. *Bulletin of the Council for Research in Music Education*, 85, 102–108.
- Khalaf, K., Janowicz, K., Dyszkiewicz-Konwińska, M., Hutchings, G., Dompe, C., Moncrieff, L., ... Kempisty, B. (2020). CRISPR/CAS9 in cancer immunotherapy: Animal models and human clinical trials. *Genes*, 11(8). <https://doi.org/10.3390/genes11080921>
- Kirchberg, V. (1996). Museum visitors and non-visitors in Germany: A representative survey. *Poetics*, 24(2–4), 239–258. [https://doi.org/10.1016/S0304-422X\(96\)00007-1](https://doi.org/10.1016/S0304-422X(96)00007-1)
- Kneib, T., Silbersdorff, A., & Säfken, B. (2023). Rage against the mean – A review of distributional regression approaches. *Econometrics and Statistics*, 26, 99–123. <https://doi.org/10.1016/j.ecosta.2021.07.006>
- Koenig, A. M. (2018). Comparing prescriptive and descriptive gender stereotypes about children, adults, and the elderly. *Frontiers in Psychology*, 9, 1086. <https://doi.org/10.3389/fpsyg.2018.01086>
- Kosakowska-Berezecka, N., Bosson, J. K., Jurek, P., Besta, T., Olech, M., Vandello, J. A., ... Zadkowska, M. (2022). Gendered self-views across 62 countries: A test of competing models. *Social Psychological and Personality Science*, 194855062211296. <https://doi.org/10.1177/19485506221129687>
- Lindström, B., Jangard, S., Selbing, I., & Olsson, A. (2018). The role of a “common is moral” heuristic in the stability and change of moral norms. *Journal of Experimental Psychology: General*, 147(2), 228–242. <https://doi.org/10.1037/xge0000365>
- Little, M. O. (1998). Cosmetic surgery, suspect norms, and the ethics of complicity. In E. Parens (Ed.), *Enhancing human traits: Ethical and social implications* (pp. 162–176). Georgetown University Press.
- Löckenhoff, C. E., Chan, W., McCrae, R. R., Fruyt, F., Jussim, L., Bolle, M., ... Terracciano, A. (2014). Gender stereotypes of personality. *Journal of Cross-Cultural Psychology*, 45(5), 675–694. <https://doi.org/10.1177/0022022113520075>
- Makowski, D., Ben-Shachar, M., & Lüdtke, D. (2019). bayestestR: Describing effects and their uncertainty, existence and significance within the Bayesian framework. *Journal of Open Source Software*, 4(40), 1541. <https://doi.org/10.21105/joss.01541>
- Makowski, D., Ben-Shachar, M. S., Chen, S. H. A., & Lüdtke, D. (2019). Indices of effect existence and significance in the Bayesian framework. *Frontiers in Psychology*, 10, 2767. <https://doi.org/10.3389/fpsyg.2019.02767>
- Marks, J. L., Lam, C. B., & McHale, S. M. (2009). Family patterns of gender role attitudes. *Sex Roles*, 61(3–4), 221–234. <https://doi.org/10.1007/s11199-009-9619-3>
- Marteau, T., Michie, S., Drake, H., & Bobrow, M. (1995). Public attitudes towards the selection of desirable characteristics in children. *Journal of Medical Genetics*, 32(10), 796–798. <https://doi.org/10.1136/jmg.32.10.796>
- Martin, A. E., & Mason, M. F. (2022). What does it mean to be (seen as) human? The importance of gender in humanization. *Journal of Personality and Social Psychology*, 123(2), 292–315. <https://doi.org/10.1037/pspa0000293>
- Martin, C. L., Andrews, N. C. Z., England, D. E., Zosuls, K., & Ruble, D. N. (2017). A dual identity approach for conceptualizing and measuring Children's gender identity. *Child Development*, 88(1), 167–182. <https://doi.org/10.1111/cdev.12568>
- Martin, C. L., Cook, R. E., & Andrews, N. C. Z. (2017). Reviving androgyny: A modern day perspective on flexibility of gender identity and behavior. *Sex Roles*, 76(9–10), 592–603. <https://doi.org/10.1007/s11199-016-0602-5>
- Martín, D., Rueda, J., Earp, B. D., & Hannikainen, I. R. (2023). Normality and the treatment-enhancement distinction. *Neuroethics*, 16(2), 13. <https://doi.org/10.1007/s12152-023-09519-0>
- McElreath, R. (2020). *Statistical rethinking: A Bayesian course with examples in R and Stan* (2nd ed.). CRC Press.
- McIntyre, K., Paolini, S., & Hewstone, M. (2016). Changing people's views of outgroups through individual-to-group generalisation: Meta-analytic reviews and theoretical considerations. *European Review of Social Psychology*, 27(1), 63–115. <https://doi.org/10.1080/10463283.2016.1201893>
- Meyer, M., & Gelman, S. A. (2016). Gender essentialism in children and parents: Implications for the development of gender stereotyping and gender-typed preferences. *Sex Roles*, 75(9–10), 409–421. <https://doi.org/10.1007/s11199-016-0646-6>
- Miller, C. F., Trautner, H. M., & Ruble, D. N. (2006). The role of gender stereotypes in children's preferences and behavior. In L. Balter, & C. S. Tamis-LeMonda (Eds.), *Child psychology: A handbook of contemporary issues* (2nd ed., pp. 293–324). Psychology Press.
- Moen, P., Erickson, M. A., & Dempster-McClain, D. (1997). Their Mother's daughters? The intergenerational transmission of gender attitudes in a world of changing roles. *Journal of Marriage and the Family*, 59(2), 281. <https://doi.org/10.2307/353470>
- Moss-Racusin, C. A., Phelan, J. E., & Rudman, L. A. (2010). When men break the gender rules: Status incongruity and backlash against modest men. *Psychology of Men & Masculinity*, 11(2), 140–151. <https://doi.org/10.1037/a0018093>
- Myers, S. M., & Booth, A. (2002). Forerunners of change in nontraditional gender ideology. *Social Psychology Quarterly*, 65(1), 18. <https://doi.org/10.2307/3090166>
- Neufeld, E. (2022). Psychological essentialism and the structure of concepts. *Philosophy Compass*, 17(5). <https://doi.org/10.1111/phc3.12823>
- Nürnberg, M., Nerb, J., Schmitz, F., Keller, J., & Sütterlin, S. (2016). Implicit gender stereotypes and essentialist beliefs predict preservice Teachers' tracking recommendations. *The Journal of Experimental Education*, 84(1), 152–174. <https://doi.org/10.1080/00220973.2015.1027807>
- Padden, C., & Humphries, J. (2020). Who Goes first? Deaf people and CRISPR germline editing. *Perspectives in Biology and Medicine*, 63(1), 54–65. <https://doi.org/10.1353/pbm.2020.0004>
- Pew Research Center. (2016). U.S. public wary of biomedical technologies to ‘enhance’ Human Abilities. <https://www.pewresearch.org/science/2016/07/26/u-s-public-wary-of-biomedical-technologies-to-enhance-human-abilities/#:~:text=For%20example%2C%2047%25%20of%20Americans,results%20in%20physical%20abilities%20%2E2%80%9Cfar.>
- Phillips, B. (2022). “They're not true humans:" beliefs about moral character drive denials of humanity. *Cognitive Science*, 46(2), Article e13089. <https://doi.org/10.1111/cogs.13089>
- Pienaar, K., Murphy, D. A., Race, K., & Lea, T. (2020). Drugs as technologies of the self: Enhancement and transformation in LGBTQ cultures. *International Journal of Drug Policy*, 78, Article 102673. <https://doi.org/10.1016/j.drugpo.2020.102673>
- Powell, R. (2012). The evolutionary biological implications of human genetic engineering. *Journal of Medicine and Philosophy*, 37(3), 204–225. <https://doi.org/10.1093/jmp/jhq004>
- Powell, R. (2015). In genes we trust: Germline engineering, eugenics, and the future of the human genome. *The Journal of Medicine and Philosophy*, 40(6), 669–695. <https://doi.org/10.1093/jmp/jhv025>
- Prentice, D. A., & Carranza, E. (2002). What women and men should be, Shouldn't be, are allowed to be, and don't have to be: The contents of prescriptive gender stereotypes. *Psychology of Women Quarterly*, 26(4), 269–281. <https://doi.org/10.1111/1471-6402.t01-1-00066>
- President's Council on Bioethics. (2003). *Beyond therapy: Biotechnology and the pursuit of happiness*.
- Proudford, D., Kay, A. C., & Koval, C. Z. (2015). A gender Bias in the attribution of creativity. *Psychological Science*, 26(11), 1751–1761. <https://doi.org/10.1177/0956797615598739>
- Rabino, I. (2003). Gene therapy: Ethical issues. *Theoretical Medicine and Bioethics*, 24(1), 31–58. <https://doi.org/10.1023/a:1022967623162>
- Redman, M., King, A., Watson, C., & King, D. (2016). What is CRISPR/Cas9? *Archives of disease in childhood. Education and Practice Edition*, 101(4), 213–215. <https://doi.org/10.1136/archdischild-2016-310459>

- Renström, E. A. (2024). Differences between prescriptive and proscriptive gender stereotypes and gendered self-evaluations in Sweden. *Scandinavian Journal of Psychology*, 65(3), 511–520. <https://doi.org/10.1111/sjop.12995>
- Resnik, D. B., & Vorhaus, D. B. (2006). Genetic modification and genetic determinism. *Philosophy, Ethics, and Humanities in Medicine*, 1, 9. <https://doi.org/10.1186/1747-5341-1-9>
- Riis, J., Simmons, J. P., & Goodwin, G. P. (2008). Preferences for enhancement pharmaceuticals: The reluctance to enhance fundamental traits. *Journal of Consumer Research*, 35(3), 495–508. <https://doi.org/10.1086/588746>
- Rudman, L. A., Moss-Racusin, C. A., Glick, P., & Phelan, J. E. (2012). Reactions to vanguards: Advances in backlash theory. In P. G. Devine, & E. A. Plant (Eds.), *Advances in experimental social psychology* (pp. 167–227). Elsevier. <https://doi.org/10.1016/B978-0-12-394286-9.00004-4>
- Rudman, L. A., Moss-Racusin, C. A., Phelan, J. E., & Nauts, S. (2012). Status incongruity and backlash effects: Defending the gender hierarchy motivates prejudice against female leaders. *Journal of Experimental Social Psychology*, 48(1), 165–179. <https://doi.org/10.1016/j.jesp.2011.10.008>
- Saguy, T., Reifen-Tagar, M., & Joel, D. (2021). The gender-binary cycle: The perpetual relations between a biological-essentialist view of gender, gender ideology, and gender-labelling and sorting. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 376(1822), 20200141. <https://doi.org/10.1098/rstb.2020.0141>
- Sanchez, D. T., & Crocker, J. (2005). How Investment in Gender Ideals Affects Well-Being: The role of external contingencies of self-worth. *Psychology of Women Quarterly*, 29(1), 63–77. <https://doi.org/10.1111/j.1471-6402.2005.00169.x>
- Sattler, S., Mehlkop, G., Bahr, V., & Betsch, C. (2021). Why parents misuse prescription drugs to enhance the cognitive performance of healthy children: The influence of peers and social media. *Journal of Drug Issues*, 51(3), 461–482. <https://doi.org/10.1177/0022042621994547>
- Savulescu, J. (2001). Procreative beneficence: Why we should select the best children. *Bioethics*, 15(5/6), 413–426.
- Savulescu, J. (2005). New breeds of humans: The moral obligation to enhance. *Reproductive Biomedicine Online*, 10, 36–39. [https://doi.org/10.1016/S1472-6483\(10\)62202-X](https://doi.org/10.1016/S1472-6483(10)62202-X)
- Scheufele, D. A., Xenos, M. A., Howell, E. L., Rose, K. M., Brossard, D., & Hardy, B. W. (2017). U.S. attitudes on human genome editing. *Science* (New York, N.Y.), Vol. 357 (6351), 553–554. doi:<https://doi.org/10.1126/science.aan3708>
- Schönthaler, E. M. D., Hofer, G., Grinschgl, S., & Neubauer, A. C. (2022). Super-men and wonder-women: The relationship between the acceptance of self-enhancement, personality, and values. *Journal of Cognitive Enhancement*. <https://doi.org/10.1007/s41465-022-00244-9>
- Sharp, R. R., McGowan, M. L., Verma, J. A., Landy, D. C., McAdoo, S., Carson, S. A., ... McCullough, L. B. (2010). Moral attitudes and beliefs among couples pursuing PGD for sex selection. *Reproductive Biomedicine Online*, 21(7), 838–847. <https://doi.org/10.1016/j.rbmo.2010.09.009>
- Shields, S. A. (1982). The variability hypothesis: The history of a biological model of sex differences in intelligence. *Signs: Journal of Women in Culture and Society*, 7(4), 769–797. <https://doi.org/10.1086/493921>
- Singer, P. (2009). Parental choice and human improvement. In J. Savulescu, & N. Bostrom (Eds.), *Human enhancement* (pp. 277–289). Oxford University Press.
- Snure Beckman, E., Deutch, N., Michie, M., Allyse, M. A., Riggan, K. A., & Ormond, K. E. (2019). Attitudes toward hypothetical uses of gene-editing Technologies in Parents of people with autosomal aneuploidies. *The CRISPR Journal*, 2(5), 324–330. <https://doi.org/10.1089/crispr.2019.0021>
- Sorgner, S. L. (2015). The future of education: Genetic enhancement and Metahumanities. *Journal of Evolution and Technology*, 25(1), 31–48.
- Sparrow, R. (2007). Procreative beneficence, obligations, and eugenics. *Genomics, Society and Policy*, 3(3), 43–59.
- Sparrow, R. (2019). Yesterday's child: How gene editing for enhancement will produce obsolescence-and why it matters. *The American Journal of Bioethics*, 19(7), 6–15. <https://doi.org/10.1080/15265161.2019.1618943>
- Sternberg, R. J., & Grigorenko, E. L. (2004). Intelligence and culture: How culture shapes what intelligence means, and the implications for a science of well-being. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 359(1449), 1427–1434. <https://doi.org/10.1098/rstb.2004.1514>
- Stotzer, R. L. (2009). Violence against transgender people: A review of United States data. *Aggression and Violent Behavior*, 14(3), 170–179. <https://doi.org/10.1016/j.avb.2009.01.006>
- Sutfin, E. L., Fulcher, M., Bowles, R. P., & Patterson, C. J. (2008). How lesbian and heterosexual parents convey attitudes about gender to their children: The role of gendered environments. *Sex Roles*, 58(7–8), 501–513. <https://doi.org/10.1007/s11199-007-9368-0>
- Tang-Péronard, J. L., & Heitmann, B. L. (2008). Stigmatization of obese children and adolescents, the importance of gender. *Obesity Reviews*, 9(6), 522–534. <https://doi.org/10.1111/j.1467-789X.2008.00509.x>
- Taylor, C. L., Said-Metwaly, S., Camarda, A., & Barbot, B. (2024). Gender differences and variability in creative ability: A systematic review and meta-analysis of the greater male variability hypothesis in creativity. *Journal of Personality and Social Psychology*, 126(6), 1161–1179. <https://doi.org/10.1037/pspp0000484>
- Tenenbaum, H. R., & Leaper, C. (2002). Are parents' gender schemas related to their children's gender-related cognitions? A meta-analysis. *Developmental Psychology*, 38(4), 615–630. <https://doi.org/10.1037/0012-1649.38.4.615>
- Thomas, A. (2022). Transhumanism and advanced capitalism: Elitist logics and dangerous implications. In P. Jorion (Ed.), *Humanism and its discontents* (pp. 151–180). Springer International Publishing.
- Thweatt-Bates, J. (2016). *Cyborg selves: A theological anthropology of the posthuman*. Routledge (Original work published 2012).
- Tobin, D. D., Menon, M., Menon, M., Spatta, B. C., Hodges, E. V. E., & Perry, D. G. (2010). The intrapsychics of gender: A model of self-socialization. *Psychological Review*, 117(2), 601–622. <https://doi.org/10.1037/a0018936>
- Van Dijke, I., Bosch, L., Bredenoord, A. L., Cornel, M., Repping, S., & Hendriks, S. (2018). The ethics of clinical applications of germline genome modification: A systematic review of reasons. *Human Reproduction*, 33(9), 1777–1796. <https://doi.org/10.1093/humrep/dey257>
- Verbeek, P.-P. (2011). *Moralizing technology: Understanding and designing the morality of things*. University of Chicago Press.
- Vuorre, M. (2019, February 18). How to analyze visual analog (slider) scale data? <https://mvuorre.github.io/posts/2019-02-18-analyze-analog-scale-ratings-with-zero-one-inflated-beta-models/>
- Wagner, K., Maslen, H., Oakley, J., & Savulescu, J. (2018). Would you be willing to zap your child's brain? Public perspectives on parental responsibilities and the ethics of enhancing children with transcranial direct current stimulation. *AJOB Empirical Bioethics*, 9(1), 29–38. <https://doi.org/10.1080/23294515.2018.1424268>
- Weaver, M. S., October, T., Feudtner, C., & Hinds, P. S. (2020). "Good-parent beliefs": Research, concept, and clinical practice. *Pediatrics*, 145(6). <https://doi.org/10.1542/peds.2019-4018>
- Weisgram, E. S., & Bruun, S. T. (2018). Predictors of gender-typed toy purchases by prospective parents and mothers: The roles of childhood experiences and gender attitudes. *Sex Roles*, 79(5–6), 342–357. <https://doi.org/10.1007/s11199-018-0928-2>
- Willoughby, E. A., Love, A. C., McGue, M., Iacono, W. G., Quigley, J., & Lee, J. J. (2019). Free will, determinism, and intuitive judgments about the heritability of behavior. *Behavior Genetics*, 49(2), 136–153. <https://doi.org/10.1007/s10519-018-9931-1>
- Wilson, S. G. (2014). Enhancement and identity: A social psychological perspective. In S. J. Thompson (Ed.), *Global issues and ethical considerations in human enhancement technologies* (pp. 241–256). IGI Global. <https://doi.org/10.4018/978-1-4666-6010-6>
- Zehnter, M. K., Olsen, J., & Kirchner, E. (2018). Obituaries of female and male leaders from 1974 to 2016 suggest change in descriptive but stability of prescriptive gender stereotypes. *Frontiers in Psychology*, 9. <https://doi.org/10.3389/fpsyg.2018.02286>