Do attitudes about and behaviors towards people who enhance their cognition depend on their looks?

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Abstract

Public attitudes towards cognitive enhancement—e.g., using stimulants like Adderall and Ritalin to improve mental functioning—are mixed. Attitudes vary by context and prompt ethical concerns about fairness, obligation, and authenticity/character. While people may have strong views about the morality of cognitive enhancement, how these views are affected by the physical characteristics of enhancers is unknown. Visible facial anomalies (e.g., scars) bear negatively on perceptions of moral character. This pre-registered study (https://osf.io/uaw6c/) tested the hypothesis that such negative biases against people with facial anomalies extend to moral beliefs surrounding their use of cognitive enhancement. In an online survey, 941 participants made moral judgments in response to a vignette about a person who had to decide whether or not to enhance. The vignette was accompanied by a face photograph that ostensibly depicted the potential enhancer and either did or did not have visible anomalies. Participants then learned whether the person ultimately decided to enhance. Next, participants played a modified Trust Game with, they were told, the person from the photograph/vignette. Participants judged enhancement to be less fair and enhancers less authentic if they had facial anomalies, while effects on judgments of moral obligation and on behavior were not detected. These findings extend previous work showing that people with visible differences are subject to an "anomalous-is-bad" stereotype that has negative consequences for perceptions of their moral character. While anomalous faces were judged more harshly, these judgments did not appear to affect behavior. These results are discussed in relation to discrimination and policy.

Keywords: bias; bioethics; cognitive enhancement; disfigurement; discrimination; faces; stigma

Introduction

Cognitive enhancement is defined as any external means of improving cognitive functioning, such as attention, focus, memory, and wakefulness (Chatterjee, 2004; Ilieva et al., 2013). Public attitudes towards cognitive enhancement are affected by the context of its use (Conrad et al., 2019; Ilieva et al., 2013; Sattler et al., 2013). Medaglia and colleagues (2019), for instance, found that repairing cognitive function (i.e., treatment) was judged more morally acceptable than enhancing it. Other influencing factors include the environment of use (e.g., work, academic, sport), personal experience with enhancement, permissibility/legality, social norms, and knowledge about safety and efficacy (Chatterjee, 2006; Conrad et al., 2019; Dinh et al., 2020; McCabe et al., 2005; Sattler et al., 2013). The consequences of incidental social information—like appearance—for attitudes about cognitive enhancement are unknown. Does physical appearance affect the morality of cognitive enhancement? Biases related to physical appearance are well-documented and known to fuel prejudice and discrimination (Diessner et al., 2018; Griffin & Langlois, 2006; Hartung et al., 2019; He et al., 2021; Jamrozik et al., 2019; Workman et al., 2021; Zebrowitz & Montepare, 2008). Physical appearance, particularly faces, represents a critical source for social information (Grammer et al., 2003; Rhodes, 2006; Zebrowitz & Montepare, 2008). Stereotyping, prejudice, and discrimination on the basis of appearance are rampant, particularly against marginalized out-groups (Amodio & Cikara, 2021; Cikara et al., 2014).

One such out-group is comprised of people with visible facial anomalies like scars. People whose faces harbor anomalous features commonly experience discrimination in social and romantic relationships, in academic contexts, and in the workplace (Changing Faces, 2017; Houston & Bull, 1994; Madera & Hebl, 2012; Mojon-Azzi et al., 2008; Partridge, 2010). Across multiple studies, we find evidence for an "anomalous-is-bad" stereotype that results in social penalties for people with anomalous faces—for example, people thought individuals with anomalous faces were less trustworthy and less competent relative to the same faces after they had undergone surgical intervention to reduce the visual salience of anomalies (Jamrozik et al., 2019). The anomalous-is-bad stereotype is informed by the Stereotype Content Model (SCM), a theoretical framework that identifies *warmth* (trustworthiness, friendliness) and *competence* (capability, assertiveness) as categorical dimensions along which stereotypes are organized (Fiske, 2018; Fiske et al., 2007). Members of out-groups seen as lacking in warmth and/or

competence are targets for prejudice and discrimination (Fiske, 2018; Fiske et al., 2007; Rudert et al., 2017). Warmth and competence are also relevant to discussions about the ethics of enhancing and can be queried in terms of fairness, obligation, and authenticity.

Concerns about fairness are especially relevant for the use of cognitive enhancement as a treatment for attention-deficit/hyperactivity disorder. The use of these drugs among healthy individuals for enhancement may delegitimize the use of those drugs to treat people suffering with a medical condition and runs counter to the use of treatment as a means of leveling the playing field (Chatterjee, 2004, 2006). The equitable distribution of resources is another issue linked to fairness since cognitive enhancement may give enhancers an unfair advantage over those without access to enhancement. Enhancement as a means of cheating has a familiar history in sports doping, with enhancers looked down upon for using steroids to gain an unfair advantage over their competitors (Chatterjee, 2004). Obligation refers to a related yet distinct concern— namely, whether people are morally obligated to enhance if doing so benefits the greater good. Finally, the concern about authenticity/character is that altering "normal functioning" may erode personhood, thus subverting the appearance of self-efficacy by rendering an individual's skills or actions seemingly "less human" (Chatterjee, 2004, 2006). Previous studies assessed the *acceptability* of cognitive enhancement (Conrad et al., 2019; Dinh et al., 2020)—extending this work, we take a more granular approach in assessing moral attitudes that differentiates between judgments of fairness, obligation, and authenticity (Kahane & Shackel, 2010).

This pre-registered study (https://osf.io/uaw6c/) used an online survey to examine the impact of physical appearance—specifically, the presence or absence of visible facial anomalies—on moral attitudes about fairness, obligation, and authenticity, as well as moral behavior, in response to a vignette about an individual deciding whether or not to cognitively enhance. We first hypothesized that the anomalous-is-bad stereotype manifests in negative moral attitudes about the potential use of cognitive enhancement by people with facial anomalies. We predicted that anomalous faces would elicit *stronger* moral opposition to cognitive enhancement compared to non-anomalous faces, consistent with the view that anomalous faces signal underlying moral deficiencies that could be exacerbated with enhancement (Bilici et al., 2022; Croley et al., 2017; Marion et al., 2018; Workman et al., 2021). Alternatively, anomalous faces may elicit *weaker* moral opposition to cognitive enhancement compared to non-anomalous faces, which could indicate that facial anomalies are perceived as hardships that trigger pity or

sympathy in viewers (Andreasen & Norris, 1972; Rumsey & Bull, 1986) that then motivates a desire to "level the playing field" for those who look different. Only after registering their moral judgments did participants learn whether the person in the vignette decided to enhance.

Our second hypothesis was that moral behavior—particularly the decision to trust someone else—is shaped by what we know about our social partners, like whether their face has anomalous features and whether they took cognitive enhancement pills. In this study, moral behavior was assessed with a modified version of the Trust Game (Krueger et al., 2008), wherein participants decided whether to split money with a partner—ostensibly the person from the vignette who decided either to enhance or to abstain from enhancing. Any money participants shared was forfeited unless their partner first passed a memory test. If successful, their partner received triple the amount that participants shared. Then, participants' partner could choose whether and how much of this tripled sum to give back. To achieve the largest payouts, participants had to trust that their partner would return more money to them than they initially shared, rather than keeping the entire sum without returning anything. We first predicted that participants would give *more* money to partners with anomalous relative to non-anomalous faces, regardless of whether they enhanced, which could be motivated by feelings of pity or sympathy (Andreasen & Norris, 1972; Rumsey & Bull, 1986). Alternatively, participants could give *less* money to partners with anomalous relative to non-anomalous faces regardless of enhancement, which would align with evidence—albeit mixed—that facial anomalies are associated with worse competence that would render them less likely to pass the memory test (Jamrozik et al., 2019; Workman et al., 2021, 2022).

It seems likely that knowing whether one's partner began cognitively enhancing would bear on the decision to trust the competence of one's partner to pass a memory test. We therefore predicted that participants would give *more* money to people who enhanced relative to those who abstained, regardless of facial appearance, which would likely indicate that enhancement bolsters beliefs in competence. Alternatively, participants may give *less* money to people who enhanced relative to those who abstained, regardless of facial appearance, if enhancement undermines perceptions of warmth (i.e., trustworthiness). It also seems likely that partners' decisions to enhance could interact with their facial appearance to affect participants' moral behavior. If correct, we might predict that participants should give the *most* money to people with facial anomalies who also enhanced, suggesting cognitive enhancement among people with facial

anomalies is seen as restorative rather than inequitable. Alternatively, participants could give the *least* to people with anomalous faces who also enhanced, which might indicate that participants think enhancement is less fair or perhaps less effective for people with facial anomalies (anomalous features may, for instance, be seen as external evidence for irreparable internal corruption to one's character; e.g., Croley et al., 2017; Marion et al., 2018).

Finally, our third hypothesis was that interactions between our social partners' facial appearances and whether they cognitively enhance are reflected in beliefs about their warmth and competence. We predicted that enhancers would be viewed as more competent than those who abstained, with pronounced effects for non-anomalous relative to anomalous faces. Alternatively, enhancers may be viewed as less warm (i.e., trustworthy), with pronounced effects for anomalous relative to non-anomalous faces. Regardless of which predictions are ultimately right and which hypotheses are supported or undermined, characterizing whether and how facial appearance influences moral attitudes and behavior related to cognitive enhancement will shed light on how people think about and treat individuals who enhance.

Method

This study was pre-registered (https://osf.io/uaw6c/) and the materials, de-identified data, code, and statistical outputs are publicly available (https://osf.io/6srwx/)

Participants

A sample of 1,001 healthy volunteers aged 18 and older and located in the United States was recruited through Amazon's Mechanical Turk (MTurk) service to participate in the present study. Participants were directed to an online survey hosted on the Qualtrics platform that took around 15 minutes to complete. A total of 60 datasets were excluded from further analysis—one duplicate dataset and 59 poor quality datasets flagged either for a failed attention check or because participants self-reported the low quality of their data. The final sample was comprised of N = 941 participants (524 male, 702 White, age $M = 37.9$ years, $SD = 11.4$). Demographic information is provided in Table 1. Although participants believed they would receive $2 USD in compensation for their time (the rationale for this deception is detailed below), all participants in fact received $6 USD for taking part. This study was approved by the Institutional Review Board (IRB) of the University of Pennsylvania (protocol 806447).

Table 1 | Summary of demographic information characterizing the study sample

Demographic	Study Sample (N = 941)
Age, mean (SD)	37.9 (11.4)
Years of education, mean (SD)	15.1 (2.2)
Sex assigned at birth, No. (%)	
Female	411 (43.7%)
Male	524 (55.7%)
Intersex	1 (0.1%)
Do not wish to say	5 (0.5%)
Sexual Orientation, No. (%)	
Lesbian, gay, or homosexual	30 (3.2%)
Straight or heterosexual	833 (88.5%)
Bisexual	71 (7.5%)
Other	3 (0.3%)
Do not wish to say	4 (0.4%)
Race, No. (%)	
White only	701 (74.5%)
Black/African American only	90 (9.6%)
Asian only	53 (5.6%)
Hispanic/Latino only	51 (5.5%)
American Indian/Alaskan Native only	3 (0.3%)
Native Hawaiian/Pacific Islander only	0 (0.0%)
Unknown only	2 (0.2%)
Other only	5 (0.5%)
Do not wish to say	4 (0.4%)
Multiracial/ethnic	32 (3.4%)
Political orientation-social issues, No. (%)	
Very liberal	174 (18.5%)
Liberal	215 (22.8%)
Slightly liberal	156 (16.6%)
Moderate; middle of the road	140 (14.9%)
Slightly conservative	79 (8.4%)
Conservative	116 (12.3%)
Very conservative	61 (6.5%)
Socioeconomic status–income, No. (%)	
Less than $25,000	222 (23.6%)

$25,000-$49,999	310 (32.9%)
$50,000-$74,999	224 (23.8%)
$75,000-$99,999	106 (11.3%)
$100,000-$124,999	42 (4.5%)
$125,000-$149,999	15 (1.6%)
$150,000-$174,999	9 (1.0%)
$175,000-$199,999	7 (0.7%)
$200,000 or more	6 (0.6%)
Cognitive enhancement pill usage, No. (%)	
Ever prescribed for treatment	111 (11.8%)
Ever used for enhancement	177 (18.8%)
Knows someone who was prescribed	468 (49.8%)
Knows someone who enhanced	372 (39.5%)
Familiarity with facial disfigurement, No. (%)	
Has a facial disfigurement	83 (8.8%)
Has a close friend or family member with a facial disfigurement	70 (7.4%)

During the study, participants saw a photograph of a face they were told belonged to an individual deciding whether or not to cognitively enhance. Participants morally judged the prospect of the photographed individual choosing to enhance. After making their judgments, participants were told whether or not the individual enhanced, ostensibly, before playing the Trust Game with them. With respect to the face photograph participants (N = 941) saw, they were randomly assigned to one of two experimental conditions: In the first, participants saw an anomalous face (N = 465). In the second, participants saw a non-anomalous face (N = 476). Random assignment was also used to determine which participants were told whether the photographed individual ultimately enhanced (anomalous face condition [N = 465]: N = 233 were told that the individual enhanced, N = 232 were told that the individual abstained; non-anomalous face condition [N = 476]: N = 231 enhanced, N = 245 abstained).

Per our pre-registration (https://osf.io/uaw6c/), we planned to recruit N = 1,000 participants based on a power analysis using an effect size of $d = 0.2$, which is typically indicative of a small effect in psychological research. The power analysis suggested a sample of N = 788 participants would be necessary to detect the effects of interest in this study. We recruited a larger sample to buffer against exclusions of low-quality data. Another study conducted by our group, which examined the influence of two different social contexts on

acceptability judgments of cognitive enhancement (Dinh et al., 2020), reported an effect similar in magnitude. A meta-analysis of ingroup favoritism in behavioral economic games, including the Trust Game, reported effects also similar in magnitude (Balliet et al., 2014). Taken together, after excluding low-quality data, our final sample of N = 941 participants was expected to provide adequate power to detect all effects of interest.

Study Design

In a between-subjects design, participants viewed a photograph of a face (Anomalous | Non-anomalous) alongside a vignette ostensibly about the photographed person. The person was given the name "M. Miller" to obscure their gender, since the photograph participants saw could have depicted someone presenting as either a man or a woman. M. Miller reportedly considered using cognitive enhancement pills to meet a stressful deadline at work (vignette provided below). Participants were told that M. Miller spoke with our team about this experience as part of our lab's research on cognitive enhancement, and that M. Miller also completed a cognitive test to measure mental speed and memory. Participants in both conditions (Anomalous | Non-anomalous) made moral judgments about M. Miller's potential cognitive enhancement use. Then, they were told whether M. Miller decided to enhance (Enhanced | Abstained). Participants in each condition completed an adaptation of the Trust Game (Krueger et al., 2008), ostensibly with M. Miller, to examine whether and how facial anomalies and cognitive enhancement interact to influence prosocial behavior.

Face Stimuli

The face photographs used for stimuli in this study were selected from the ChatLab Facial Anomaly Database (Workman & Chatterjee, 2021): https://cfad.clffwrkmn.net/. The anomalous faces—all harboring scars—belonged to 10 different people (5 male and 5 female), all of whom were white, aged between 45 to 76 years (approx. $M = 61.2$ years, approx. $SD = 10.6$), forward-facing, and in neutral repose. The non-anomalous face photographs were of the same people but after surgical intervention to reduce the visual salience of any scarring. Each participant saw only one face (Anomalous | Non-anomalous). The face photographs were pre-processed as follows (Workman & Chatterjee, 2021): 1. Normalized to inter-pupillary distance (algorithms from the OpenCV computer vision library: https://opencv.org/; facial landmarks from the dlib machine

learning toolkit: http://dlib.net/). 2. Resized and cropped (width: 345px; height: 407px). 3.

Backgrounds removed (https://www.remove.bg/) and replaced with black (GIMP 2 software

package: https://www.gimp.org/).

Vignette on Cognitive Enhancement in the Workplace

Next, participants read a vignette describing a dilemma facing a person—ostensibly the same

person in the photograph they just saw—who had to decide whether to use cognitive

enhancement to meet workplace demands. The vignette is comparable to others already found in

the literature (Conrad et al., 2019; Dinh et al., 2020) and reads as follows:

> *Cognitive enhancement pills such as Adderall and Ritalin increase*
> *attention, focus, and wakefulness. M. Miller is a company employee whose*
> *performance at work requires long hours spent paying attention to detail.*
> *The past weekend, M. Miller had an unexpected yet important project*
> *deadline. This project required more time and mental effort than expected.*
> *In order to increase concentration and improve efficiency during work, M.*
> *Miller considered taking a cognitive enhancement pill that improves the*
> *brain's ability to pay attention to tasks. Meeting this deadline would make*
> *money for the company and lead to a bonus pay for M. Miller.*

Moral Judgments

Participants answered three questions about the possibility of M. Miller using cognitive

enhancement, each along a 7-point scale (1 = "Absolutely Not", 7 = "Absolutely Yes"). In

previous studies, moral attitudes about cognitive enhancement were assessed in terms of

"acceptability" (e.g., Conrad et al., 2019; Dinh et al., 2020). Judgements of acceptability are

ambiguous, however, since it is unclear who exactly is judged (i.e., oneself or others) and what

criteria are used to render those judgments (e.g., moral, societal, and/or legal norms; Kahane &

Shackel, 2010). We sought to reduce this ambiguity by assessing three facets of moral judgment:

fairness, obligation, and authenticity. To assess fairness, participants were asked: "Given the

tight project deadline, would it be fair for M. Miller to take this cognitive enhancement pill for

work?" To assess moral duty/obligation, participants were asked: "Given the tight project

deadline, should M. Miller take this cognitive enhancement pill?" In assessing authenticity, we

wished to establish whether cognitive enhancement changes people's attitudes about how authentic/natural a person's abilities are under cognitive enhancement. To assess authenticity, participants were asked: "If M. Miller were to take the cognitive enhancement pill, do you think that the project work reflects M. Miller's own actual skills?"

Trust Game

After making moral judgments, participants were redirected to a new screen to start the second part of the online survey. This screen included the face photograph, ostensibly of M. Miller, and it told participants whether M. Miller ended up taking cognitive enhancement pills. After learning whether they enhanced or abstained, participants were told M. Miller would play a game with them. The game was an adapted version of the Trust Game (Krueger et al., 2008). Participants were tasked with deciding how much of their own study compensation—which they believed would be $2 USD—if any to share with M. Miller in increments of $0.20 USD. Participants were told that, at an earlier study visit, M. Miller completed a test of memory and mental speed. If M. Miller passed that test, any money participants shared with M. Miller would be tripled upon receipt. If M. Miller failed that test, any money shared with them would be forfeited. Participants were also told that, should the money be tripled, M. Miller would decide whether and how much of that money to return to the participant. Since participants were led to believe playing the Trust Game could result in compensation exceeding $2 USD, all participants were ultimately compensated $6 USD for taking part.

After deciding whether or not to share with M. Miller, participants answered follow-up questions to assess their perceptions of M. Miller's warmth and competence. Warmth was assessed with the following question: "How confident were you that M. Miller would **share the money fairly with you**?" Participants also reported the extent to which they thought warmth influenced their Trust Game behavior: "How much was your decision to send money to M. Miller based on whether you thought they would **share the money fairly with you**?" Competence and its perceived influence on participant behavior were assessed with the following questions: 1. "How confident were you that M. Miller **passed the memory test**?" 2. "How much was your decision to send money to M. Miller based on whether you thought they **passed the memory test**?" Participants responded using a 7-point scale (1 = "Not at all", 7 = "Entirely").

Finally, participants were debriefed about the true nature of the study and the use of deception was explained.

Dispositional and Attitudinal Measures

The following scales of psychological dispositions relevant to intergroup bias, discrimination, and moral attitudes were acquired and submitted to secondary analyses: The Interpersonal Reactivity Index measured the empathic concern and perspective taking facets of empathy (Davis, 1983). Since these facets of empathy are highly interrelated, we constructed a composite variable that averages across the empathic concern and perspective taking subscales to provide a general measure of trait empathy. The Three Domains of Disgust Scale measured sensitivity to pathogen-related and moral disgust (Tybur et al., 2009). The Social Dominance Orientation Scale measured beliefs about egalitarianism (Pratto et al., 1994). The Procedural and Distributive Just World Beliefs Scale measured beliefs that the world is just and/or fair (Lucas et al., 2011). Participants also reported their previous experience with cognitive enhancement, including whether they and/or people they know had ever used cognitive enhancement (adapted from Dinh et al., 2020). Participants were further asked about their experiences with people whose faces harbor anomalies using the Explicit Bias Questionnaire (EBQ; Hartung et al., 2019; Workman et al., 2021). Finally, participants provided basic demographic information including age, income, education, sex, gender, sexual orientation, and race/ethnicity.

Statistical Analyses

The statistical analysis plan was pre-registered (https://osf.io/uaw6c/). Analyses were conducted in R (R Core Team, 2018) and JASP (JASP Team, 2019). For the moral judgements, all three scores were transformed to a range of -3 to +3 (0 = "Neutral") for data presentation purposes. Higher positive values reflect more positive moral attitudes about cognitive enhancement. The distributions of moral judgment scores were not normal, so non-parametric Mann-Whitney tests were used in lieu of independent samples t-tests to examine between-subject differences in moral judgments (i.e., fairness, obligation, and authenticity) as a function of whether M. Miller had facial anomalies (Anomalous | Non-anomalous). For the adapted Trust Game, analyses of variance (ANOVAs) examined between-subject differences in moral behavior (i.e., amount given to M. Miller) and perceptions of warmth and competence as functions of whether M.

Miller's face had anomalous features and whether M. Miller ultimately enhanced. We were interested in main effects of face type (Anomalous | Non-anomalous) and enhancement outcome (Enhanced | Abstain) and interactions between them. We also carried out a multiple logistic regression analysis of the Trust Game data, the rationale for which is elaborated in the results.

In addition to the pre-registered analyses, we also ran exploratory analyses to examine whether individual differences in demographic features and/or psychological dispositions were associated with moral judgment and trust game behavior. Since these analyses were not pre-registered, they should be considered as hypothesis generating rather than confirming. Each model was first constructed with all variables entered. Variables that contributed the least to model fit were removed, and the resulting model was evaluated according to its AIC value. Variables were removed until the AIC could not be reduced any further. We determined which variables contributed the least using measures of "relative importance" rather than p-values. Relative importance quantifies an individual regressor's contribution to a multiple regression. When variables are correlated, metrics such as p-values are flawed indicators of variable importance. Relative importance analysis allows for more accurate variance partitioning among correlated predictors.

Results

Moral Judgments of Cognitive Enhancement

Participants who saw M. Miller with a facial anomaly rated cognitive enhancement significantly less fair than participants who saw M. Miller with a non-anomalous face, $W = 118740$, $p = .047$, $r = .073$. When asked whether M. Miller *should* take the cognitive enhancement pills, there was no significant difference between participants who saw M. Miller with an anomalous face compared to those who saw a non-anomalous face, $W = 111951$, $p = .755$, $r = .012$. Regarding authenticity, participants who saw M. Miller with a facial anomaly rated M. Miller's skills while using cognitive enhancement significantly less authentic than participants who saw M. Miller with a non-anomalous face, $W = 119493$, $p = .031$, $r = .080$. The distribution of scores for all three moral judgment questions across both types of faces (Anomalous | Non-anomalous) is shown in Figure 1.

With respect to the influence of sex on moral attitudes towards cognitive enhancement, female participants ($M = 3.76$, $SD = 1.70$) were less likely than males ($M = 4.27$, $SD = 1.64$) to
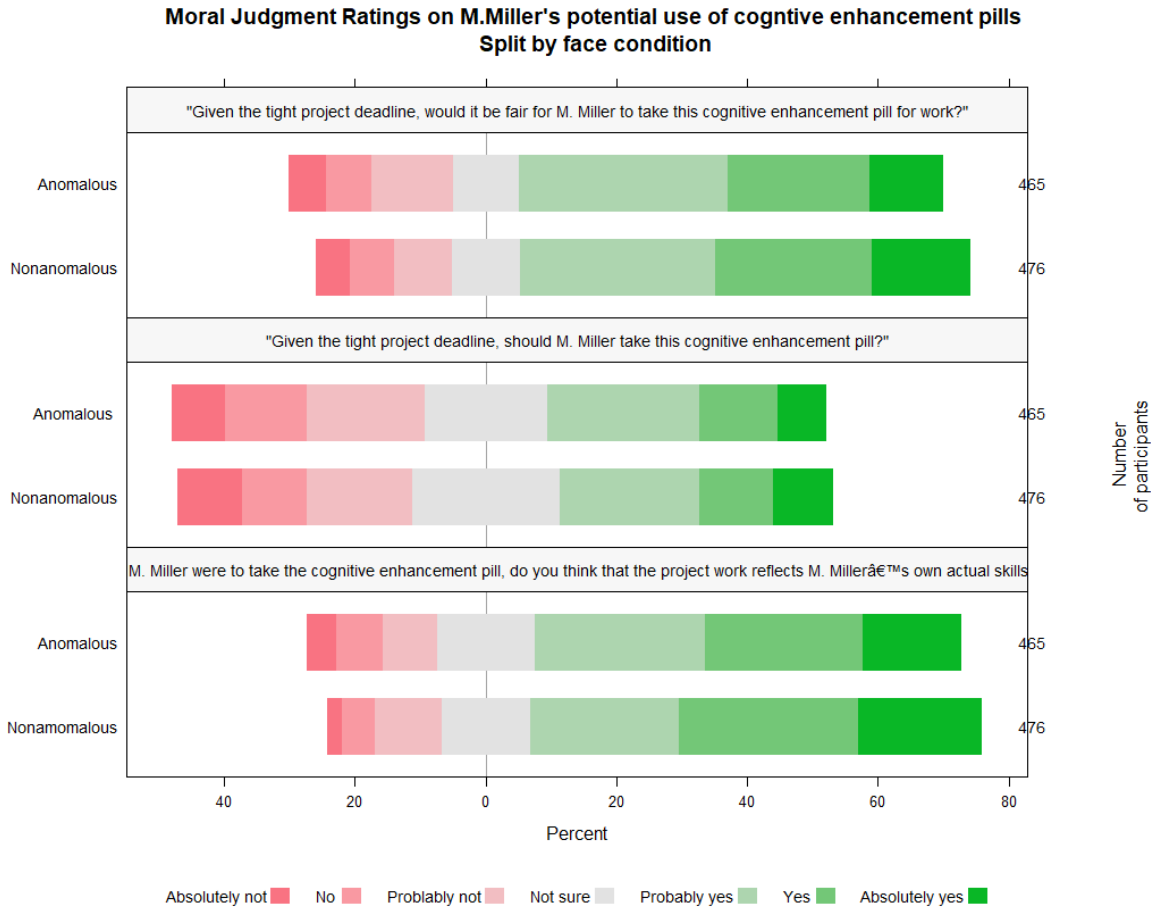
Figure 1 | Distributions of moral judgments by face type (anomalous or non-anomalous)

Face type is indicated on the left vertical axis. Scores representing moral judgments about the use of cognitive enhancement asked three separate ways. The horizontal width of each color bar represents the proportion of respondents who selected the corresponding score in the legend. Positive ratings are in green and negative ratings are in red.

indicate that they thought M. Miller *should* take the cognitive enhancement pills (β = -.55, SE = .11, t = 4.94, p < .001). With respect to psychological dispositions, stronger attitudes regarding the moral obligation to enhance were positively associated with beliefs about procedural justice towards others (β = .09, SE = .04, t = 2.19, p =.03) and with sensitivity to pathogen disgust (β = .02, SE = .01, t = 2.46, p = .01). Stronger views about M. Miller's obligation to enhance also correlated negatively with trait empathy (β = -.19, SE = .08, t = 2.56 p = .01) and explicit biases against people with facial anomalies (β = -.21, SE = .07, t = 3.19, p = .001).
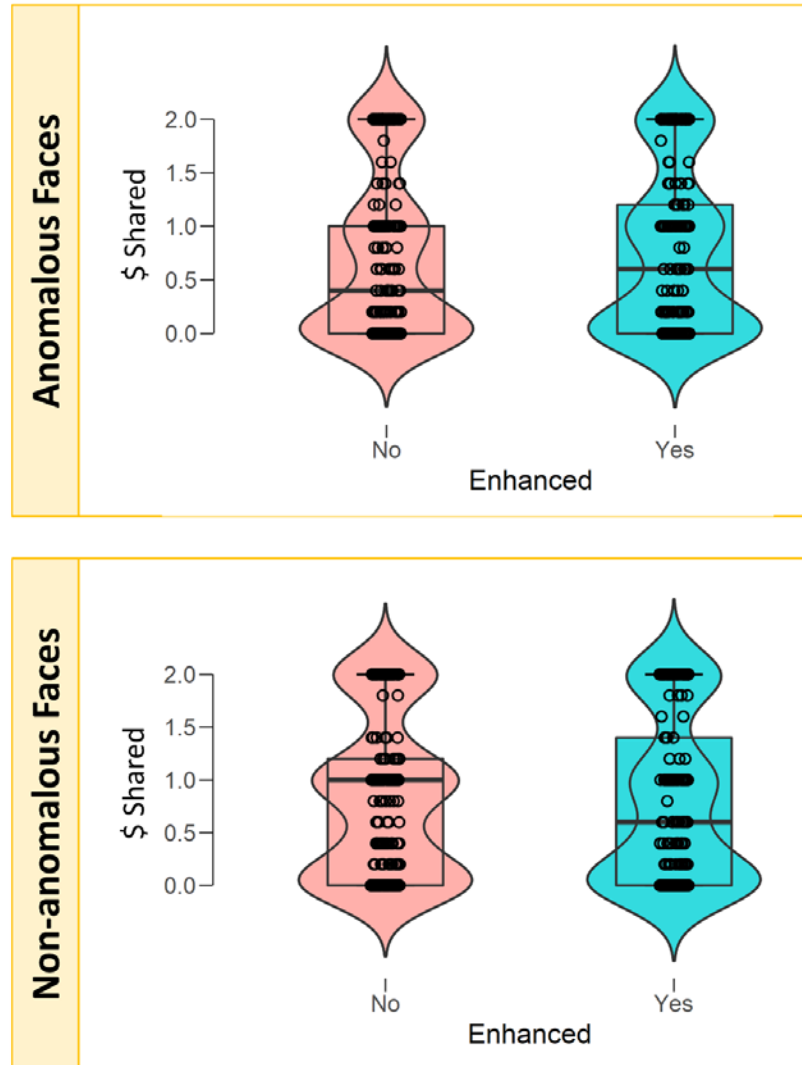
Figure 2 | Distribution of Trust Game amounts according to experimental condition

Distribution of money shared in the Trust Game visualized with violin plots (showing kernel probability density) overlaid with boxplots and jitter. Box = 25th and 75th percentiles; bars = minimum and maximum values. The median is indicated by a horizontal line inside each box. Participants could share between $0.00 USD and $2.00 USD in increments of $0.20 USD. Each violin represents one of 4 possible experimental conditions (Anomalous + Enhanced | Anomalous + Abstained | Non-anomalous + Enhanced | Non-anomalous + Abstained).

Moral Behavior in the Trust Game

We did not detect a significant main effect of face type ($F(1, 937) = 1.92$, $p = .166$, $\eta^2_{partial} = .002$) nor of enhancement outcome ($F(1, 937) = 0.036$, $p = .849$, $\eta^2_{partial} = .000$) on the amount of money shared with M. Miller in the Trust Game (Figure 2). There was also no significant interaction between face type and enhancement outcome ($F(1, 937) = 0.729$, $p = .393$, $\eta^2_{partial} = $
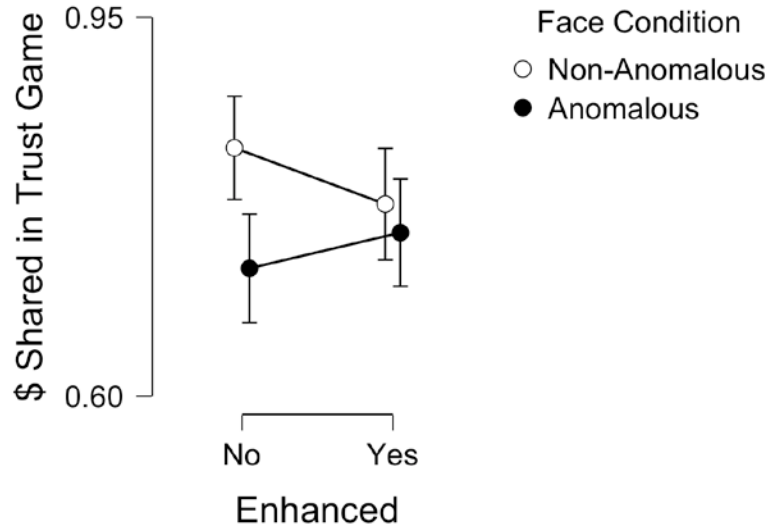
Figure 3 | Interaction effect of face type and enhancement outcome on money shared with M. Miller in the Trust Game

We did not detect significant main effects for face type (Anomalous | Non-anomalous) and enhancement choice (Enhanced | Abstained) nor an interaction between the two for money shared with M. Miller in the Trust Game. Participants could share an amount ranging from $0.00 USD to $2.00 USD in increments of $0.20 USD. Error bars represent SEM.

.001; Figure 3). Our pre-registered analysis plan assumed the amount given would be continuous, since participants could share any amount between $0 USD and $2 USD in $0.20 USD increments, but the data were better characterized by a bimodal distribution whereby participants either shared something or nothing at all. We therefore dichotomized the amount shared (Shared | Did not share) and submitted this variable to a logistic regression, which showed no significant effect of either experimentally manipulated condition in predicting Trust Game behavior, χ^2 = 3.27, p = .35. The distribution of the dichotomized behavioral data is visualized in Figure 4.

Secondary analyses of Trust Game behavior converged on a model that included face type, participant sex, belief in procedural justice towards others, and explicit biases. Only sex (β = -.16, SE = .05, t = 3.29, p = .001) and beliefs about procedural justice towards other (β = .04, SE = .02, t = 1.97, p = .049) were statistically significant predictors, although the latter would not survive correction for multiple comparisons. Interestingly, women (M = 0.68, SD = 0.71) shared less than men (M = 0.84, SD = 0.79) during the Trust Game.
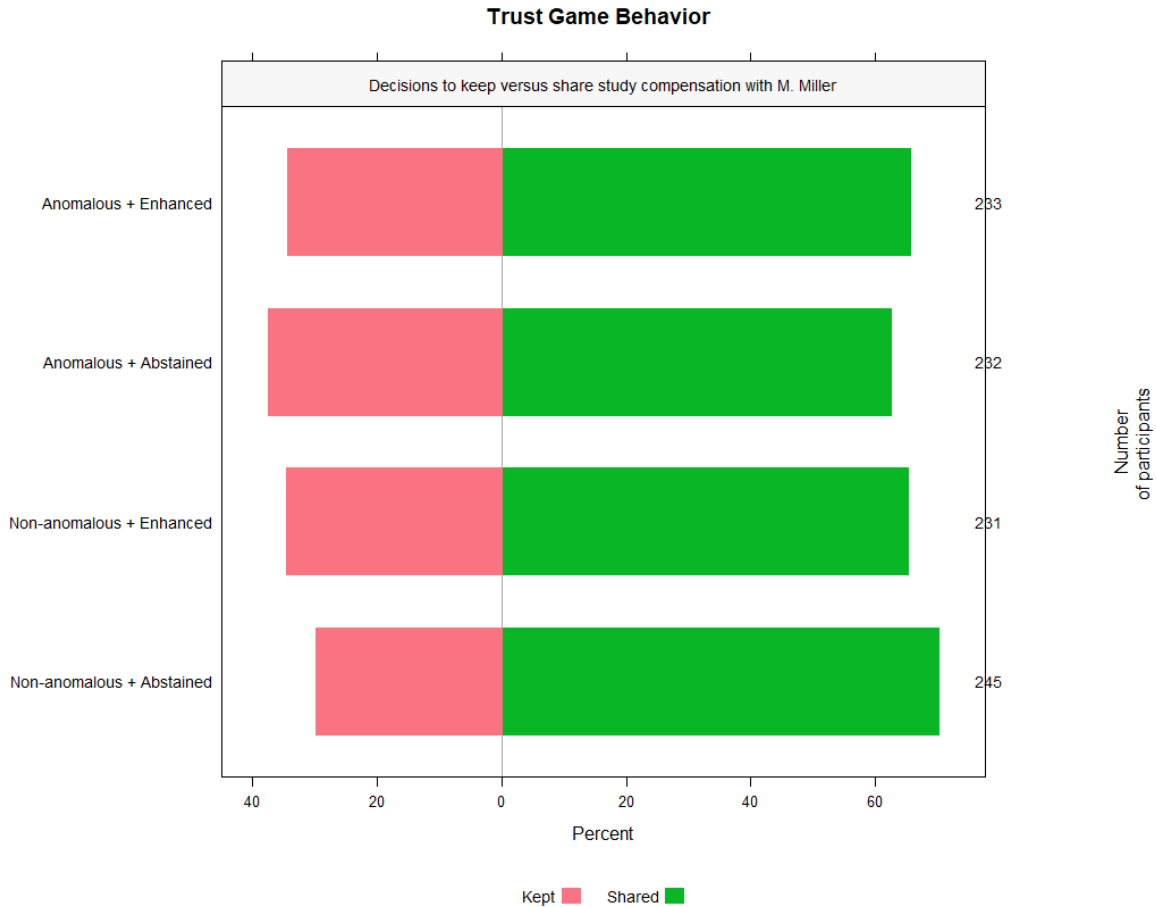
Figure 4 | Distribution of Trust Game data for binary analysis

Numbers of participants who either kept their compensation in its entirety instead of sharing with M. Miller or who shared any value greater than $0.00 USD with M. Miller. The horizontal width of each color bar represents the proportion of respondents who responded in the Trust Game according to the category indicated in the legend. Responses for each category are further split according to experimental condition—specifically, face type and enhancement outcome (left vertical axis).

Perceptions of Warmth and Competence

With respect to M. Miller's perceived warmth, there was a significant main effect of enhancement outcome ($F(1, 937) = 4.19$, $p = .04$, $\eta^2_{partial} = .004$). Participants who thought M. Miller enhanced were less confident that M. Miller would share the money fairly ($M = 3.62$, $SD = 1.97$) than participants who thought M. Miller abstained ($M = 3.88$, $SD = 1.90$). We did not detect a significant main effect of face type ($F(1, 937) = 2.43$, $p = .12$, $\eta^2_{partial} = .003$) nor a significant interaction between face type and enhancement outcome ($F(1, 937) = 0.08$, $p = .77$, $\eta^2_{partial} = .000$). Regarding the perceived importance of warmth to participants' Trust Game
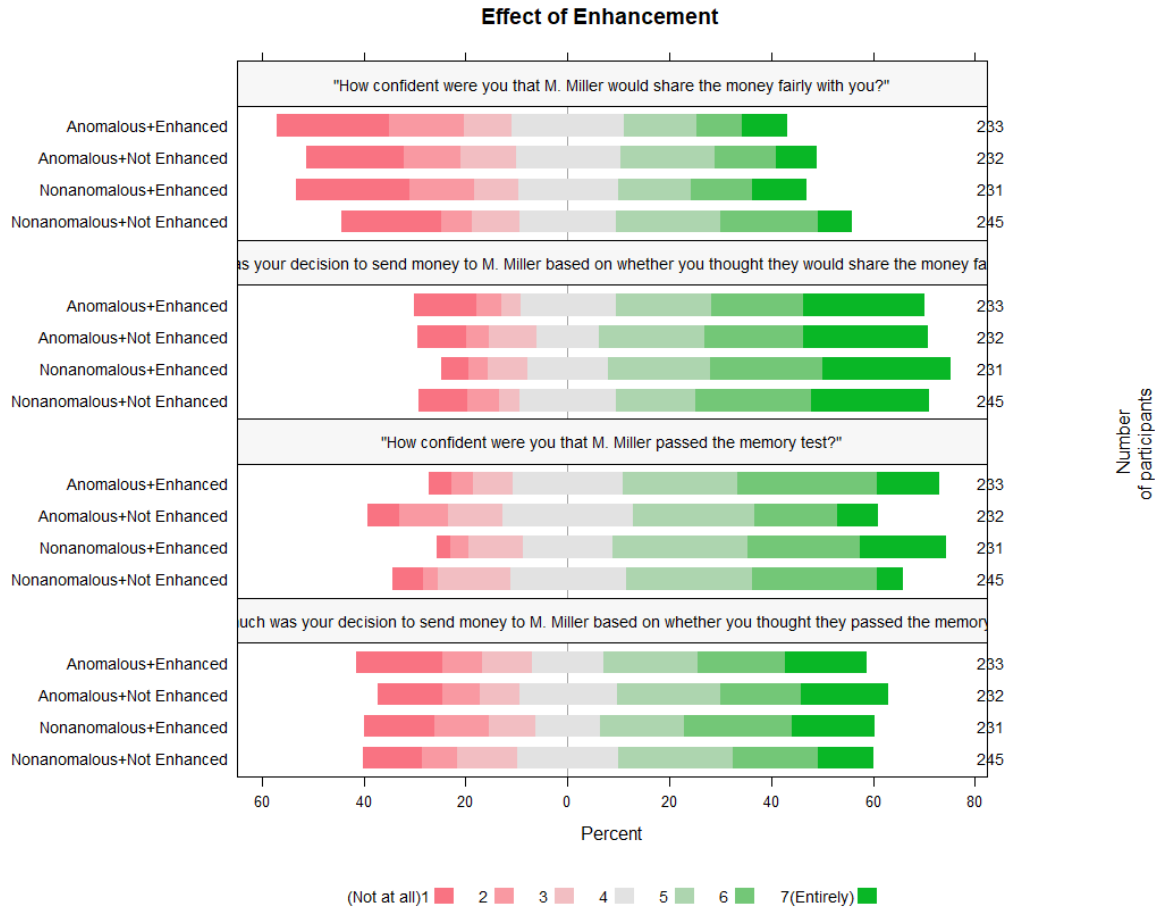
Figure 5 | Effects of enhancement on perceptions of warmth and competence

Distributions of ratings for warmth and competence by experimental condition—specifically, face type and enhancement outcome (left vertical axis). Scores represent assessments of warmth and competence as well as the perceived importance of each factor in determining Trust Game behavior (1 = "Not at all confident", 7 = "Entirely confident"). The horizontal width of each color bar represents the proportion of respondents who selected the corresponding score in the legend. Positive ratings are in green and negative ratings are in red.

behavior, we did not detect significant main effects of face type ($F(1, 937) = 1.73$, $p = .19$, $\eta^2_{partial} = .002$) or enhancement outcome ($F(1, 937) = 0.33$, $p = .56$, $\eta^2_{partial} = .000$) nor did they significantly interact ($F(1, 937) = 1.73$, $p = .19$, $\eta^2_{partial} = .002$).

With respect to M. Miller's perceived competence, there was a significant main effect of enhancement ($F(1, 937) = 23.55$, $p < .001$, $\eta^2_{partial} = .025$). Participants who thought M. Miller enhanced were more confident that M. Miller passed the memory test ($M = 4.90$, $SD = 1.51$) than participants who thought M. Miller abstained ($M = 4.42$, $SD = 1.54$). We did not detect a significant main effect of face type ($F(1, 937) = 2.45$, $p = .12$, $\eta^2_{partial} = .003$) nor a significant
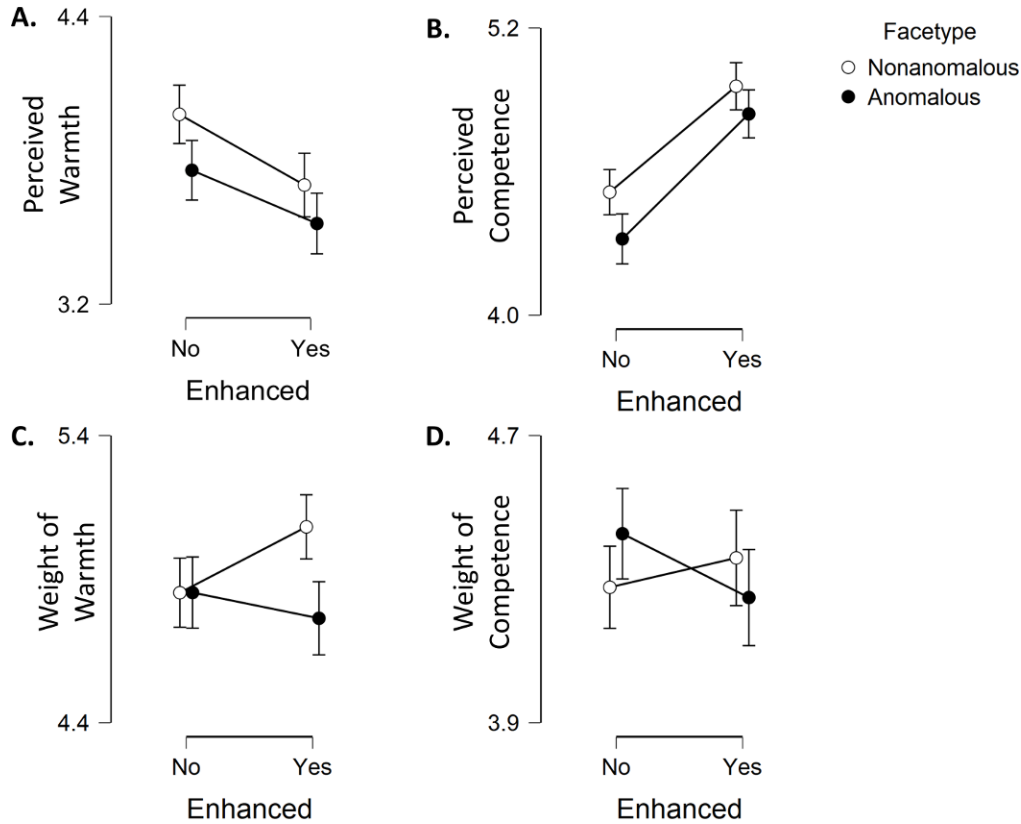
Figure 6 | Interaction effect of face type and enhancement outcome on perceptions of warmth and competence

Mean ratings for confidence in warmth and competence according to face type and enhancement outcome (1 = "Not at all confident", 7 = "Entirely confident"). Error bars reflect SEM. A. Belief that M. Miller would return a fair share of the money, reflected in a main effect of enhancement, $p < 0.04$. No other significant effects, $p > .05$. B. Belief that M. Miller passed the memory test, reflected in a significant main effect of enhancement, $p < .001$ (no other significant effects, $p > .05$). C. Belief that participants decided how much money to share with M. Miller because of M. Miller's warmth, no significant effects, $p > .05$. D. Belief that participants decided how much money to share with M. Miller because of M. Miller's competence, no significant effects, $p > .05$.

interaction between face type and enhancement outcome ($F(1, 937) = 0.16$, $p = .69$, $\eta^2_{partial} = .000$) on beliefs about competence. With respect to the perceived importance of competence to participants' Trust Game behavior, we did not detect significant main effects of face type ($F(1, 937) = 0.02$, $p = .88$, $\eta^2_{partial} = .000$) or enhancement outcome ($F(1, 937) = 0.14$, $p = .71$, $\eta^2_{partial} = .000$) nor did they interact significantly ($F(1, 937) = 1.05$, $p = .31$, $\eta^2_{partial} = .001$). The distributions of the warmth and competence ratings are given in Figure 5, and plots visualizing

interactions between face type and enhancement outcome on perceived warmth and competence are shown in Figure 6.

Discussion

This pre-registered study (https://osf.io/uaw6c) tested the hypothesis that visible facial differences—namely, scars—have negative repercussions for people's moral judgments and behavior related to cognitive enhancement. As predicted, and in support of this hypothesis, participants who saw a picture of M. Miller with facial anomalies found the prospect of M. Miller enhancing less fair and would judge M. Miller to be less authentic than participants who saw M. Miller with a typical face. Previous studies explored the consequences of social context on the prevalence and perceived moral acceptability of cognitive enhancement for improving mental functioning (Conrad et al., 2019; Dinh et al., 2020). Orthogonal to this work, a growing literature in moral cognitive science finds that spontaneous inferences about moral character are informed by aesthetic features like physical appearance (He et al., 2022; Klebl et al., 2022), including the presence or absence of facial anomalies (Workman et al., 2021). We sought to establish the generalizability of this effect by determining whether moral judgments and behavior linked to cognitive enhancement also depend on facial typicality. People with facial anomalies experience social penalties in everyday life (Hartung et al., 2019; Houston & Bull, 1994; Jamrozik et al., 2019; Madera & Hebl, 2012; Mojon-Azzi et al., 2008; Workman et al., 2021), an effect we call the "anomalous-is-bad" stereotype (Workman et al., 2021). We find evidence that these social penalties include negative moral beliefs about the fairness and authenticity of people with facial anomalies who use cognitive enhancement. The findings also bolster the claim that moral attitudes towards cognitive enhancement depend on social context—here, the facial appearance of our social partners.

Diverging from fairness and authenticity, facial appearance did not impact judgments of whether M. Miller *should* have used cognitive enhancement pills. This divergence illustrates the importance of the language used to elicit moral judgments in shaping what those judgments ultimately capture (Kahane & Shackel, 2010). Beliefs about what one *ought* to do may be less susceptible to the social contextual features examined here. This insusceptibility could indicate that beliefs about moral obligation are more central to personal identity than beliefs about fairness and authenticity and are consequently less flexible to social contextual factors

(Strohminger & Nichols, 2014). Although exploratory, we also extend earlier work linking just world beliefs to the anomalous-is-bad bias (Workman et al., 2021) by demonstrating relations between judgments of moral obligation and individual differences in just world beliefs (i.e., people are generally subjected to fair procedures). Taken together, we find evidence for malleability in moral attitudes towards cognitive enhancement as reported previously (Bedzow, 2018; Mayor et al., 2019; Medaglia et al., 2019), although the extent of this elasticity depends on the specific moral attitude or behavior in question and on the characteristics of the moral agent.

This study also tested the hypotheses that people with facial anomalies are subjected to harsher moral treatment, and that this treatment is contingent on whether those people ostensibly enhanced. Interestingly, we did not detect significant differences in whether and how much participants shared in the Trust Game as a function of face type and enhancement outcome. This null finding raises intriguing possibilities. First, although participants made negative moral judgments about M. Miller with facial anomalies, they may discard or update these crude moral intuitions in favor of newly acquired information as it becomes available (e.g., from the vignette and from whether M. Miller enhanced). This perspective aligns with evidence that individuating outgroup members with personal information about them can ameliorate negative biases directed against them (Bilici et al., 2022; Majdandžić et al., 2012). Alternatively, the Trust Game may not capture the kinds of social penalties levied upon people with facial anomalies in the real world. This alternative seems unlikely, however, since negative consequences of facial anomalies for perceived trustworthiness have been replicated (Jamrozik et al., 2019; Workman et al., 2021).

Previous work has consistently demonstrated that facial anomalies negatively affect perceptions of warmth (e.g., trustworthiness), with less consistent evidence for a negative effect on perceptions of competence (Bilici et al., 2022; Jamrozik et al., 2019; Workman et al., 2021, 2022). In contrast to these studies, however, we did not uncover evidence that facial anomalies influenced perceptions of warmth let alone competence. This discrepancy may be attributable to differences in how warmth and competence were operationalized relative to previous studies (e.g., warmth as confidence in "fairness" here, warmth as a composite of multiple rating dimensions in previous studies). Alternatively, this discrepancy may stem from *how* (i.e., as informed judgments about a specific event here, as intuitions in previous studies) and/or *when* (i.e., after learning information about the person being judged in this study, before learning information about the person in previous studies) warmth and competence were assessed.

Although facial appearance did not affect sharing in the Trust Game, the enhancement outcome did—as predicted, M. Miller was seen as more competent if they cognitively enhanced than if they did not. Information about cognitive enhancement may have weighed more heavily on behavior than facial appearance since the outcome of the Trust Game was directly linked to M. Miller's competence. We consider one final possibility. The majority of participants shared either $0 or the maximum possible amount ($2) with M. Miller. This could be indicative of floor and ceiling effects. If participants have a strong propensity to either risk everything or nothing at all, then a subtle effect of facial anomalies may be difficult to detect. Of note, since compensation for research participation represents a source of income for some MTurkers, their personal financial needs may have prevented them from sharing with M. Miller (this prospect is explored further below).

In addition to determining whether facial anomalies and cognitive enhancement impacted moral judgment and behavior, we also wished to explore *why* this might (or might not) be the case. People reportedly believe that cognitive enhancement improves competence, which has been positively related to judgments of ethicality (Baranski et al., 2004; Ilieva et al., 2013; Lafrenière et al., 2016; Mayor et al., 2019). Consistent with earlier reports, cognitive enhancement had consequences for perceptions of warmth and competence (regardless of face type). Participants who were told M. Miller enhanced judged M. Miller to be more competent and less warm than participants who were told M. Miller abstained. The observation of higher competence ratings after M. Miller ostensibly enhanced agrees with earlier work showing that people believe cognitive enhancement is effective at improving mental functioning. Additionally, lower ratings for warmth detected after M. Miller enhanced suggests that moral concerns about cognitive enhancement translate into moral concerns about character.

Several potential limitations to our study warrant consideration. First, our participants were crowdsourced from MTurk. We recruited through MTurk because it provides access to a diverse pool of potential participants, and because its large response rate renders it more reliable than several other online platforms for participant recruitment (Buhrmester et al., 2011). MTurk is not, however, without drawbacks—for instance, some of the characteristics of MTurkers may not generalize to the greater population. In contrast to undergraduate research participants seeking pocket money, some MTurkers likely receive a significant proportion of their income from completing surveys. which could render them hesitant or even unable to share their

compensation (Ross et al., 2010). Second, we measured moral behavior with the Trust Game. It is possible that facial anomalies are linked to moral mistreatment, but the Trust Game is not the right test for detecting that mistreatment. This could happen if, for instance, the Trust Game fails to approximate real world conditions, or if another test (e.g., a different economic game or a different paradigm entirely) is better suited to detecting mistreatment. We used the Trust Game because the finding that anomalous faces are perceived as less trustworthy has been replicated (Jamrozik et al., 2019; Workman et al., 2021). Third, we used a hypothetical vignette. The vignette—which describes one person's experience with cognitive enhancement—may have included extraneous information and/or excluded critical information necessary for eliciting ecologically valid moral judgments about cognitive enhancement. These were necessary features of the study design that constitute limitations that we hope will be addressed in future studies.

Conclusion

We present evidence that appearance is yet another contextual factor that guides public attitudes about cognitive enhancement. Specifically, the use of cognitive enhancement by people with anomalous faces was judged less fair and less authentic than the use of cognitive enhancement by people with typical faces. Facial anomalies did not affect attitudes about the moral obligation to cognitively enhance, however, nor did they affect moral behavior assessed with the Trust Game. Our findings extend earlier work by demonstrating the generalizability of the anomalous-is-bad stereotype to moral judgments about cognitive enhancement, while also carving out facets of moral judgment and behavior that are unaffected by facial typicality. Public attitudes towards facial anomalies are complex and, in view of burgeoning evidence for the anomalous-is-bad stereotype, are in urgent need of further characterization.

Declaration of Conflicting Interests: The Authors declare that there is no conflict of interest.

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