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Koverola, Mika

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Treatments approved, boosts eschewed: Moral limits of neurotechnological enhancement☆

Mika Koverola [a,*], Anton Kunnari [b], Marianna Drosinou [b], Jussi Palomäki [a], Ivar R. Hannikainen [c], Michaela Jirout Košová [d], Robin Kopecký [d], Jukka Sundvall [a,1], Michael Laakasuo [a,1]

[a] University of Helsinki, Faculty of Arts, Department of Digital Humanities, Cognitive Science, P.O. Box 24 00014 University of Helsinki, Finland
[b] University of Helsinki, Faculty of Medicine, Department of Psychology and Logopedics, Haartmaninkatu 8 P.O. Box 63 00014, University of Helsinki, Finland
[c] University of Granada, Departamento de Filosofía I, Edificio de la Facultad de Psicología Campus de la Cartuja, 18011 Granada (España), Spain
[d] Charles University (Czechia), Ovocný trh 5 Prague 1, 116 36 Czech Republic, Europe

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ABSTRACT

In six vignette-based experiments, we assessed people's moral reactions towards various cognition-enhancing brain implants, including their overall approval and perceived fairness, as well as the dehumanization of brain-implanted agents. Across the domains of memory (Studies 1–4, 6), general intelligence (Study 5A), and emotional stability (Study 5B), people in general approved of alleviating ailments, and even of attaining optimal human performance, but expressed greater opposition towards superhuman levels of enhancement. Further analyses of individual differences indicated that the tendency to condemn transhumanist technologies, such as brain implants, was linked to sexual disgust sensitivity and the binding moral foundations – two characteristic correlates of a conservative worldview. In turn, exposure to science fiction was tied to greater approval of brain implants. We also examined potential idiosyncrasies associated with our stimulus materials and did not find reliable effects of any secondary factors on moral attitudes. Taken together, our studies reveal certain moral boundaries to neurotechnological enhancement, strong among those with conservative affective and moral dispositions but relaxed among those familiar with science fiction themes.

Cognitive enhancement can be defined as "the use of medications or other brain treatments for improving normal healthy cognition" (Farah, 2015, p. 379), or more widely as any enhancement of cognitive capacities from any baseline, whether healthy or impaired (Glannon, 2015). In this paper, we use the wider definition of enhancement as we look into the different moral responses evoked by different levels of enhancement. Cognitive enhancement technology can be seen as a *transhumanist* technology: something that enables the modification of human bodies or minds, or overcoming human limitations. The idea of using technology not simply to treat illness or injury but to improve the brains of healthy people is known to raise a variety of moral objections. Would "boosting the brain" give an unfair advantage to the enhanced? Would such enhancement take away something fundamentally *human* from the enhanced? We examined a suite of attitudes in relation to varying levels of neurocognitive enhancement: moral approval, perceived unfairness, and dehumanization. Our studies focus on aspects of neurocognitive enhancement that have been repeatedly highlighted in the literature as factors affecting people's judgments of enhancement, as well as individual difference measures related to both moral judgment and familiarity with science fiction themes. In sum, we asked: what kinds of people are more likely to view enhancement negatively, what kinds of enhancement are viewed more negatively than others, and why?

The theme of making oneself more intelligent or perceptive recurs throughout different cultures, from ancient Greek religion (Ahearne-Kroll, 2014) and the Indian yogic tradition (Aguiar & Borowski, 2013) to Western mysticism (Mathers, 1904). Probably the most famous Western example of fictional cognitive enhancement is the story of Dr. Faust, who makes a deal with the Devil to gain knowledge (Marlowe, 1604; von Goethe, 1808). Neurocognitive enhancement is also a fixture of the

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* Corresponding author.
E-mail address: mika.koverola@helsinki.fi (M. Koverola).

[1] Equal contributions.

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modern science fiction genre, owing in part to movies like *The Matrix* and *Johnny Mnemonic* released in the late 1990s. In terms of real-world technology, the first generation of neural implants have already seen moderate success: for instance, cochlear implants enable the deaf to regain their hearing (Ylikoski & Raivio, 1997), and deep brain stimulating microchips alleviate the symptoms of Parkinson's disease (Houston, Thompson, Ko, & Chizeck, 2018). More advanced neural implants that would allow individuals to enhance their memory recall (Hampson et al., 2018) or control robotic limbs (Clites et al., 2018) are being piloted. The societal implications are becoming apparent as companies like Neuralink claim they are approaching breakthroughs of installing silicon chips into human brains on a commercial scale (Musk, Elon, & Neuralink, 2019). Will this lead to a cycle of competitive enhancement, where people unable to afford newest neural implants will be marginalized?

Although superhuman cognitive enhancement remains a fantasy, it is interesting to note its long presence in fiction and mythology, and the kinds of moral reactions associated with it. The idea of maximizing one's cognitive capacities is fascinating, but it can also cause moral apprehension – even within the same person. In Faust's case the price of enhancement was his soul. Even in the cyberpunk genre, where brain-enhancing implants are an everyday technology, the moral of the story is frequently that too much enhancement leads to mental illness or characters "frying" their brains (for example, *Mona Lisa Overdrive* by William Gibson, 1988 or *Snowcrash* by Neal Stephenson, 1992). This echoes real-world concerns, voiced by The President's Council on Bioethics (2003), that enhanced individuals may end up "turning into someone else" or undergo other forms of "soul corruption". Leon Kass, former chair of the Council, called cognitive enhancement technologies "dehumanizing" (Kass, 2002). Empirical evidence on folk dualism (Anglin, 2014; Richert & Harris, 2008) and the concept of personal identity (Heiphetz, Strohminger, Gelman, & Young, 2018; Jirout Košová, Kopecký, Oulovský, Nekvinda, & Flegr, 2021; Strohminger & Nichols, 2014, 2015) help in understanding these ethical concerns. The central traits in the folk characterization of soul overlap substantially with the traits that constitute the core of the folk concept of personal identity (i.e., the "essential moral self" and the "true self"), both emphasizing broad features like mental acuity and empathy over specific talents like mathematical ability or musicality.

Moral attitudes towards cognitive enhancements have been examined by various philosophers and interdisciplinary research teams (Bostrom & Roache, 2007; Fitz, Nadler, Manogaran, Chong, & Reiner, 2014; Hyman, 2011; Landy, Walco, & Bartels, 2017; Scheske & Schnall, 2012). In this literature, four ethical concerns emerge repeatedly: (1) *authenticity* (whether the achievements of enhanced individuals can be considered truly theirs), (2) *safety* (whether there are considerable negative side-effects of the enhancement), (3) *fairness* (whether enhancement confers undue advantages to individuals), and (4) *social pressure* (whether enhancement technologies could become a de facto demand, e.g., in professional contexts). Another recurring theme, within the field of bioethics, is the distinction between treatment (as the term is used in the field of bioethics: alleviating symptoms of an illness or restoring capacities lost to illness) and enhancement (specifically, enhancement above the normal human baseline; Daniels, 2000; Wolpe, 2002). For the sake of clarity, we will hence refer to this distinction as a distinction between treatment and "boosting", as the definition of enhancement in the bioethical literature is narrower than the definition we will use throughout this paper (where it covers both treatment and boosting). The general public and bioethicists largely agree that using medical technologies for treatment is acceptable, but using them to gain superhuman abilities is not (Persson & Savulescu, 2008; Sahakian & Morein-Zamir, 2011; for contrasting views see Gazzaniga, 2005; Greely et al., 2008). Research also suggests that people may *dehumanize* cognitively boosted individuals, that is, view them as "less human". Specifically, Castelo, Schmitt, and Sarvary (2019) found that people rated a hypothetical user of cognitive enhancement as more "robot-like" if the user boosted their cognitive capacities above the normal human baseline than if they merely restored capacities lost due to illness. In other words, a superhuman increase in a person's cognitive capacities may result in the perception that they are lacking in humanity (e.g., that they may have lost some of their emotional capacities).

In the current studies, we presented participants with fictional scenarios involving futuristic neurocognitive enhancement and documented their attitudes of moral approval, perceived unfairness, and dehumanization. First, we sought to replicate the moral distinction between treatment and boosting to superhuman capabilities observed in prior studies. We also wished to clarify this distinction by examining whether it stems from treatment being seen as more justifiable than (any amount of) non-therapeutic enhancement, or from a selective opposition to 'boosting' above the normal human range. To this end, we included a third experimental condition describing enhancement that did not treat an illness, but also did not enhance cognition above a normal human level (Studies 1–4 and 6). Additionally, we adopted an individual differences approach, examining the predictors of moral attitudes towards neurocognitive enhancement. In the following section, we provide an overview of the measures of interest.

1. Individual differences and science fiction hobbyism

Both anecdotal and empirical evidence suggest that cognitive enhancement is a divisive issue. Therefore, in our present studies, we took into consideration various individual differences, in conjunction with our experimental manipulations, to strengthen our understanding of the psychological mechanism (see Young & Saxe, 2011 for a brief review). In particular, we examined participants' patterns of moral foundations (i.e., what kinds of values and virtues they consider relevant in their moral reasoning), their levels of disgust sensitivity, and exposure to science fiction as potentially relevant individual difference measures in the context of futuristic neurocognitive enhancement.

The Moral Foundations Theory (MFT; Graham, Haidt, & Nosek, 2009; Graham et al., 2011) proposes a set of different foundations for moral judgment, with the importance of each foundation varying from person to person. The moral foundations can be roughly grouped into two categories: *individualizing* (harm/care, fairness/reciprocity) and *binding* (ingroup/loyalty, authority/respect, and purity/sanctity). Political liberals tend to emphasize the individualizing moral foundations, while conservatives demonstrate concern for both binding and individualizing foundations (Van Leeuwen & Park, 2009; Waytz, Iyer, Young, Haidt, & Graham, 2019). It is not yet clear where cognitive enhancement would land in terms of the moral foundations (Mihailov, Rodríguez López, Cova, & Hannikainen, 2021). As mentioned earlier, people express concerns about *fairness* on the grounds that enhancement technology can exacerbate privilege and inequality, suggesting that condemnation of cognitive enhancement would arise among people who prioritize individualizing foundations. On the other hand, enhancement technologies may be seen as violations of bodily purity, or as deviation from ingroup norms, which would make them a concern for those who prioritize binding foundations.

Ample work in moral psychology has documented associations between disgust and moral judgment (see Haidt, Rozin, McCauley, & Imada, 1997; Schaich Borg, Lieberman, & Kiehl, 2008; Van Leeuwen, Dukes, Tybur, & Park, 2017). Currently, there are several models of disgust sensitivity but the field lacks agreement on which model is to be preferred (Burlington, McDaniel, & Wilson, 1997; Davey, 2011; Tybur, Lieberman, Kurzban, & DeScioli, 2013). One of the most studied and validated instruments is an evolutionary psychological model of disgust (Tybur, Lieberman, & Griskevicius, 2009). This model argues that there are three different functions for disgust, stemming from evolutionary pressures; these dimensions are pathogen disgust, sexual disgust and moral disgust. The function of pathogen disgust is to protect the organism from disease vectors, while the function of sexual disgust is to help the organism avoid costly mate choices. Originally, when these

instruments were being developed, there was speculation as to whether moral disgust is an independent dimension of disgust or an artifact (Chapman & Anderson, 2014; Landy & Goodwin, 2015; Olatunji et al., 2012; Rozin & Haidt, 2013; Tybur et al., 2013). Olatunji et al. (2012) found that the moral disgust sensitivity subscale specifically seems to more reliably measure anger towards moral violations rather than disgust. Laakasuo, Sundvall, and Drosinou (2017) also found that the non-moral disgust sensitivity subscales predicted moral judgments in commonly-used utilitarian dilemmas, whereas moral disgust sensitivity did not.

Interestingly, individual differences in non-moral disgust sensitivity predict moral condemnation of several different types of technology. For instance, in a recent paper by Royzman, Cusimano, and Leeman (2017), the authors show that pathogen disgust predicts general disapproval of genetic modification and other futuristic technologies. Similarly, Koverola et al. (2020) found that sexual disgust sensitivity is associated with disapproval of sex robots. There is also prior evidence that sexual disgust specifically predicts disapproval of hypothetical transhumanist technologies such as *mind uploading* (Laakasuo et al., 2018, 2021). Although existing research has not yet explained why a connection between sexual disgust and reactions towards transhumanistic technology exists, it seems to be a robust association. Also, even though the purity moral foundation, a part of the binding foundations, concerns the moral judgment of acts seen as disgusting, sexual disgust sensitivity and moralization of the purity domain predict independent variance in attitudes towards transhumanist technologies (Laakasuo et al., 2018). Therefore, these findings motivate the prediction that disgust reactions may undergird disagreements in the domain of neurotechnological enhancement as well.

Moreover, previous research has shown that individual levels of science fiction hobbyism are associated with moral approval of futuristic technologies, even after controlling for the effects of moral foundations (Laakasuo et al., 2018). It therefore stands to reason that science fiction hobbyists could hold more favorable attitudes towards cognitive enhancement. We thus measured science fiction hobbyism in our studies.

Finally, while we have proposed that the individual difference measures may have direct associations with attitudes towards cognitive enhancement, we do not rule out the possibility of effects moderated by level of enhancement. For example, prior to running our studies it appeared equally possible that moralization of the purity domain could be related to condemnation of neurotechnology use, regardless of enhancement level, *or* to condemnation of non-therapeutic or superhuman enhancement specifically. Thus, we had no a priori assumptions on moderated effects for any of the individual difference measures.

2. Current studies

In six studies, we examined moral judgments of memory (Studies 1–4 and 6), intelligence (Study 5A) and emotional (Study 5B) enhancement using the contrastive vignettes method. Our primary experimental factor was the level of enhancement (how much cognition was enhanced compared to baseline). Our dependent variables were the moral approval of the enhancement procedure, the perceived unfairness of the enhancement, and the dehumanization of the enhancement user. Our studies experimentally manipulated several secondary factors related to safety and the mode of treatment (established vs. experimental, surgery vs. nano-robots, surgery vs. drugs), yet none of these manipulations had consistent effects (see Appendix A for full coverage). In addition to experimental factors, we assessed participants' moral foundations, disgust sensitivity and exposure to science fiction as potential (i) correlates of moral attitudes, and (ii) moderators of the distinction between levels of enhancement.

Our interim meta-analysis revealed individual differences in attitudes towards neurotechnological enhancement that were unrelated to levels of enhancement. So, in Study 6, we contrasted attitudes towards agents who *agreed* versus *refused* to undergo a brain enhancement surgery. This condition helped to rule out the possibility that the observed associations reflected an overall negativity effect and provided support for the conclusion that they document differences in approval versus opposition to the *use* of cognitive enhancement. Our aim was to expand the research on moral judgments about enhancement towards understanding individual differences in judgment, in a similar way to Mihailov et al. (2021).

Research questions (RQs). We expected to conceptually replicate survey evidence of a moral distinction between treatment (i.e., alleviating the adverse effects of age or illness) and boosting (i.e., enabling superhuman abilities; see Pew Research Center, 2016). Expanding on previous studies in this area, we contrasted how people react to cognitive enhancement technologies when these are used to attain three distinct levels of enhancement: *alleviation*[2] (of an existing ailment), *optimization* (enhancement within the normal human range), and *superhuman* (enhancement above the normal human range). Adopting this design enabled us to understand whether enhancements within the natural human range suffice to elicit a treatment/boosting distinction, or whether instead the distinction is driven by specifically *super*-human cognitive capacities (RQ 1). In Studies 1–4 and 6, the optimization and superhuman conditions described enhancements without any underlying ailment; in Studies 5A and 5B, these conditions described enhancements that helped a person with an underlying ailment to different degrees.

Because our studies manipulated the level of enhancement relative to one's personal ability, and the extent of the normal human range, we assessed whether the perceived unfairness of the enhancement would vary as a function of the level of enhancement along with moral approval. That is: Is moral disapproval of neurocognitive enhancement accompanied by perceptions about its unfairness (RQ 2)? Beyond examining people's attitudes towards the act of enhancement, we were also interested in understanding their perceptions of the enhancement *users* themselves. Inspired by previous research, we speculated that enhancement users could be a target of dehumanization. Accordingly, we evaluated the degree to which the level of enhancement caused participants to dehumanize enhancement users throughout our studies (RQ 3).

In terms of individual differences, we were primarily interested in disgust sensitivity, moral foundations, and exposure to science fiction as covariates of judgments about enhancement. The inclusion of these measures was motivated by prior studies, in which these measures have been associated with moral judgment in general, and/or moral judgment about futuristic technology in particular (Laakasuo et al., 2018; Royzman et al., 2017). We were interested in understanding whether the individualizing and/or binding foundations would predict moral disapproval, perceived unfairness, and/or dehumanization. Additionally, we examined whether these two types of moral foundations would yield opposing directional effects, given their associations with opposite value clusters (RQ 4.1). Given previous links between disgust sensitivity and moral judgment, we explored connections between three different forms of disgust sensitivity and our dependent variables (RQ 4.2). Lastly, we were interested in seeing if cultural exposure to ideas about futuristic technology (or familiarity on a conceptual level) would predict

[2] We use the term *alleviation* instead of *treatment*, because while treatment often refers to treating an existing medical condition and is commonly used in that sense in the bioethical discussion, it can also be used in a broader sense (Merriam-Webster: *treatment* definition 2b: something [such as a product or technique] used in treating, enhancing, or improving the performance, condition, or appearance of someone or something). Alleviation is a more precisely defined term, meaning exactly what we wanted the condition to be (Merriam-Webster: *alleviate* definition a: to make [something, such as pain or suffering] more bearable or definition b: to partially remove or correct [something undesirable]).

favorable attitudes towards neurotechnological enhancement, by assessing individual differences in science fiction hobbyism (RQ 4.3). After reporting a summary of our experimental results, we present a series of covariate analyses (in the aggregate for all studies) investigating the role of moral foundations, disgust sensitivity and science fiction hobbyism in attitudes towards cognitive enhancement.

3. General methods

3.1. Participants and design

In each study, participants were randomly assigned to one of the experimental conditions with an equal probability for each. The experimental design was 1 × 3 in Study 1 (enhancement: alleviation, optimization, superhuman), and 2 × 3 in Studies 2–6 (secondary experimental factor × enhancement: alleviation, optimization, superhuman). Studies 1, 2 and 6 were conducted online (156 Finnish participants recruited in online forums, 435 MTurk crowdworkers and 990 Prolific users, respectively) and Studies 3–5 in the lab (198, 213 and 263 Finnish participants respectively; for more details see Table 1). Full recruitment and procedure descriptions are provided in Appendix F. Required minimum sample size per condition was calculated beforehand based on having 80% power to detect small-to-medium effects (Cohen's *d* between 0.2 and 0.5) with 0.05 level of significance by using G*Power calculations. No data was viewed or analyzed before closing data collection. Study 4 was preregistered at [3]https://osf.io/6k28x/ and Study 6 at https://osf.io/zwm5c/. All materials, data, power and sensitivity analyses, and exclusions can be found at https://osf.io/5h8a4/. We report all measures, manipulations, and exclusions in these studies.

3.2. Procedure

Participants first completed a series of individual difference measures, then read the vignette and completed the dependent measures, and finally provided demographic information.

Table 1
Participants in Studies 1–6.

	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
Participants (N)	156	435	198	213	263	990
Male	78	156	76	93	114	405
Female	67	273	122	120	149	582
Mean age	33.06	33.40	29.51	32.68	30.15	39.04
SD_{age}	12.16	9.95	9.43	12.00	9.93	13.85
% with at least bachelor's degree	30%	58%	58%	66%	63%	62%
Level of income (see note)	76%	75%	90%	83%	89%	68%

Note. The participants in Studies 5A and 5B were the same. Level of income = % participants with average or lower income compared to the general population subjectively. Genders do not always sum to the total N because some participants did not indicate their gender.

3.3. Materials

3.3.1. Stimuli

In Study 1, participants were randomly assigned to read one of three vignettes involving either alleviation, optimization or superhuman cognitive enhancement. The vignettes described a scenario in the year 2050 where getting memory-improving brain implants is a common procedure for treating various illnesses. An office worker named Alex is about to retire and is given the opportunity to have an implant operation, the purpose of which varied across experimental conditions. Specifically, the operation would either cure his early stage dementia (alleviation condition), restore his memory capacity to the level of his youth (optimization condition), or give him the ability to perfectly remember everything he has read, heard or otherwise experienced (superhuman condition). After discussing the operation with a doctor, Alex decides to sign up for the waiting list for the procedure. The outcome of the implant operation was not described.

Studies 2–6 built upon this template, by including a second, orthogonal factor, which varied from study to study. Descriptions are provided in the sections for each study in Appendix A. Study 5 switched the domain of enhancement from memory to intelligence and emotional stability. Study 6 was the only study to include conditions where the character in the vignette decides to not undergo the enhancement operation (refuse conditions) in addition to conditions where the character does decide to undergo it (accept conditions). In Study 6, the implant procedure was also described as simply a technology that has become possible, and not described as a common treatment, in order to control for a potential confound in how safe or established the different levels of enhancement were.[4] See Appendix E for vignettes. All materials can be found at https://osf.io/5h8a4/.

3.3.2. Dependent variables

All items were rated on seven-point scales, anchored at 1 (*strongly disagree*) and 7 (*strongly agree*). See Appendices B, C and D for full lists of items and further details, and Table 2 for Cronbach's alphas.

Moral Approval. Our dependent variable was the average score of five items measuring participants' moral approval of the decision to start using an enhancement technology (example item: "Having the operation is acceptable"). Higher scores indicate greater moral approval.[5]

Perceived Unfairness. Our secondary dependent variable was the average score of three items assessing the perceived unfairness of gaining an advantage by means of enhancement (example item: "For someone in work life, the advantage provided by the microchip would be unfair). Higher scores indicate greater perceived unfairness.[6]

Dehumanization. In Study 1, we employed a single-item measure of dehumanization: "In my opinion, Alex is not completely human after the operation". From Study 2 onwards, we included a 10-item measure of dehumanization (example item: "After the operation, Alex can still feel emotions" [reverse coded]"), with higher scores indicating more dehumanization. The items were modeled according to the recommendations of Haslam (2006) and Haslam, Bastian, Laham, and Loughnan (2012) but were adapted to our context.

[3] The focus of the present studies has shifted to individual differences, which were not a focus of the preregistration. Additionally, the DV scales listed in the preregistrations of our studies have been amended to be more face-valid, while the dehumanization measure had researcher degrees of freedom from the start, as it was not clear to us how to best measure dehumanization. The list of items used in each of the studies reported here are listed in Appendices B-D; the data available online contains all of the items, including items dropped for face-validity or other concerns.

[4] Namely, describing brain implants as a common procedure for treating illnesses could make the implant in the alleviation condition seem like a more established technology than in the other two conditions, and thus bias results. Based on the results of Study 6, this does not seem to have been the case.

[5] One item was removed from the scale for Study 6, because it did not assess moral approval of a character who refuses the enhancement operation in the refuse condition. This item was "If the operation in the story existed in real life, everyone should have the right to it".

[6] One item was removed from the scale for Studies 5A and 5B, because it concerned whether users of enhancement technology should be disqualified from competitive memory sport events. As such, the item was unrelated to the subject of Studies 5A and 5B (IQ and mood, respectively).

Table 2
Cronbach's alphas for the dependent variables across studies.

	Study 1	Study 2	Study 3	Study 4	Study 5A	Study 5B	Study 6
Dependent Variable							
Moral Approval	0.85	0.86	0.83	0.86	0.88	0.90	0.79
Perceived Unfairness	0.80	0.76	0.73	0.73	0.88	0.86	0.81
Dehumanization	N/A	0.93	0.88	0.86	0.90	0.90	0.88

Note. All DVs were measured on a Likert scale from 1 to 7. Moral approval: 5 items; perceived unfairness: 3 items; dehumanization: 10 items. Dehumanization in Study 1 was measured using a single-item measure. Studies 5A and 5B had the same sample of participants.

Covariates (for Cronbach's alphas, see Table 3).

Moral Foundations Questionnaire (MFQ). The MFQ consists of 32 items measuring agreement with different claims about what is important for judging right and wrong. It was originally developed to measure individual differences in intuitive ethics based on five different foundations of morality: harm/care, fairness/reciprocity, ingroup/loyalty, authority/respect, purity/sanctity (Graham et al., 2011). However, recent studies suggest the five-factor scale structure is relatively inconsistent and unreliable (Graham et al., 2012), and instead propose dividing the MFQ into two factors: *individualizing foundations* (harm/care + fairness/reciprocity) and *binding foundations* (ingroup/loyalty + authority/respect + purity/sanctity).

Science Fiction Hobbyism Scale. This scale consists of 12 items measuring cultural exposure to science fiction themes, both consumption of science fiction in various forms and involvement in science fiction fandom. Example items include: "I consider myself a major consumer of science fiction", "I think science fiction is an interesting topic". All items were anchored from 1 (*strongly disagree*) to 7 (*strongly agree*), with responses averaged to produce a score indicating interest in and exposure to science fiction. For a full list of items, see Appendix G. For more details, see Laakasuo et al. (2018).

Three Domain Disgust Scale (TDDS). The TDDS was developed by Tybur et al. (2009) and draws on evolutionary theory. The scale has 21 items and three subscales (moral, sexual and pathogen disgust sensitivity; 7 items each). As moral and pathogen disgust had no consistent effects in our studies, we focus on the sexual disgust sensitivity subscale in this paper.

3.4. Data analysis

3.4.1. Experimental analysis

We pooled together data from Studies 1–6 (except Refuse condition), and used mixed-models to check whether participants' mean answers on each DV (moral approval, perceived unfairness and dehumanization) differed significantly across level of enhancement conditions. We then calculated meta-analytic contrast effects between Alleviation and the other two levels of enhancement.

For examining study-level effects, we ran one-way ANOVAs (Study 1) and full factorial two-way ANOVAs (Studies 2–6) including all experimental conditions. As noted above, none of the secondary experimental factors in Studies 2–6 had a consistent main effect or consistently moderated the effect of enhancement level; we report these in full in Appendix A. Where there was a main effect of enhancement level, our primary independent variable of interest, we used contrast analyses to assess the significance and direction of pairwise differences between levels of enhancement (See Appendix A for full details).

Table 3
Cronbach's alphas for the covariates across studies.

	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
Covariate						
MFQ Individualizing	0.76	0.81	0.72	0.70	0.73	0.81
MFQ Binding	0.85	0.89	0.86	0.86	0.84	0.87
Sci-Fi Hobbyism	0.89	0.91	0.89	0.91	0.89	0.92
Sexual Disgust	NA	0.90	0.78	0.79	0.79	0.84

Note. Studies 5A and 5B had the same sample of participants.

3.4.2. Covariate analyses

First, to assess whether a covariate predicted our dependent variables in general, we analyzed the connection between covariates and dependent variables by collapsing the experimental factors and running mixed-models with each covariate included as a single predictor in separate models. For these models, we used data pooled together across all studies (except Study 1 where sexual disgust measure was not collected, and Study 6 Refuse condition), and included study as a random effect. Next, we ran similar mixed-models where additionally dummy-coded superhuman enhancement level and its interaction with covariate were included to see whether the effects of the covariates on dependent variables differed between human and superhuman levels of enhancement.

3.5. Results

We focus on results from data pooled across all studies (excluding the conditions in Study 6 where the character refuses the operation), and report individual study results in Appendix A, but our figures and tables report key results for each individual study as well. Moreover, the main text reports additional results from Study 6 specifically, dealing with the accept vs. refuse manipulation. Here, we present only results for the primary manipulation (level of enhancement). We present effects from random effects meta-analyses for comparisons between the alleviation condition and the optimal and superhuman conditions; see Table 4 and Figs. 1-2. For full results including secondary factors, see Appendix A.

3.6. Primary experimental factors

3.6.1. Moral approval

We investigated the overall effect of level of enhancement with a random intercepts mixed-model created from the pooled data, with study entered as a random factor. Across the aggregated data, moral approval significantly differed between levels of enhancement ($F(2, 2292.1) = 96.46, p < .001, \eta_p^2 = 0.078$). Meta-analytic contrasts between alleviation (reference group) and the other two conditions indicated that superhuman enhancement was rated less morally approvable than alleviation ($d = -0.67$, 95% CI [−0.81; −0.52], $Z = -8.89, p < .001$). Optimization was also approved of less than alleviation, but this difference was smaller ($d = -0.20$, 95% CI [−0.39, −0.01], $Z = -2.09, p = .036$). In sum, we observed a trend where greater enhancement was progressively associated with lower moral approval, but the main effect of level of enhancement was driven by the superhuman condition. For graphical presentation of the results, see Figs. 1-2. For study-level full factorial ANCOVAs see Appendix I.

3.6.2. Perceived unfairness

We examined the overall differences in perceived unfairness between levels of enhancement similarly to the above. There was a significant main effect of level of enhancement ($F(2, 2292.2) = 116.23, p < .001, \eta_p^2 = 0.092$). Meta-analytic contrasts between alleviation (reference group)

Table 4
Main effects of level of enhancement for Studies 1–5.

	Moral approval			Perceived unfairness			Dehumanization		
Study	F-value	*p*-value	η_p^2	F-value	p-value	η_p^2	F-value	*p*-value	η_p^2
Study 1	8.00	< 0.001***	0.095	11.00	< 0.001***	0.126	5.16	0.007**	0.063
Study 2	14.28	< 0.001***	0.062	7.57	0.001***	0.034	8.01	< 0.001***	0.036
Study 3	5.23	0.006**	0.051	8.88	< 0.001***	0.084	4.82	0.009**	0.047
Study 4	15.41	< 0.001***	0.128	21.67	< 0.001***	0.171	16.39	< 0.001***	0.135
Study 5A	2.81	0.062	0.022	5.61	0.004**	0.043	6.28	0.002**	0.048
Study 5B	19.92	< 0.001***	0.138	12.04	< 0.001***	0.088	13.36	< 0.001***	0.097

Note: DFs for the models: Study 1 F(2, 153), Study 2 F(2, 432), Study 3 F(2, 195), Study 4 F(2,210), Studies 5 A & B F(2, 249). * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

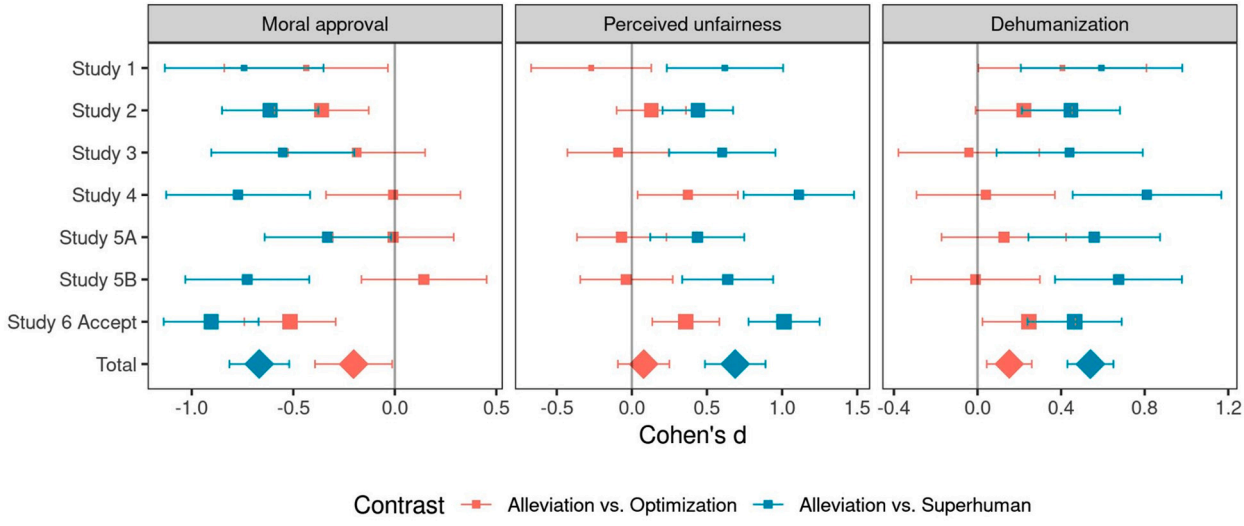

Fig. 1. Synthesis of results from studies 1–6. Squares and their 95% CI:s are computed from raw data. Diamonds and their 95% CIs represent effect sizes from the random effects meta-analysis. The size of the squares and diamonds represent group size.

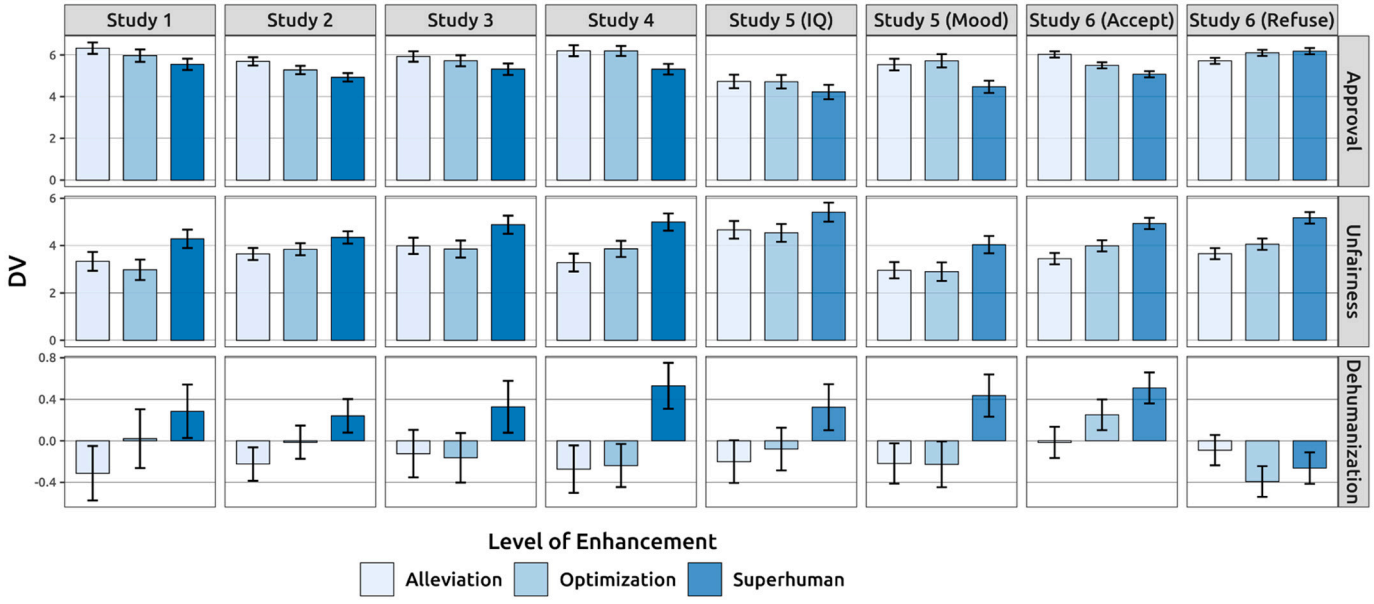

Fig. 2. Means of moral approval and perceived unfairness and standardized means (z-scores) for dehumanization in all conditions in Studies 1–6. Items were on a scale from 1 to 7. Error bars indicate 95% Confidence Intervals.

and the other two conditions indicated that superhuman enhancement was considered more unfair than alleviation ($d = 0.69$, 95% CI [0.49; 0.89], $Z = 6.70$, $p < .001$), but for optimization, such difference was not found ($d = 0.07$, 95% CI [−0.09; 0.24], $Z = 0.89$, $p = .897$). For graphical presentation of the results, see Figs. 1-2. For study-level full factorial ANCOVAs, see Appendix I.

3.6.3. Dehumanization

We examined the overall differences in dehumanization between levels of enhancement similarly to the above. A mixed-model indicated that dehumanization was significantly different between levels of enhancement ($F(2, 2292.2) = 56.07$, $p < .001$, $\eta_p^2 = 0.047$). Meta-analytic contrasts between alleviation (reference group) and the other two conditions indicated that a user of superhuman enhancement was dehumanized more than a user of alleviating enhancement ($d = 0.54$, 95% CI [0.43; 0.65], $Z = 9.62$, $p < .001$), but the difference between alleviation and optimization was smaller ($d = 0.15$, 95% CI [0.04; 0.26], $Z = 2.76$, $p = .005$). Again, the main effect seems to have been driven by the superhuman condition. For graphical presentation of the results, see Figs. 1-2. For study-level full factorial ANCOVAs see Appendix I.

3.6.4. Results of Study 6: effect of refusal

Study 6 contrasted a condition where the character in the vignette decides to not undergo the enhancement operation (refuse condition) with one where the character does decide to undergo it (accept condition). Study 6 had a 2 × 3 between-subjects design (decision: accept, refuse × level of enhancement: alleviation, optimization, superhuman). We ran a full-factorial two-way ANOVA for each of our dependent variables. For results, see Table 5 and Fig. 3.

For moral approval, we observed both main effects (level of enhancement: $F(2, 947) = 5.63$, $p = .003$, $\eta_p^2 = 0.01$; decision: $F(1, 947) = 57.71$, $p < .001$, $\eta_p^2 = 0.05$) and an interaction in our model ($F(2, 947) = 45.69$, $p < .001$, $\eta_p^2 = 0.08$). As shown in Fig. 3, there were two opposite trends for the accept and refuse conditions. Accepting the offer of the enhancement operation was associated with lower levels of moral approval; with approval decreasing as the level of enhancement increased. In the refuse condition, the trend seemed to be to the opposite direction, but less markedly.

For perceived unfairness, there was a significant main effect of level of enhancement ($F(2, 947) = 79.77$, $p < .001$, $\eta_p^2 = 0.14$). As shown in Fig. 3, the perceived unfairness of the technology linearly tracked the level of enhancement for both decisions. Note that perceived unfairness was measured as in the previous studies, by asking participants whether the enhancement operation would offer an unfair advantage. Thus, it is not surprising that the main effect of the decision was non-significant ($F(1, 947) = 3.08$, $p = .079$, $\eta_p^2 = 0.00$).

For dehumanization, we observed both main effects (level of enhancement: $F(2, 947) = 3.92$, $p = .020$, $\eta_p^2 = 0.00$; decision: $F(1, 947) = 64.20$, $p < .001$, $\eta_p^2 = 0.06$) and an interaction ($F(2, 487) = 11.89$, $p < .001$, $\eta_p^2 = 0.02$) in our model. As can be seen in Fig. 3, there were opposite trends for dehumanization depending on the decision made by the character in the vignette. Accepting the enhancement operation was progressively associated with greater levels of dehumanization for greater levels of enhancement. Refusing the enhancement operation was associated with lower levels of dehumanization when the enhancement went further than alleviation, but both optimal and superhuman levels of enhancement were equally dehumanized.

3.7. Individual differences analyses

First, we analyzed the effects of the covariates to detect any main effects on DVs (i.e., collapsing across any experimental manipulations). Using the data pooled across the studies, we created random-intercept mixed-models where we predicted the DVs separately with each covariate with study as a random effect, totaling 12 models. As shown in Table 6, both the MFQ binding foundations and sexual disgust sensitivity predicted less moral approval and higher perceived unfairness and dehumanization. Additionally, science fiction hobbyism predicted more positive opinions overall. Pathogen and moral disgust sensitivities had no consistent effects and are not reported. See Appendix H for full statistics.

Next, we investigated whether the effects of the covariates differed between human and superhuman levels of enhancement. We again created a mixed-model for each DV-covariate pair using the pooled data (except the refuse condition of Study 6, as this condition did not involve the character in the vignette actually getting a cognition-enhancing implant) but included dummy-coded superhuman condition and its interaction with covariate as predictors. Study was included as a random effect for both the intercept and the effect of the dummy-coded superhuman condition, that is, the effect of enhancement was allowed to vary between studies due to differences in study design and materials. Below, we summarize our main findings (see Fig. 4 and Table 7; see Appendix I for study-level ANCOVAs with complete design).

We did not find any statistically significant interactions between covariates and human vs superhuman levels of enhancement for any of the DVs. Higher binding foundation scores predicted less moral approval and more perceived unfairness and dehumanization for both enhancement levels. Higher individualizing foundation scores predicted lesser dehumanization for both enhancement levels. Significantly, in a reversal to the trend seen in studies where the protagonist of the vignette gets an enhancement, individualizing, but not binding, moral foundations predicted higher approval in the refuse condition of Study 6 (Appendix I, Table I7).

Science fiction hobbyism predicted higher moral approval and lower dehumanization across levels of enhancement and was unrelated to perceived unfairness. Interestingly, in the refuse condition of Study 6, science fiction hobbyism predicted *lower* moral approval and *higher* dehumanization (Appendix I, Table I7). Thus, the results stemming from science fiction hobbyism reveal a robust effect of cultural conditioning on attitudes towards brain implants and/or cognitive enhancement: exposure to these themes and ideas (via science fiction) is associated with greater receptivity. This receptivity may even extend to more negative attitudes towards those who would refuse an offer to enhance their brains. These findings also suggest the possibility of variation across countries and age groups, although cross-cultural replications of this finding are needed to draw any firm conclusions.

Sexual disgust sensitivity consistently predicted lower moral approval, higher perceived unfairness, and higher dehumanization of enhancement users. These associations were consistent across levels of enhancement. In the refuse condition of Study 6, sexual disgust sensitivity was not associated with any of our dependent variables (Appendix I, Table I7). Thus, sexual disgust sensitivity, similarly to the binding

Table 5
ANOVA table for Study 6.

		Moral approval			Perceived unfairness			Dehumanization		
ANOVA term	df	F-value	*p*-value	η_p^2	F-value	p-value	η_p^2	F-value	*p*-value	η_p^2
Level of Enhancement	2	5.63	0.003**	0.013	79.77	< 0.001***	0.143	3.92	0.020*	0.009
Decision	1	57.71	< 0.001***	0.056	3.08	0.079	0.003	64.20	< 0.001***	0.063
Level of Enhancement x Decision	2	45.69	< 0.001***	0.088	0.28	0.754	0.001	11.89	< 0.001***	0.024

Note: residual df = 947. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

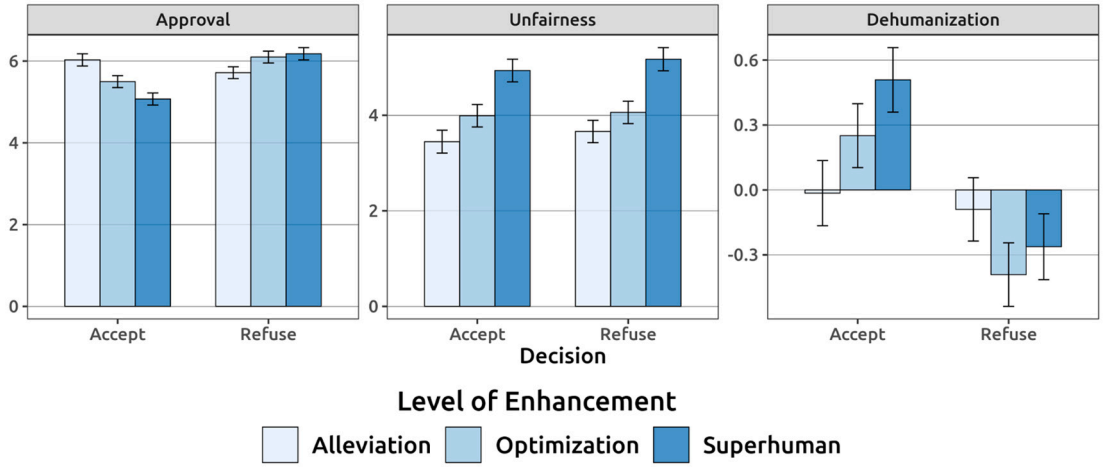

Fig. 3. Means of moral approval and perceived unfairness and standardized means (z-scores) for dehumanization in all conditions in Study 6. Items were answered on a scale from 1 to 7. Error bars indicate 95% Confidence Interval. Note that for clarity this figure presents the same data as the two rightmost panels in Fig. 2.

Table 6
Mixed-model results for individual differences analysis.

	Moral approval			Perceived unfairness			Dehumanization		
Covariate	B	*t* value	*p*-value	B	*t* value	*p*-value	B	*t* value	*p*-value
Binding	−0.22***	−8.21	< 0.001	0.10**	2.91	0.004	0.14***	7.33	< 0.001
Individualizing	0.04	1.36	0.172	0.05	1.10	0.270	−0.19***	−7.73	< 0.001
Scifi Hobbyism	0.19***	9.34	< 0.001	−0.06*	−2.19	0.028	−0.04**	−2.66	0.008
Sexual disgust	−0.23***	−12.11	< 0.001	0.10***	4.00	< 0.001	0.09***	6.35	< 0.001

Note: Data from studies 2 to 6 were included in the analysis ($N = 1824$). Study 1 data was omitted because sexual disgust sensitivity was not measured. The refuse condition of Study 6 was omitted because we wanted to examine factors predicting attitudes towards enhancement users.

foundations, seems to have specifically predicted more negative attitudes towards enhancement users.

In summary, the MFQ binding foundations and sexual disgust sensitivity predicted overall negative views of cognitive enhancement. Science fiction hobbyism was generally linked to favorable views of enhancement across the dependent variables. The MFQ individualizing foundations consistently predicted decreased dehumanization. As the two MFQ factors, differently associated with liberal and conservative political views, also differently predict attitudes towards cognitive enhancement, it seems possible that these technologies will become a future area of conflict in the so-called "culture wars" between liberals and conservatives (Graham et al., 2009).

4. Discussion

Through six studies, we measured three separate judgments about cognitive enhancement: 1) moral approval, or the general acceptance of the idea of cognition-enhancing brain implants and people getting such implants, 2) perceived unfairness of the enhancement, and 3) dehumanization of enhancement users. In our vignettes, the enhancement obtained one of three levels: it either a) alleviated an ailment, b) gave optimal human level performance, or c) gave superhuman performance. Studies 1 to 4 and 6 concerned various forms of memory enhancement, while Studies 5A and 5B described enhancements of general intelligence and emotional stability, respectively.

Overall, our participants were quite approving of cognitive enhancement, with average rates of moral approval consistently placing above the midpoint of the scale (see Fig. 2). There was also a consistent pattern where alleviation of ailments was approved and not considered unfair, but enhancement to superhuman levels was less approved and perceived as more unfair and more dehumanizing. This is in line with previous studies that have also concluded that treatment of existing conditions and enhancement to above-normal level are viewed differently (Castelo et al., 2019; Daniels, 2000; Greely et al., 2008; Hyman, 2011; Pew Research Center, 2016; Sahakian & Morein-Zamir, 2011; Scheske & Schnall, 2012; Wolpe, 2002). In our studies, attitudes towards enhancement to an "optimal" human level differed very little, if at all, from attitudes towards alleviation, but we found large differences between alleviation and superhuman enhancement. This was true both for situations where "optimizing" enhancement was offered to a person without an ailment (Studies 1–4 and 6) and situations where it was offered to a person with an ailment (Studies 5A-5B). Thus, our Research Question 1 has a clear answer: the distinction between treatment and boosting observed in previous studies is driven specifically by *super*-human cognitive capacities. This effect replicated across each of our DVs (moral approval, perceived unfairness and dehumanization) and each of our studies. The DVs, however, showed differential sensitivity to other manipulations (described in detail in Appendix A) and were aligned in different ways with our individual differences measures that assessed cultural influences as well as personality features. These alignments are discussed in detail below. Thus, our Research Questions 2 (the role of perceived *unfairness*) and 3 (the role of *dehumanization*) also have a tentative answer: both perceived unfairness and dehumanization seem to be aligned with but separate from moral approval of cognitive enhancement.

Across six studies, the MFQ binding foundations were consistently associated with lower approval of enhancement, and higher dehumanization of enhancement users. Furthermore, in five of our studies we found a positive link between sexual disgust sensitivity and more negative attitudes towards enhancement. Given that sexual disgust and the binding foundations are higher among religious conservatives (Haidt & Graham, 2007; Koleva, Graham, Iyer, Ditto, & Haidt, 2012), these results also help to anticipate ideological intergroup disagreement surrounding the permissibility of cognitive enhancement. These findings resonate with Laakasuo et al. (2018), who found that both the binding foundations and sexual disgust sensitivity predict lower approval of

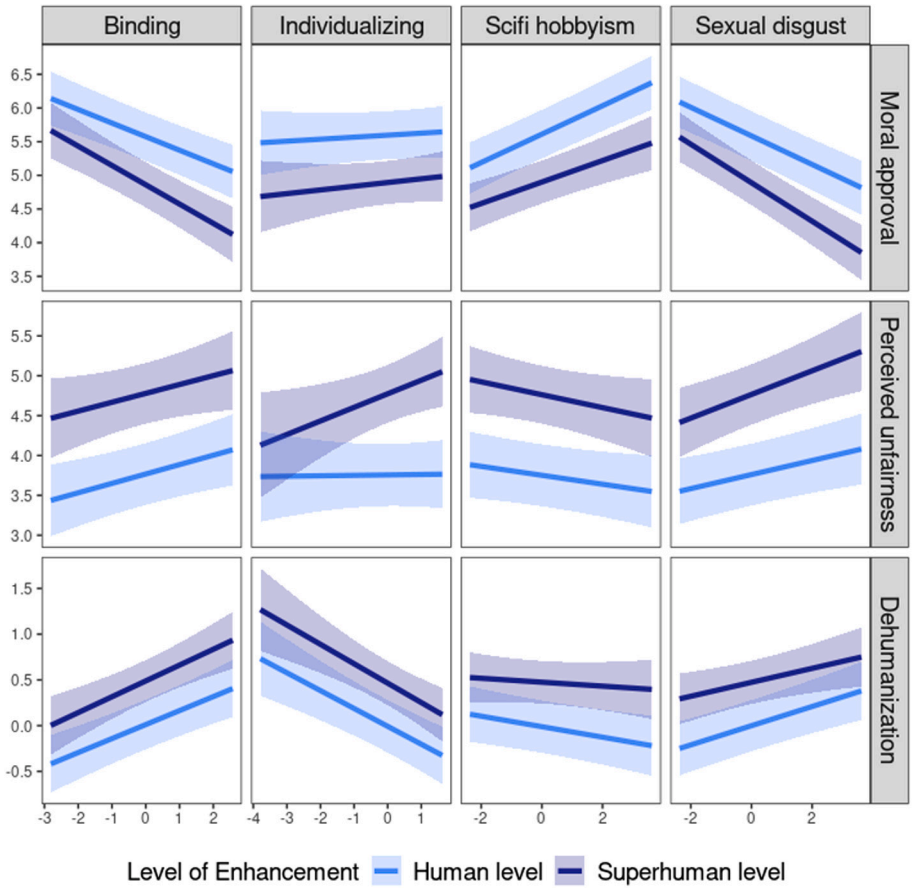

Fig. 4. Associations of covariates and dependent variables by condition.
Note: "Humal level" has both Alleviation and Optimization conditions collapsed. Shading represents 95% confidence bands.

Table 7
Mixed-model results with covariate and superhuman condition as predictors.

Covariate	Fixed effect	Moral approval	Perceived unfairness	Dehumanization
Binding	Binding	−0.20***	0.11**	0.14***
	Superhuman	−0.71**	1.01***	0.43***
	Binding x Superhuman	−0.08	−0.00	0.02
Individualizing	Individualizing	0.03	0.00	−0.18***
	Superhuman	−0.70**	1.01***	0.41***
	Individualizing x Superhuman	0.02	0.16	−0.01
Scifi Hobbyism	Scifi	0.21***	−0.05	−0.05**
	Superhuman	−0.71**	1.01***	0.43***
	Scifi x Superhuman	−0.05	−0.02	0.04
Sexual disgust	Sexual disgust	−0.21***	0.08**	0.09***
	Superhuman	−0.69**	1.00***	0.42***
	Sexual disgust x Superhuman	−0.07	0.06	−0.02

Note: Models were fitted separately for each DV-covariate pair. Pooled data across the studies except Study 6 Refuse condition were used. Study was included as a random effect for the intercept and condition. Superhuman is a dummy variable for the superhuman condition.

mind upload, another transhumanist technology (see also Laakasuo et al., 2021). In Study 6, when the character in the vignette refused the offer of cognitive enhancement, neither binding foundations nor sexual disgust sensitivity were associated with any of our DVs, but individualizing foundations were. These results suggest that the binding foundations and sexual disgust sensitivity specifically predict negative attitudes towards enhancement users and not generally increased negative attitudes towards anyone. Thus, we have some answers to our Research Questions 4.1–4.2: only binding foundations (RQ 4.1) and only sexual disgust sensitivity (RQ 4.2) were consistently associated with our DVs, specifically so that they predicted more negative attitudes towards undergoing enhancement.

We also found a consistent effect of science fiction hobbyism predicting higher approval, less perceived unfairness and less dehumanization of enhancement users, implying that cultural factors, such as exposure to the ideas of cognitive enhancement and brain implants through books, films and pop culture, reduces condemnation. Science fiction hobbyism was also associated with lesser moral approval and higher dehumanization when the main character of the vignette refused cognitive enhancement in Study 6. Thus, our Research Question 4.3 has a clear answer: exposure to science fiction does predict favorable views on cognitive enhancement and brain implants. This implies that familiarity may indeed breed acceptance, in the same way as in previous studies on acceptance of mind upload technologies (Laakasuo et al.,

2018) and sex robots (Koverola et al., 2020). However, the exact causal route between exposure to science fiction and approval of futuristic technology is not obvious from these studies. Consuming science fiction could familiarize people with the idea of human enhancement and/or brain implants and induce a positive attitude towards them. Research on attitude change following accustomization (e.g., robots in elderly care; Stafford et al., 2010) supports the interpretation of cultural influences as a causal factor. On the other hand, it is also possible that certain personality types may be more inclined to like both science fiction and transhumanist technologies, since science fiction hobbyists seem to differ from the general population along certain psychological dimensions (Bainbridge, 1986). As in most "nature vs. nurture" comparisons, it is likely that both play a role. In other words, cultural influences (familiarization with transhumanist themes) together with personality traits seem to jointly determine whether people condemn or approve of cognitive enhancement (see also Tomasello, 2018 for biocultural models of human moral development).

4.1. Limitations and future directions

Like all behavioral studies, ours suffers from a standard set of limitations in laboratory or online questionnaires. Our respondents were not a random sample representing the general population. Instead, they were likely more curious and open-minded than the population average, having volunteered to participate in scientific research. Our participants were also younger than the population average. In addition, survey-based studies utilizing self-report measures are biased by a mixture of positive response biases and demand characteristics. However, these are inherent problems in any research involving volunteers, and not specific to our studies.

In addition, our preregistered DV scales have changed from the original preregistration of Study 4; that is, we have used only a part of the original pool of items. This pool of items was carried through Studies 1–5, with the exception of the dehumanization DV, which only had one item in Study 1. Choices to remove items were made due to face-validity concerns. Also, the dehumanization measure preregistered for Study 4 was exploratory, and had researcher degrees of freedom due to uncertainty in the early stages of our research. However, we used the same scale composition out of the pool of items in the final analyses of the studies, with the only exceptions being cases where a specific item could not be included due to the content of the vignettes (in Studies 5–6, where the vignettes differed in some key respects from Studies 1–4).

Regardless of how brain implant technologies actually develop in the future, it is important to understand people's perceptions and preferences regarding their use. Thus, different descriptions of enhanced capabilities and the methods used to achieve them offer a fruitful line for future research on human perceptions of transhumanist technologies. Furthermore, even if these technologies do not become reality within the next 20 years, we feel that the ethics and moral psychology regarding them need to be discussed well in advance, due to their serious implications for society. The subject clearly fascinates people: without any concrete products or schedules yet, Elon Musk's Neuralink gives more than a million Google results today (Pisarchik, Maksimenko, & Hramov, 2019). As digital technologies can develop at exponential speeds, and given that the first generation of brain implants is already well established (Houston et al., 2018; Ylikoski & Raivio, 1997), we should be prepared to have a serious ethical discussion about the further use of these technologies.

In this paper, we have mainly concentrated on finding out who would condemn those who enhance their cognitive capabilities and whether different kinds and levels of enhancement elicit different moral judgments. Our findings provide insight into these questions as a starting point for future research. Perhaps a more profound question on these topics is "Why?" and that needs to be addressed by a more qualitative research approach. An interview-based qualitative study could also shine a light on the internal conflicts many people are likely to have on the subject of cognitive enhancement. Enhancement may seem at the same time enticing and unsettling, but measuring this was outside of the scope of the current studies.

As the results of the science fiction hobbyism scale indicate, cultural influences may play a significant role in attitudes towards transhumanist technologies. This suggests the need for cross-cultural replication, be it in various countries or different cultural settings. Future research should also look into the question of why sexual disgust sensitivity and binding moral foundations predict negative attitudes towards brain implant technology (and mind upload; Laakasuo et al., 2018, 2021). Are these constructs possibly associated with rejecting "human enhancement" technologies in general, and if so, why?

5. Conclusion

In summary, we showed that moral approval, sense of fairness and dehumanization are relevant in modern day contexts, where moral implications of new technologies are being evaluated, and that while people generally approve of curing ailments, they are more cautious of unfamiliar levels of enhancement. Furthermore, in five studies, the tendency to condemn transhumanist technologies was associated with sexual disgust sensitivity and the binding orientation of the MFT. We found that science fiction hobbyism is linked to approval of brain implants. We also examined possible idiosyncrasies associated with our stimulus materials and did not find any reliable additional factors associated with moral cognition (e.g. body-envelope violations and familiarity). Understanding moral cognition in this context could be an important issue when it comes to acceptance or rejection of new technologies.

"Whatever is the lot of humankind.
I want to taste within my deepest self.
I want to seize the highest and the lowest,
to load its woe and bliss upon my breast,
and thus expand my single self titanically.
and in the end go down with all the rest."

— Johann Wolfgang von Goethe, Faust, First Part

Author note

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Appendix A. Secondary experimental factors

Scheske and Schnall (2012) explored pharmacological cognitive enhancement and found that participants were particularly sensitive to safety and health issues and concerned about possible coercion or social pressure. They also observed what they label as "irrational" concerns, like a preference for certain modes of delivery (pill vs. injection) and for the "naturalness" of cognitive enhancers. In Studies 2–5 we examined some of these factors as a secondary experimental factor (see Table A1 for full results).

Table A1
Main ANOVA results of Studies 1–5

STUDY 1 (memory chip)	Level of Enhancement $F(2, 153)$		
DV	*F*	η_p^2	*p*
Moral Approval	8.00	0.095	< 0.001***
Perceived Unfairness	11.01	0.126	<0.001***
Dehumanization	5.16	0.063	0.007**

STUDY 2 (memory chip)	Level of Enhancement $F(2, 429)$			Experimental/Established $F(1, 429)$			Interaction $F(2, 429)$		
DV	*F*	η_p^2	*p*	*F*	η_p^2	*p*	*F*	η_p^2	*p*
Moral Approval	14.42	0.063	< 0.001***	0.42	0.001	0.515	4.35	0.020	0.014*
Perceived Unfairness	7.94	0.035	< 0.001***	0.68	0.002	0.409	4.55	0.021	0.011*
Dehumanization	7.97	0.036	< 0.001***	0.46	0.001	0.497	1.28	0.006	0.278

STUDY 3 (memory chip)	Level of Enhancement $F(2, 192)$			Surgery/Nano-robots $F(1, 192)$			Interaction $F(2, 192)$		
DV	*F*	η_p^2	*p*	*F*	η_p^2	*p*	*F*	η_p^2	*p*
Moral Approval	5.23	0.051	0.006**	0.75	0.004	0.387	0.32	0.003	0.730
Perceived Unfairness	8.89	0.084	< 0.001***	0.48	0.003	0.477	0.94	0.010	0.392
Dehumanization	4.83	0.047	0.008**	0.15	0.001	0.694	1.96	0.020	0.143

STUDY 4 (memory chip)	Level of Enhancement $F(2, 207)$			Surgery/ Drug $F(1, 207)$			Interaction $F(2, 207)$		
DV	*F*	η_p^2	*p*	*F*	η_p^2	*p*	*F*	η_p^2	*p*
Moral Approval	14.87	0.129	< 0.001***	0.38	0.002	0.540	0.93	0.010	0.397
Perceived Unfairness	22.42	0.174	< 0.001***	4.09	0.020	0.044*	0.21	0.002	0.808
Dehumanization	17.28	0.135	< 0.001***	4.83	0.026	0.019*	0.13	0.001	0.879

STUDY 5A (IQ chip)	Level of Enhancement $F(2, 246)$			Experimental/ Established $F(1, 246)$			Interaction $F(2, 246)$		
DV	*F*	η_p^2	*p*	*F*	η_p^2	*p*	*F*	η_p^2	*p*
Moral Approval	2.83	0.023	0.061	2.84	0.010	0.093	2.58	0.021	0.078
Perceived Unfairness	5.69	0.043	0.003**	0.087	0.004	0.352	0.00	0.000	0.997
Dehumanization	6.21	0.048	0.002**	0.04	0.000	0.836	0.04	0.000	0.961

STUDY 5B (mood chip)	Level of Enhancement $F(2, 246)$			Experimental/ Established $F(1, 246)$			Interaction $F(2, 246)$		
DV	*F*	η_p^2	*p*	*F*	η_p^2	*p*	*F*	η_p^2	*p*
Moral Approval	19.36	0.139	< 0.001***	0.66	0.003	0.416	0.31	0.002	0.737
Perceived Unfairness	11.54	0.090	< 0.001***	5.30	0.019	0.022*	0.64	0.005	0.526
Dehumanization	12.76	0.098	< 0.001***	0.60	0.002	0.440	0.85	0.007	0.430

Note. Significant *p*-values shaded. Studies 5A and 5B had the same sample of participants. The level of enhancement manipulation had three levels in each study: alleviation, optimization and superhuman. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

A.1. Study 2

Emerging technologies may be opposed merely by virtue of being new and unfamiliar (Inbar, Phelps, & Rozin, 2020). In Study 2, we adapted the vignettes of Study 1, introducing variation in familiarity as well as in levels of enhancement. Thus, we sought to replicate our results from Study 1, while also evaluating whether moral disapproval and dehumanization are driven by the perceived novelty and unfamiliarity of the technology.

Participants were assigned to one of six conditions in a 2 (familiarity: experimental vs. established) × 3 (level of enhancement: alleviation, optimal, superhuman) between-subjects design and read about a person undergoing either an *experimental* or an *established* neurosurgical procedure for cognitive enhancement. We then assessed participants' moral attitudes, perceptions of unfairness and attitudes of dehumanization towards the enhanced agent as in Study 1. See General Methods and Appendices B-F for details.

A.2. Results and discussion of Study 2

Study 2 replicated the effect of level of enhancement on each dependent measure: superhuman enhancement was approved of less (B = −0.56, 95% CI = [−0.80, −0.32], t(429) = −4.52, $p < .001$), and viewed as more unfair (see below) and more dehumanizing (B = 0.36, 95% CI = [0.16, 0.56], t(429) = 3.56, $p < .001$) than the other two levels of enhancement (for full statistics, see Table 1). In contrast, we did not find an effect of familiarity on any of our measures. An level of enhancement-by-familiarity interaction effect arose for perceived unfairness: specifically, in the experimental technology condition, all treatments were seen as comparably fair/unfair (superhuman vs. the rest: B = 0.21, 95% CI = [−0.23, 0.64], t(429) = 0.93, $p = .35$; alleviating vs. optimal: B = −0.10, 95% CI = [−0.61, 0.41], t(429) = −0.39, $p = .698$), whereas in the established technology condition there was a statistically significant linear trend where the superhuman level was perceived as the most unfair (superhuman vs. the rest: B = 1.01, 95% CI = [0.56, 1.46], t(429) = 4.45, $p < .001$; alleviating vs. optimal: B = 0.50, 95% CI = [0.00, 1.00], t(429) = 1.95, $p = .052$). Thus, while perceived unfairness was greatest for superhuman enhancement using established technologies, weaker effects of level of enhancement arose among users of experimental technologies. No corresponding two-way interaction emerged for dehumanization. Taken together, these results could indicate that incurring the heightened risk of using experimental technologies attenuates the unfairness in gaining superhuman abilities (though not its dehumanizing effects).

A.3. Study 3

Previous studies have shown that invasive events such as surgery (a "body envelope violation") cause a stronger disgust reaction than non-invasive events (Haidt, McCauley, & Rozin, 1994; Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999), which could affect our results. In Study 3, we examine whether the body-envelope violation aspect of enhancement promotes moral condemnation and dehumanization. To this end, we contrasted two different methods of administration of the enhancement in the vignettes: receiving surgery vs. ingesting nano-robots. Thus, in the control condition, the protagonist ingested nano-robots and these nano-robots then enhanced the memory. In a 2 (administration: surgery vs nano-robots) × 3 (level of enhancement: alleviation, optimal, superhuman) between-subjects design, participants were assigned to one of six conditions. In each condition, participants read about a person undergoing brain surgery or ingesting nano-robots for cognitive enhancement, and then assessed undergoing such enhancement, as well as the user's dehumanization. See General Methods and Appendices B-F for details.

A.4. Results and discussion of Study 3

Again, level of enhancement had a significant effect on each of our measures, with superhuman enhancement viewed as less acceptable, more unfair, and more dehumanizing than alleviation or optimization (moral approval: B = −0.51, 95% CI = [−0.84, −0.18], t(192) = −3.02, $p = .003$; perceived unfairness: B = 0.96, 95% CI = [0.51, 1.42], t(192) = 4.20, $p < .001$; dehumanization: B = 0.47, 95% CI = [0.17, 0.77], t(192) = 3.11, $p = .002$), replicating the main findings of Studies 1 and 2. However, we found no main effects of the method of administration, or administration×level interactions, on any of our measures. Thus, participants did not perceive a moral distinction between cognitive enhancement via surgery and via nano-robots.

This pattern of results provides initial evidence that opposition to cognitive enhancement is not driven primarily by moralization of body envelope violations. However, it is also possible that *ingestion* (i.e. of nano-robots) and *body envelope violations* elicit comparable disgust reactions (Rozin et al., 1999), and belong to a more general class of disgust elicitors which inspire the moralization of enhancement.

A.5. Study 4

The results of Study 3 indicated that surgery and ingestion do not morally differ. It is possible that subjects may perceive both behaviors to constitute "body envelope violations" in a broader sense (Rozin et al., 1999). Thus, in Study 4, we contrasted surgically implanted microchips with traditional pharmacological intervention. Participants were assigned to one of six conditions in a 2 × 3 between-subjects design, read about a person undergoing cognitive enhancement and evaluated their behavior, as in previous studies. See General Methods and Appendices B-F for details. Study 4 was preregistered.

A.6. Results and discussion of Study 4

Once again, we replicated the effects of level of enhancement: superhuman enhancement was viewed as less acceptable, more unfair, and more dehumanizing than the other two levels of enhancement (moral approval: B = −0.88, 95% CI = [−1.19, −0.56], t(207) = −65.44, $p < .001$; perceived unfairness: B = 1.48, 95% CI = [1.03, 1.92], t(207) = 6.50, $p < .001$; dehumanization: B = 0.81, 95% CI = [0.54, 1.08], t(207) = 5.87, $p < .001$). However, this time, we also found main effects of the method of administration: specifically, traditional pharmacological interventions were seen as fairer and less dehumanizing than novel interventions. No corresponding effect was found for moral approval.

This implies that some of people's negative attitudes towards brain implants can be partially driven by negative attitudes towards the method of administration. Whereas in Study 3 both receiving surgery and ingesting nano-robots were seen as comparable from the moral point of view, Study 4 demonstrated that enhancement via conventional means (i.e., medication) garnered more favorable attitudes. This effect, however, was absent for our general measure of moral approval which appeared to be influenced solely by the level of enhancement (i.e., exceeding optimal human abilities or not).

A.7. Studies 5 A and B: general intelligence and emotional stability

In Studies 5A and 5B, we examined whether the patterns found for *memory* enhancement specifically would generalize to other facets of higher cognition, such as emotional stability ("mood") and general intelligence ("IQ"). The motivation for these studies was to examine whether attitudes towards enhancement would vary as a function of which aspect of cognition is enhanced, as some aspects of cognition may be seen as more central to, e.g., identity than others (see, e.g., Jirout Košová et al., 2021). In addition, we re-ran the level of familiarity manipulation of Study 2 in a slightly less subtle form to test whether the familiarity of the technology has an effect depending on what part of human cognition is altered, since the results of

implant vs. traditional medication in Study 4 could be interpreted as an effect of familiarity.

In studies 5A and 5B, participants read two short futuristic stories in a randomized order. The stories described a person exhibiting either slow cognitive processes (5A) or recurring periods of anxiety (5B), who then receives a neural implant to help with this condition. We manipulated the level of enhancement as in Studies 1–4 (5A: level of a typical, adequately performing adult; level of a typical, well performing adult; super-human level; 5B: mitigate anxieties; return the function of the emotional system to the level of a healthy adult; give complete control over one's emotional state).

Thus, Study 5 was a 3 between (level of enhancement: alleviation, optimization, superhuman) × 2 between (familiarity: experimental vs established) × 2 within (domain: IQ, mood) subjects design. Below, we report the results for each domain separately: intelligence as Study 5A, and mood as Study 5B. See General Methods and Appendices B-F for details.

A.8. Results of Studies 5A and 5B

We first report the results separately by domain (general intelligence and mood), and then in a single aggregate analysis with domain as a within-subjects factor. The results are largely unaffected by the choice of the analytic approach.

A.8.1. 5A: general intelligence

Again, level of enhancement exerted a significant effect on each of our measures, with attitudes being the most negative towards superhuman enhancement compared to alleviation or optimization (moral approval: $B = -0.50$, 95% CI = [−0.91, −0.09], $t(246) = -2.38$, $p = .018$; perceived unfairness: $B = 0.82$, 95% CI = [0.34, 1.31], $t(246) = 3.33$, $p = .001$; dehumanization: $B = 0.47$, 95% CI = [0.20, 0.73], $t(246) = 3.42$, $p < .001$). There was no significant main effect of familiarity nor a significant interaction effect between familiarity and level of enhancement on any of the DVs. However, a contrast analysis revealed that the main effect of level of enhancement on moral approval (indicating reduced approval of superhuman enhancement) was driven by the experimental technology condition (superhuman vs. the rest: $B = -0.95$, 95% CI = [−1.53, −0.36], $t(246) = -3.19$, $p = .002$), and non-significant in the established technology condition ($B = -0.05$, 95% CI = [−0.63, 0.53], $t(246) = -0.17$, $p = .867$).

A.8.2. 5B: emotional stability

As with memory and intelligence, superhuman mood enhancements were viewed as less acceptable, more unfair, and more dehumanizing than either alleviation or optimization (moral approval: $B = -1.14$, 95% CI = [−1.51, −0.78], $t(246) = -6.52$, $p < .001$; perceived unfairness: $B = 1.08$, 95% CI = [0.64, 1.53], $t(246) = 4.79$, $p < .001$; dehumanization: $B = 0.64$, 95% CI = [0.39, 0.90], $t(246) = 5.02$, $p < .001$). We also found a main effect of level of familiarity on perceived unfairness (but not on approval or dehumanization), indicating that an established treatment was seen as more fair. No interactions between familiarity and level of enhancement were observed for any DVs.

A.9. Discussion on secondary experimental factors

In Studies 2 and 5, we tested whether describing the method used for enhancement as experimental or established (i.e. familiarity) would affect opinions. We found clear differences in attitudes due to familiarity only for perceived unfairness: experimental memory chips (Study 2) and established mood drugs (Study 5B) were seen as more fair than the alternative. This difference might be due to the difference between real life familiarity (drugs for mood imbalance) and something described as familiar (microchips for memory) – that is, there are two different processes in play. Our results do not give us enough insight to solve this discrepancy. Familiarity had no effect on moral approval or dehumanization.

Inspired by previous links between a binding foundation orientation, sexual disgust and disapproval of related biotechnologies (Koverola et al., 2020; Laakasuo et al., 2018, 2021), we tested whether explicitly invasive enhancement (a body envelope violation) like surgery affected judgment in Studies 3 (nanorobots vs. implant surgery) and 4 (pharmacological intervention vs. surgery). Here, we found only the traditional pharmacological intervention to differ from implant surgery in that it was perceived as less unfair and less dehumanizing (similar to Castelo et al., 2019). Given the convergent effect of familiarity on fairness in Study 5, it seems possible that the greater perceived fairness of conventional ways of administration is partly due to their greater familiarity. Furthermore, everybody is familiar with "alleviating ailments" and can imagine what an "optimal human level" of memory, intelligence or emotional stability is, while a "superhuman" ability is by definition outside of human experience, thus "not familiar" or even "weird". Future research with more robust manipulations of such closely aligned concepts as "familiar", "unfamiliar", "novel", "established" or "weird" is needed if their effects are to be confirmed and/or understood.

In sum, we examined possible idiosyncrasies associated with our stimulus materials and did not find any reliable additional factors associated with moral cognition (e.g. body-envelope violations or familiarity).

Appendix B. Moral approval scale items (Studies 1–5)

1. Having the operation is the proper thing to do.
2. Having the operation is acceptable.
3. Having the operation is wrong.
4. If the operation in the story existed in real life, everyone should have the right to it.
5. Having the operation is unethical.

We report the English materials as they were used in the only studies ran in English, Study 2 and 6. Studies 1, 3, 4, 5A and 5B were run in Finnish. The English materials were translated by the authors from the Finnish originals. The character in the vignette was called Antti in the Finnish materials; other than this, the materials were the same.

Appendix C. Perceived unfairness scale items (Studies 1–5)

1. For someone in work life the advantage provided by the microchip would be unfair.
2. For a student the advantage provided by the microchip would be unfair.

3. After his operation, Alex should be disqualified from competitive memory sport events.

We report the English materials as they were used in the only studies ran in English, Study 2 and 6. Studies 1, 3, 4, 5A and 5B were run in Finnish. The English materials were translated by the authors from the Finnish originals. The character in the vignette was called Antti in the Finnish materials; other than this, the materials were the same.

Appendix D. Dehumanization scale items (Studies 2–5)

1. I don't think Alex can be called fully human after his operation.
2. After the operation, Alex can still feel emotions.
3. After the operation, Alex can still be kind.
4. After the operation, Alex is still capable of being a good partner.
5. After the operation, Alex is still capable of friendship.
6. After the operation, Alex is less valuable as a human being.
7. After the operation, Alex is still a normal human being.
8. After the operation, Alex should still have the same rights as everyone else.
9. After the operation, Alex is more a machine than a man.
10. After his operation, I don't think Alex belongs to the same species as I.

(Study 1 used a single item for this measure: "In my opinion, Alex is not completely human after the operation".)

We report the English materials as they were used in the only studies ran in English, Study 2 and 6. Studies 1, 3, 4, 5A and 5B were run in Finnish. The English materials were translated by the authors from the Finnish originals. The character in the vignette was called Antti in the Finnish materials; other than this, the materials were the same.

Appendix E. Vignettes for Studies 1–6

Study 1 – memory implant 3 (level of enhancement) x 1

(1: superhuman, 2: optimal, & 3: alleviation)

It is the year 2050. Medical science has advanced significantly, and implanting microchips in people's brains is an everyday procedure. These microchips can be used to treat, for example, depression or Parkinson's disease, and the results are much better with fewer side effects than those obtained with traditional long-term medication.

Alex is an office worker soon to retire. Work health services offer him a chance to have an operation, where a microchip would be implanted in his brain to improve his memory functions.

The operation would give him the ability to perfectly remember everything he has seen, read, heard or otherwise experienced. // The operation would restore his memory capacity to the level of his youth and prevent any further age-related memory deterioration. // The operation would repair his memory impairments, which are related to an early stage dementia, and prevent any further disease progression. After discussing the potential risks with his physician, Alex signs up for the operation and enters the waitlist.

Study 2 – memory implant 3 (level of enhancement) x 2 (level of familiarity)

(1: superhuman, 2: optimal, & 3: alleviation) x (1: established, 2: experimental)

It is the year 2050. Medical science has advanced significantly, and implanting microchips in people's brains is an everyday procedure. These microchips can be used to treat, for example, depression or Parkinson's disease, and the results are much better // have so far been much better with fewer side effects than those obtained with traditional long-term medication.

Alex is an office worker soon to retire. Work health services offer him a chance to have an operation, where a microchip would be implanted in his brain to improve his memory functions.

The operation would give him the ability to perfectly remember everything he has seen, read, heard or otherwise experienced. // The operation would restore his memory capacity to the level of his youth and prevent any further age-related memory deterioration. // The operation would repair his memory impairments, which are related to an early stage dementia, and prevent any further disease progression. After discussing the potential risks with his physician, Alex signs up for the operation and enters the waitlist.

Study 3 – memory implant 3 (level of enhancement) x 2 (method of enhancement).

(1: superhuman, 2: optimal, & 3: alleviation) x (1: surgery, 2: nano-robots)

It is the year 2050. Medical science has advanced significantly, and implanting microchips in people's brains is an everyday procedure. These microchips can be used to treat, for example, depression or Parkinson's disease, and the results are better with fewer side effects than those obtained with traditional long-term medication. The microchip will be inserted via surgery. // The microchip will be built in place by nano-robots that are swallowed with no need for surgery.

Alex is an office worker soon to retire. Work health services offer him a chance to have an operation, where a microchip would be implanted in his brain to improve his memory functions.

The operation would give him the ability to perfectly remember everything he has seen, read, heard or otherwise experienced. // The operation would restore his memory capacity to the level of his youth and prevent any further age-related memory deterioration. // The operation would repair his memory impairments, which are related to an early stage dementia, and prevent any further disease progression. After discussing the potential risks with his physician, Alex signs up for the operation and enters the waitlist.

Study 4 – memory implant 3 (level of enhancement) x 2 (method of enhancement).

(1: superhuman, 2: optimal, & 3: alleviation) x (1: surgery, 2: drugs)

It is the year 2050. Medical science has advanced significantly, and implanting microchips in people's brains is an everyday procedure. These microchips // complex single dose pharmacological interventions to alter the brain structure are an everyday procedure. These interventions can be

used to treat, for example, depression or Parkinson's disease, and the results are better with fewer side effects than those obtained with traditional long-term medication.

Alex is an office worker soon to retire. Work health services offer him a chance to have an operation, where a microchip would be implanted in his brain // complex single dose pharmacological intervention to alter the brain structure to improve his memory functions.

The operation would give him the ability to perfectly remember everything he has seen, read, heard or otherwise experienced. // The operation would restore his memory capacity to the level of his youth and prevent any further age-related memory deterioration. // The operation would repair his memory impairments, which are related to an early stage dementia, and prevent any further disease progression. After discussing the potential risks with his physician, Alex signs up for the operation and enters the waitlist.

Study 5A – general intelligence implant 3 (level of enhancement) x 2 (level of familiarity).

(1: alleviation, 2: optimal, & 3: super-human) x (1: established, 2: experimental)

It is the year 2035. Medical science has advanced significantly, and for example the neural basis of thought processes is now known. Implanting microchips that improve brain functions is an everyday procedure // is a new and promising procedure. These microchips can be used to treat, for example, depression or Parkinson's disease, and the results are much better // have so far been much better with fewer side effects than those obtained with traditional long-term medication.

Alex is a 35-year old office worker. He feels that he is not especially intelligent, and tests done by his work health services show that his cognitive functions are significantly slower than normal. His doctor recommends implanting a microchip in his brain that would raise his intelligence to the level of a typical, adequately performing adult // to the level of a typical, well performing adult // to a super-human level.

Alex decides to follow the recommendation of his doctor.

Study 5B – emotional stability implant 3 (level of enhancement) x 2 (level of familiarity).

(1: alleviation, 2: optimal, & 3: super-human) x (1: established, 2: experimental)

It is the year 2035. Medical science has advanced significantly, and for example the neural basis of emotional states is now known. Implanting microchips that improve brain functions is an everyday procedure // is a new and promising procedure. These microchips can be used to treat, for example, depression or Parkinson's disease, and the results are much better // have so far been much better with fewer side effects than those obtained with traditional long-term medication.

Alex is a 35-year old office worker. He suffers from recurring but short periods of anxiety. His doctor recommends implanting a microchip in his brain that would mitigate his anxieties // return the function of his emotional system to the level of a healthy adult // give him complete control over his emotional state.

Alex decides to follow the recommendation of his doctor.

Study 6 – memory implant 3 (level of enhancement) x 2 (decision).

(1: superhuman, 2: optimal, & 3: alleviation) x (accept/refuse)

It is the year 2050. Medical science has advanced significantly, and implanting microchips in people's brains for various purposes has become possible.

Alex is an office worker soon to retire. Work health services offer him a chance to have an operation, where a microchip would be implanted in his brain.

The operation would give him the ability to perfectly remember everything he has seen, read, heard or otherwise experienced. // The operation would restore his memory capacity to the level of his youth and prevent any age-related memory loss. // The operation would reverse impairments in his memory, which are related to early stage dementia, and prevent any further disease progression.

After discussing the potential risks with his physician, Alex signs up for the microchip operation // Alex refuses the microchip operation.

Appendix F. Full recruitment and process descriptions

F.1. Study 1

In total, one hundred and fifty six participants were recruited via invitations posted on various Finnish online discussion forums (open to the general public), as well as university student email lists ($N = 156$, 67 female, 78 male, Mean age = 33, SD = 12.16, Range = 18–66). Open discussion forums were targeted to obtain a sample more representative of the general population than merely students. People were invited to fill in an online questionnaire taking about 30 min of their time and given the chance to participate in a movie ticket raffle for 5 movie tickets (approximately $5 \times 10€$).

Study 1 had a 1×3 between-subjects design. Each participant read one of three vignettes, in which a person is given the chance to go under surgery to get a brain implant that would either 1) cure his early stage dementia (alleviating an ailment); 2) restore his memory capacity to the level of his youth (optimal human level), or 3) give him the ability to perfectly remember everything he has read, heard or otherwise experienced (superhuman enhancement). Participants were randomized into one of the three conditions.

F.2. Study 2

In total, 491 participants were recruited via Amazon's Mechanical Turk (mTurk) to complete an online survey prepared with Qualtrics. After removing outliers and improper responses, the final sample size was 435 (273 female, Mean age = 33.4, SD = 9.9, Range = 18–70). All participants were US residents and were given US $1.2 as compensation.

Study 2 had a 3×2 between-subjects design. Like in Study 1, the outcome was either 1) alleviation of an ailment, 2) optimal of performance or 3) superhuman. The second factor (level of familiarity) had two levels, describing the implant technology as either 1) experimental (i.e. the technology was in an experimental stage), or 2) established (i.e. the technology was well established and in common use). The vignettes were modified versions of the vignette used in Study 1. The participants first responded to the covariate measures, then read one of the stories (randomized) and gave responses to each of the DVs, then read the second story and responded to each of the DVs.

F.3. Study 3

We ran Study 3 in a laboratory. In total, 198 participants were recruited from a lobby of the main library of University of Helsinki (122 female, 76 male, Mean age = 29.51, SD = 9.43, Range = 18–71). Participants approached a research assistant, who sat with a sign saying "participate in a psychological study". They signed an informed consent form, after which they were directed to our laboratory where they completed a computer-administered experiment. Participants were compensated 3€ for their time. This sample of participants also provided responses to another study, the results of which will be reported elsewhere.

Study 3 had a 3 × 2 between-subjects design. Like in previous studies, participants read a short, futuristic story about a person diagnosed with early-phase memory disorder. In this study, we varied the method of enhancement so that half of the participants read a story about the memory enhancement happening through surgically implanting a microchip, and half of the participants read a story about the memory enhancement happening through nano-robots that the person could swallow in the form of a pill. Like in previous studies, the level of enhancement was either 1) normal, 2) youth-level, or 3) superhuman memory.

F.4. Study 4

We ran Study 4 in a laboratory. In total, 213 participants were recruited from a lobby of the main library of University of Helsinki (120 female, 93 male, Mean age = 32.68, SD = 12.00, Range = 18–72). Participants approached a research assistant with a sign saying "participate in a psychological study". They signed an informed consent form, after which they were directed to our laboratory where they completed a computer-administered experiment. Participants were compensated 7€ for their time. This sample of participants also provided responses to two other studies, the results of which will be reported elsewhere.

Study 4 had a 3 × 2 between-subjects design. Like in our previous studies, participants read a short, futuristic story about a person diagnosed with early-phase memory disorder. In this study, we varied the method of enhancement so that half of the participants read a story about the memory enhancement happening through surgically implanting a microchip, and half of the participants read a story about the memory enhancement happening through medication. Like in previous studies, the level of enhancement was either 1) normal, 2) youth-level, or 3) superhuman memory.

F.5. Studies 5A and 5B

We ran Study 5 in a laboratory. In total, 263 participants were recruited from a lobby of the main library of University of Helsinki (149 female, 114 male, Mean age = 30.15, SD = 9.94, Range = 18–66). These demographics are based on the sample before applying a filter excluding 11 participants based on two attention checks ("Please answer 2"). Participants approached a research assistant with a sign saying "participate in a psychological study". They signed an informed consent form, after which they were directed to our laboratory where they completed a computer-administered experiment. Participants were compensated 3€ for their time. This sample of participants also provided responses to another study, the results of which will be reported elsewhere.

Study 5 consisted of two experiments with a 3 × 2 between-subjects design. Participants read two short, futuristic stories in a randomized order. The stories were about a person diagnosed with A) slow cognitive processes and B) recurring periods of anxiety getting a neural implant to help with his symptoms. Like in previous studies, the level of enhancement was either 1) alleviation of an ailment, 2) optimal or 3) superhuman ability (A: level of a typical, adequately performing adult / level of a typical, well performing adult / super-human level; B: mitigate anxieties / return the function of emotional system to the level of a healthy adult / give complete control over his emotional state). The second factor (level of familiarity) had two levels, describing the implant technology as either 1) experimental (i.e. the technology was in an experimental stage), or 2) established (i.e. the technology was well established and in common use). The vignettes were modified versions of the vignette used in Study 1. The participants first responded to the covariate measures, then read one of the stories (randomized) and gave responses to each of the DVs, then read the other story and responded to each of the DVs again.

F.6. Study 6

In total, 1000 participants were recruited via Prolific.com to complete an online survey prepared with Qualtrics. After removing improper responses, the final sample size was 990 (582 female, Mean age = 39.04, SD = 13.85, Range = 18–70). All participants were US, UK or Canada residents and were given 1.9 £ as compensation for their time.

Study 6 had a 3 × 2 between-subjects design. Like in Study 1, the level of enhancement was either 1) normal, 2) youth-level, or 3) superhuman memory. The second factor (decision) had two levels, describing the main character either 1) accepting or 2) refusing to take the implant. The vignettes were modified versions of the vignette used in Study 1. The participants first responded to the covariate measures, then read one of the stories (randomized) and gave responses to each of the DVs, then read the second story and responded to each of the DVs.

Appendix G. Science Fiction Hobbyism Scale Items

1. For me, science fiction is an interesting topic.
2. I have spent a lot of time on SF movies, literature, games, TV shows and/or comics.
3. I tend to notice scientific or technological inaccuracies in movies and books.
4. I consider myself a big science fiction fan.
5. I have actively participated in conventions and gatherings related to science fiction.
6. I am active in an organization, club or society related to SF.
7. I try to keep up to date on technological and scientific advances.
8. Fiction set in the future is often more interesting than other kinds of fiction.
9. Transhumanism is a familiar topic to me.
10. I often think about things related to artificial intelligence.

11. I spend a lot of time finding out more about space and space technology.
12. I often think about what machines are going to be like in the future.

Appendix H. ANCOVA results for Studies 1–6

		Moral approval		Perceived unfairness		Dehumanization	
Study	Covariate	B	*p*-value	B	*p*-value	B	*p*-value
Study 1	Binding	−0.32**	0.001	0.32*	0.025	0.60***	< 0.001
	Individualizing	−0.10	0.330	0.39*	0.013	0.20	0.193
	Scifi Hobbysim	0.31***	< 0.001	−0.22*	0.034	−0.11	0.269
Study 2	Binding	−0.20***	< 0.001	0.13	0.059	0.12	0.004
	Individualizing	0.25**	0.001	0.08	0.391	−0.31***	< 0.001
	Scifi Hobbysim	0.33***	< 0.001	−0.14*	0.019	−0.09*	0.014
	Sexual Disgust	−0.24***	< 0.001	0.21***	< 0.001	0.13***	< 0.001
Study 3	Binding	−0.25**	0.003	0.03	0.795	0.19**	0.004
	Individualizing	0.07	0.464	0.04	0.781	−0.06	0.466
	Scifi Hobbysim	0.14*	0.020	0.03	0.668	−0.03	0.445
	Sexual Disgust	−0.12	0,05	0.05	0.553	0.07	0.123
Study 4	Binding	−0.25**	0.003	0.11	0.390	0.18**	0.002
	Individualizing	0.09	0.428	−0.09	0.571	−0.10	0.171
	Scifi Hobbysim	0.12*	0.040	−0.02	0.771	−0.06	0.110
	Sexual Disgust	−0.23***	< 0.001	0.03	0.687	0.13**	0.001
Study 5A	Binding	−0.28*	0.012	0.13	0.298	0.25**	0.001
(IQ)	Individualizing	−0.23	0.082	0.24	0.129	0.00	0.943
	Scifi Hobbysim	0.38***	< 0.001	−0.13	0.160	0.03	0.556
	Sexual Disgust	−0.30***	< 0.001	0,14	0.142	0.13**	0.015
Study 5B	Binding	−0.36**	0.001	0.38**	0.003	0.28***	< 0.001
(Mood)	Individualizing	0.01	0.912	−0.04	0.776	−0.20*	0.018
	Scifi Hobbysim	0.06	0.408	0.16	0.082	0.11*	0.030
	Sexual Disgust	−0.26***	< 0.001	0.09	0.324	0.06	0.219
Study 6	Binding	−0.18**	0.001	0.03	0.668	0.08*	0.039
(Accept)	Individualizing	0.01	0.894	0.04	0.676	−0.23***	< 0.001
	Scifi Hobbysim	0.13**	0.001	−0.08	0.137	−0.06*	0.038
	Sexual Disgust	−0.22***	< 0.001	0.06	0.263	0.05	0.053
Study 6	Binding	−0.00	0.983	0.02	0.754	0.01	0.539
(Refuse)	Individualizing	0.13**	0.006	0.13	0.213	−0.17***	< 0.001
	Scifi Hobbysim	−0.07*	0.015	−0.08	0.166	0.04*	0.032
	Sexual Disgust	0.01	0.529	0.05	0.381	0.01	0.579

Note: Each slope was estimated in a separate regression analysis. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Appendix I. ANCOVA results for each study

Table I1
ANCOVA results for Study 1. $N = 156$.

		Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enhancement	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Alleviation	−0,42	−2,79	,006**	0,20	0,87	,386	0,69	3,06	,003**
	Optimization	0,06	0,41	,684	0,21	0,92	,358	0,43	1,89	,061
	Superhuman	−0,59	−3,67	< 0.001***	0,62	2,56	,012	0,64	2,67	,008**
Individualizing	Alleviation	−0,23	−1,11	,270	0,30	1,00	,318	0,51	1,63	,105
	Optimization	0,21	1,18	,240	0,24	0,93	,354	0,07	0,27	,785
	Superhuman	−0,28	−1,74	,084	0,72	3,11	,002**	0,11	0,45	,650
Scifi Hobbyism	Alleviation	0,08	0,82	,413	0,01	0,06	,954	−0,06	−0,38	,707
	Optimization	0,35	2,60	,010**	−0,45	−2,12	,036*	0,15	0,68	,496
	Superhuman	0,50	4,80	< 0.001***	−0,31	−1,93	,056	−0,28	−1,65	,101

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I2
ANCOVA results for Study 2. $N = 435$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Familiarity	Level of Enhancement	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Established	Alleviation	−0,05	−0,41	,681	0,03	0,20	,839	0,12	1,15	,249
		Optimization	−0,61	−4,29	< 0.001***	0,55	2,95	,003**	0,20	1,70	,089
		Superhuman	−0,28	−2,03	,043*	0,06	0,36	,720	0,24	2,17	,031*
	Experimental	Alleviation	−0,18	−1,46	,146	0,18	1,14	,256	0,01	0,08	,937
		Optimization	0,00	−0,03	,977	−0,14	−0,80	,423	0,02	0,19	,847
		Superhuman	−0,11	−0,87	,385	0,06	0,39	,699	0,15	1,51	,132

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Table I2 (*continued*)

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Familiarity	Level of Enhancement	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Individualizing	Established	Alleviation	0,40	1,86	,063	−0,34	−1,24	,214	−0,26	−1,58	,115
		Optimization	0,12	0,64	,522	0,11	0,48	,630	−0,50	−3,54	< 0.001***
		Superhuman	0,25	1,43	,152	0,43	1,92	,056	−0,02	−0,14	,889
	Experimental	Alleviation	−0,10	−0,52	,604	−0,12	−0,48	,630	−0,33	−2,19	,029*
		Optimization	0,36	2,00	,046*	0,45	1,92	,056	−0,39	−2,71	,007**
		Superhuman	0,24	1,38	,169	0,06	0,26	,791	−0,27	−1,99	,048*
Scifi Hobbyism	Established	Alleviation	0,16	1,48	,139	0,08	0,52	,603	−0,05	−0,58	,565
		Optimization	0,59	6,31	< 0.001***	−0,28	−2,19	,029	−0,21	−2,61	,009**
		Superhuman	0,26	2,60	,010**	−0,13	−0,97	,334	0,13	1,57	,117
	Experimental	Alleviation	0,45	4,19	< 0.001***	−0,37	−2,52	,012	−0,29	−3,19	,002**
		Optimization	0,10	0,84	,403	−0,06	−0,35	,730	−0,02	−0,22	,827
		Superhuman	0,29	2,78	,006**	−0,03	−0,23	,816	−0,07	−0,80	,422
Sexual Disgust	Established	Alleviation	−0,11	−1,23	,218	0,09	0,76	,449	0,18	2,44	,015**
		Optimization	−0,52	−5,24	< 0.001***	0,36	2,70	,007**	0,20	2,49	,013*
		Superhuman	−0,26	−2,51	,012*	0,26	1,85	,065	0,14	1,66	,097
	Experimental	Alleviation	−0,21	−2,45	,015*	0,22	1,91	,057	0,19	2,59	,010**
		Optimization	−0,13	−1,33	,184	0,19	1,49	,138	0,00	−0,06	,950
		Superhuman	−0,27	−2,85	,005**	0,11	0,88	,378	0,09	1,14	,254

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I3
ANCOVA results for Study 3. $N = 198$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Method	Level of Enhancement	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Nanorobots	Alleviation	−0,05	−0,29	,772	0,01	0,03	,973	0,02	0,16	,875
		Optimization	−0,39	−2,24	,026*	0,10	0,39	,696	0,37	2,62	,010**
		Superhuman	−0,36	−1,73	,085	0,23	0,79	,429	0,33	1,94	,054
	Surgery	Alleviation	−0,60	−3,08	,002**	0,34	1,24	,217	0,34	2,17	,031*
		Optimization	0,04	0,17	,867	−0,36	−1,11	,270	0,10	0,55	,581
		Superhuman	−0,39	−1,66	,099	0,40	1,19	,235	0,32	1,65	,100
Individualizing	Nanorobots	Alleviation	0,04	0,19	,853	0,37	1,32	,190	0,14	0,82	,411
		Optimization	0,10	0,34	,736	−0,08	−0,20	,843	−0,11	−0,49	,621
		Superhuman	−0,56	−2,15	,033*	0,39	1,08	,281	0,10	0,50	,620
	Surgery	Alleviation	0,23	1,07	,284	0,07	0,24	,812	0,02	0,14	,886
		Optimization	0,35	1,12	,263	−0,68	−1,59	,114	−0,49	−1,94	,054
		Superhuman	0,51	1,65	,100	−0,23	−0,54	,591	−0,38	−1,51	,133
Scifi Hobbyism	Nanorobots	Alleviation	0,30	1,85	,066	−0,17	−0,75	,455	−0,19	−1,41	,161
		Optimization	0,14	0,92	,359	0,12	0,56	,575	0,07	0,52	,605
		Superhuman	−0,18	−1,19	,237	−0,04	−0,17	,862	0,06	0,45	,651
	Surgery	Alleviation	0,22	1,54	,125	0,08	0,41	,683	−0,02	−0,17	,867
		Optimization	0,24	1,69	,092	0,36	1,82	,070	0,02	0,21	,837
		Superhuman	0,32	2,21	,029*	−0,36	−1,81	,073	−0,28	−2,36	,019*
Sexual disgust	Nanorobots	Alleviation	−0,12	−0,93	,355	0,19	1,05	,296	0,13	1,20	,230
		Optimization	−0,31	−1,82	,070	0,21	0,86	,390	0,08	0,61	,542
		Superhuman	0,02	0,12	,901	0,39	1,69	,092	0,06	0,48	,632
	Surgery	Alleviation	−0,42	−3,08	,002**	0,03	0,16	,875	0,34	3,13	,002**
		Optimization	−0,17	−1,15	,251	0,05	0,24	,810	0,15	1,32	,190
		Superhuman	0,11	0,69	,490	−0,15	−0,68	,500	−0,20	−1,59	,115

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I4
ANCOVA results for Study 4. $N = 213$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enhancement	Method	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Alleviation	Surgery	0,10	0,37	,709	−0,28	−0,76	,450	−0,07	−0,44	,662
	Optimization		−0,25	−1,37	,173	0,17	0,66	,510	0,12	0,97	,332
	Superhuman		−0,52	−2,80	,006**	0,09	0,32	,750	0,45	3,71	< 0.001***
	Alleviation	Drug	−0,27	−1,51	,132	−0,05	−0,19	,848	0,23	2,00	,047*
	Optimization		−0,02	−0,08	,935	0,03	0,10	,920	−0,04	−0,32	,746
	Superhuman		−0,27	−1,21	,227	0,63	1,97	,051	0,25	1,74	,084
Indlividualizing	Alleviation	Surgery	0,07	0,23	,821	−0,32	−0,80	,423	−0,05	−0,25	,805
	Optimization		0,08	0,36	,719	−0,44	−1,36	,176	−0,06	−0,42	,677
	Superhuman		0,15	0,68	,500	−0,13	−0,42	,672	−0,21	−1,38	,170
	Alleviation	Drug	0,07	0,21	,832	−0,34	−0,76	,448	−0,02	−0,10	,924
	Optimization		0,16	0,45	,651	0,29	0,59	,555	−0,14	−0,63	,531

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Table I4 (*continued*)

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enhancement	Method	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
	Superhuman		0,04	0,15	,880	0,61	1,68	,094	−0,09	−0,53	,594
Scifi Hobbyism	Alleviation	Surgery	0,13	0,90	,370	−0,05	−0,27	,789	−0,12	−1,26	,209
	Optimization		0,25	1,94	,053	−0,12	−0,67	,502	−0,14	−1,69	,092
	Superhuman		0,26	1,75	,081	−0,07	−0,33	,743	−0,08	−0,76	,448
	Alleviation	Drug	−0,03	−0,20	,842	0,36	2,01	,046	0,07	0,82	,416
	Optimization		0,03	0,16	,875	0,27	1,14	,255	0,03	0,25	,802
	Superhuman		−0,10	−0,70	,484	−0,15	−0,71	,479	0,02	0,20	,843
Sexual disgust	Alleviation	Surgery	0,06	0,42	,673	−0,36	−1,82	,070	−0,01	−0,14	,891
	Optimization		−0,04	−0,29	,776	0,25	1,30	,195	−0,07	−0,75	,452
	Superhuman		−0,44	−3,07	,002**	0,16	0,75	,453	0,29	3,08	,002*
	Alleviation	Drug	−0,26	−2,02	,045*	−0,19	−1,00	,317	0,21	2,43	,016*
	Optimization		−0,15	−0,93	,354	−0,08	−0,35	,724	0,12	1,08	,282
	Superhuman		−0,40	−2,77	,006**	0,18	0,86	,391	0,14	1,42	,158

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I5
ANCOVA results for Study 5A. $N = 252$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enahncement	Familiarity	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Alleviation	Established	−0,50	−1,62	,107	0,28	0,78	,436	0,21	1,04	,298
	Optimization		−0,34	−1,18	,239	0,58	1,72	,087	0,51	2,70	,007**
	Superhuman		−0,12	−0,51	,613	−0,05	−0,16	,870	0,17	1,04	,300
	Alleviation	Experimental	−0,38	−1,19	,235	−0,03	−0,07	,946	0,31	1,47	,143
	Optimization		−0,15	−0,69	,488	−0,17	−0,64	,520	0,27	1,86	,064
	Superhuman		−0,40	−1,32	,188	0,50	1,41	,161	0,14	0,69	,489
Individualizing	Alleviation	Established	0,27	0,98	,327	0,07	0,20	,838	−0,05	−0,26	,797
	Optimization		−0,51	−1,35	,179	−0,39	−0,88	,380	−0,29	−1,15	,253
	Superhuman		−0,16	−0,52	,606	0,26	0,72	,470	0,03	0,13	,896
	Alleviation	Experimental	−0,31	−0,90	,367	0,70	1,76	,080	−0,25	−1,09	,277
	Optimization		−0,39	−1,17	,243	0,34	0,88	,380	0,38	1,71	,089
	Superhuman		−0,41	−0,99	,322	0,57	1,17	,243	0,19	0,67	,500
Scifi Hobbyism	Alleviation	Established	0,28	1,75	,081	−0,16	−0,83	,410	0,10	0,85	,398
	Optimization		0,32	1,57	,119	−0,28	−1,12	,264	−0,08	−0,57	,572
	Superhuman		0,34	1,50	,136	−0,54	−1,94	,054	0,07	0,45	,654
	Alleviation	Experimental	0,32	1,79	,074	0,25	1,14	,254	0,11	0,86	,392
	Optimization		0,25	1,25	,212	0,04	0,15	,878	−0,06	−0,40	,688
	Superhuman		0,66	3,49	,001***	−0,26	−1,15	,253	0,02	0,17	,865
Sexual disgust	Alleviation	Established	−0,32	−1,50	,136	0,31	1,19	,236	0,17	1,19	,234
	Optimization		−0,34	−1,85	,066	0,46	2,08	,039*	0,23	1,82	,070
	Superhuman		−0,13	−0,80	,422	−0,18	−0,98	,328	−0,02	−0,18	,857
	Alleviation	Experimental	−0,38	−1,70	,091	−0,19	−0,72	,475	0,21	1,39	,165
	Optimization		−0,42	−2,35	,019*	0,10	0,47	,641	0,25	2,10	,037*
	Superhuman		−0,29	−1,22	,225	0,48	1,71	,089	−0,13	−0,82	,414

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I6
ANCOVA results for Study 5B. $N = 252$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enhancement	Familiarity	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Alleviation	Established	−0,31	−1,57	,117	0,35	1,43	,154	0,3	2,22	,028*
	Optimization		−0,07	−0,25	,801	0,26	0,77	,443	0,08	0,4	,689
	Superhuman		−0,54	−2,17	,031*	0,37	1,21	,229	0,21	1,26	,209
	Alleviation	Experimental	−0,19	−0,78	,438	0,54	1,74	,083	0,21	1,26	,210
	Optimization		−0,12	−0,43	,671	−0,01	−0,02	,981	0,2	0,99	,323
	Superhuman		−0,63	−2,57	,011*	0,27	0,89	,377	0,44	2,65	,009**
Individualizing	Alleviation	Established	0,09	0,35	,727	−0,5	−1,5	,134	−0,27	−1,47	,142
	Optimization		−0,29	−1,02	,308	−0,43	−1,24	,218	−0,2	−1,03	,305
	Superhuman		−0,3	−1,01	,312	−0,11	−0,3	,765	−0,17	−0,86	,393
	Alleviation	Experimental	0,2	0,7	,483	0,13	0,37	,712	−0,24	−1,25	,214
	Optimization		−0,65	−1,49	,138	0,53	0,99	,324	0,58	1,95	,053
	Superhuman		0,42	1,5	,135	0,73	2,14	,033*	−0,35	−1,84	,068
Scifi Hobbyism	Alleviation	Established	0,21	1,18	,239	0,14	0,63	,527	0,06	0,49	,626
	Optimization		0,35	1,92	,056	0,21	0,96	,339	−0,07	−0,54	,588
	Superhuman		−0,02	−0,1	,922	0,47	2,07	,040*	0,32	2,57	,011*
	Alleviation	Experimental	−0,06	−0,35	,728	0,16	0,77	,445	0,22	1,94	,053

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Table I6 (*continued*)

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Level of Enhancement	Familiarity	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
	Optimization		0,13	0,69	,491	−0,21	−0,9	,368	−0,1	−0,8	,426
	Superhuman		−0,08	−0,47	,638	−0,02	−0,1	,921	0,16	1,37	,171
Sexual Disgust	Alleviation	Established	−0,14	−0,88	,380	0,21	1,03	,304	0,14	1,25	,212
	Optimization		−0,31	−1,76	,080	−0,05	−0,24	,813	0,05	0,36	,716
	Superhuman		−0,23	−1,31	,193	0,13	0,58	,562	−0,1	−0,79	,432
	Alleviation	Experimental	−0,16	−0,97	,334	−0,11	−0,52	,602	0,18	1,58	,115
	Optimization		−0,18	−0,79	,433	0,01	0,04	,967	−0,09	−0,55	,583
	Superhuman		−0,41	−2,51	,013*	0,08	0,36	,718	0	−0,03	,978

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

Table I7
ANCOVA results for Study 6. $N = 990$.

			Moral approval			Perceived unfairness			Dehumanization		
Covariate	Decision	Level of Enhancement	B	*t*-value	*p*-value	B	*t*-value	*p*-value	B	*t*-value	*p*-value
Binding	Accept	Alleviation	−0,11	−1,33	,185	0,12	0,92	,358	0,10	1,64	,101
		Optimization	−0,22	−2,50	,013*	0,01	0,06	,948	0,09	1,41	,160
		Superhuman	−0,26	−3,25	,001***	0,03	0,26	,792	0,08	1,39	,163
	Refuse	Alleviation	−0,02	−0,27	,784	0,14	1,19	,236	0,02	0,38	,706
		Optimization	0,02	0,28	,777	−0,15	−1,14	,256	−0,01	−0,17	,869
		Superhuman	−0,03	−0,35	,723	0,02	0,13	,896	0,06	0,89	,375
Individualizing	Accept	Alleviation	0,05	0,43	,670	0,07	0,39	,694	−0,15	−1,87	,061
		Optimization	−0,10	−0,97	,333	0,02	0,12	,908	−0,23	−3,12	,002**
		Superhuman	0,07	0,74	,458	0,04	0,25	,804	−0,30	−4,13	,000***
	Refuse	Alleviation	0,17	1,76	,080	−0,06	−0,38	,707	−0,25	−3,56	,000***
		Optimization	0,04	0,36	,717	0,06	0,34	,732	−0,16	−2,10	,036*
		Superhuman	0,20	1,80	,073	0,40	2,24	,026*	−0,10	−1,17	,244
Scifi Hobbyism	Accept	Alleviation	0,19	3,00	,003**	−0,18	−1,81	,071	−0,07	−1,51	,131
		Optimization	0,17	3,07	,002**	−0,08	−0,86	,393	−0,07	−1,57	,116
		Superhuman	0,08	1,28	,201	−0,05	−0,50	,619	−0,06	−1,40	,162
	Refuse	Alleviation	−0,10	−1,62	,105	0,00	0,04	,968	0,09	2,06	,040*
		Optimization	−0,08	−1,23	,220	−0,05	−0,49	,627	0,04	0,84	,403
		Superhuman	−0,02	−0,27	,791	−0,14	−1,50	,133	−0,01	−0,21	,836
Sexual Disgust	Accept	Alleviation	−0,25	−4,29	,000***	0,04	0,42	,676	0,09	2,12	,034*
		Optimization	−0,15	−2,79	,005**	0,04	0,52	,606	0,00	−0,10	,918
		Superhuman	−0,36	−6,10	,000***	0,19	1,93	,054	0,11	2,49	,013*
	Refuse	Alleviation	0,09	1,59	,112	0,11	1,13	,261	0,03	0,61	,542
		Optimization	0,02	0,45	,651	0,12	1,35	,178	0,00	0,05	,959
		Superhuman	−0,06	−1,15	,249	−0,10	−1,05	,293	0,01	0,21	,831

Notes: Highlighted cells indicate significant slopes for the covariate. * = significant at 0.05 alpha level, ** = significant at 0.01 alpha level, *** = significant at 0.001 alpha level.

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