Ethical Considerations of Cognitive Enhancement: Conventions and Controversies

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Author

Pai Li
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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature _____ Date _____

Approved _____ Date _____
Rider Foley, Department of Engineering and Society

Introduction

The advances of biomedical technology in the past century have raised a number of concerns about the ethical implications of such technologies. The issues raised in dystopian literature such as Huxley's *Brave New World* and Orwell's *1984* are becoming increasingly relevant as the line between science fiction and reality continues to be crossed. Biomedical technology has reached the point where it is possible not only to correct defects, but to actually improve upon and enhance the human condition. Despite the focus on newer enhancements, the practice of enhancement itself is quite old. Pharmacological enhancement of cognitive functions via caffeine is at least 2100 years old, although the case can be made that tea consumption in the 2nd century BCE may not qualify as human enhancement (Lu et al., 2016). On one hand, people in ancient China were probably not drinking tea with the explicit aim of enhancement the same way modern humans drink coffee for a morning boost. On the other, the reason tea became adopted by ancient civilizations in the first place may be related its psychoactive effects. Regardless of whether or not ancient caffeine usage qualifies as enhancement, the fact remains that historically accepted forms of enhancement such as caffeine exist in 2020.

This being the case, why have ethical controversies sprung up over more recent enhancements such as gene therapy? What exactly differentiates a conventional enhancement from a controversial one? To help answer these questions, American ethical views on human enhancements can be viewed through the ethical frameworks of acceptance rule consequentialism and neo-Aristotelian naturalism. These frameworks can then serve as a guide to understanding and categorizing the nature of American ethical concerns surrounding human enhancement.

Acceptance Rule Consequentialism

Consequentialism is an ethical framework wherein the moral quality of an action depends on the consequences of said action. Actions that lead to good consequences are morally good. Actions that lead to bad consequences are morally bad. A prominent school of thought within consequentialism is utilitarianism, which makes the claim that all human good can be ultimately reduced to utility, a general term for pleasure, happiness, and well-being. Under utilitarianism, utility then becomes the basis for moral judgment. For example, when the Gestapo show up at the front door, the morally correct action is to lie about Anne Frank's presence in the attic since lying leads to more utility than telling the truth. This type of ethical framework is attractive in that it is a simplified, applicable model that allows for direct comparisons of different options. A formalized application of consequentialism can be found in healthcare administration and policy, where determinations are made based on cost per difference in quality-adjusted life years (ΔQALY) (Whitehead & Ali, 2010). However, while doing the most good for the most people makes intuitive sense, applying this type of direct consequentialism can lead to some abhorrent conclusions.

Under direct consequentialism, it is not only morally acceptable, but morally correct to harvest organs from an unconsenting donor if it means a net gain in utility. However, Americans react with shock and abhorrence at China's suspected source for organs (Rogers, 2019). Given the organ shortage in America, why does the U.S. not follow suit and allow hospitals to harvest organs from prisoners, or even relatively healthy patients? Clearly, direct consequentialism is missing some key moral considerations.

In contrast to direct consequentialism, acceptance rule consequentialism (ARC) judges the morality of an action based on the consequences should everyone be allowed to take said action (Sinnott-Armstrong, 2003). If doctors were generally allowed to harvest organs from patients

without consent, patients' trust in doctors would plummet out of fear of being killed for their organs. People might hesitate to get treatment for all but the most serious conditions, leading ultimately to lower public health and decreased QALY overall. Furthermore, doctors and healthcare administrators are humans prone to error and misjudgment. Even if harvesting organs in some specific instances results in greater utility, allowing the practice as a whole may not. Surgery is inherently risky, and the expected value of allowing such a practice may lead to less utility overall. Thus, ARC allows for a more nuanced view of consequentialism that helps to explain American moral reasoning better than direct consequentialism.

Neo-Aristotelian Naturalism

Neo-Aristotelian naturalism (NAN) is a form of moral naturalism wherein moral truth is based on objective reality independent of culture and convention, and this reality can be observed through natural facts (Lutz & Lenman, 2018). The specific moral naturalistic framework used in this study is one described in Fukuyama's *Our Posthuman Future* (2002). Although Fukuyama doesn't explicitly say so, his ethical framework is essentially one of neo-Aristotelian virtue ethics based upon an underlying, universal human nature. To be a morally good human is to act according to human virtues and dignity, which are based on human nature. This type of naturalistic virtue ethics can be seen most clearly in religion, where the soul is a sacred gift from God, and human virtues are quite literally spelled out in revelation. For many Americans, perhaps the most prominent examples are Christian virtues and to be a morally good Christian is to act upon the virtues taught by Jesus Christ.

However, Fukuyama also claims that most secular deontological frameworks, from Kant to Rawls to Robertson, ultimately appeal to virtues and human nature, only covertly so. These

frameworks refer to "the appointed aim and purpose of mankind" or "that the potential of (human) life be realized rather than wasted" and contain numerous assumptions and assertions about human nature (Fukuyama, 2002, p.120-121). *Our Posthuman Future* goes into great detail about the arguments for this ethical framework, defending it from criticisms such as the naturalistic fallacy, but starts with the assertion that all humans are privy to a certain set of equal rights. In Western Civilization, this assertion is relatively uncontroversial due to a long history of philosophers extending back to Thomas Hobbes and John Locke. For Americans, belief in inalienable rights is literally spelled out in the Declaration of Independence. However, in order to have universal rights, there must be some underlying "humanness" present in every person that qualifies them for these universal rights. The egalitarian principles upon which America is built therefore require the assertion of universal human rights. In the NAN framework, ethical considerations in American democratic society are thus based on human rights, human virtues, and, ultimately, human nature.

Cognitive Enhancement and Convention

Although human enhancement can take on a variety of forms, this thesis focuses on enhancement of human cognition. Cognition refers to the mental processes by which organisms understand and organize information. CE, therefore, refers to "the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems (Bostrom & Sandberg, 2009)." Under this definition, CE covers a wide range of technologies and practices from biochemical strategies such as pharmaceuticals and nutrition, behavioral strategies such as sleep and exercise, and physical strategies such as implants and gadgets (Dresler et al., 2018).

In addition to modality-based classifications, CE can be further classified according to convention. Conventional enhancements, such as diet and education, are either well established or culturally accepted, whereas unconventional enhancements, such as implants and gene therapy, are either experimental or socially taboo or ambiguous (Bostrom & Sandberg, 2009). It should be noted that convention will depend heavily on both the technology as well as the underlying cultural background. In the U.S., for example, caffeine can be considered a conventional cognitive enhancing nootropic, whereas cocaine cannot (D. C. Mitchell et al., 2014; *National Survey of Drug Use and Health*, 2018). Certainly, physiological factors such as safety and risk play a key role in determining convention, as is likely the case in the distinction between caffeine and cocaine, but can hardly account for the entire picture. This point can be seen explicitly when considering psychoactive drug use and classification in the United States more broadly. Alcohol and tobacco are more psychologically and physiologically harmful than amphetamines, hallucinogens, and cannabis, despite the latter being tightly regulated as Schedule I drugs (Morgan et al., 2013). Furthermore, convention varies across cultures. Coca plants, from which cocaine is derived, are an integral part of indigenous Andean culture (Biondich & Joslin, 2016). While the case can be made that Andean traditional coca plant usage is not synonymous with contemporary cocaine usage, the physiological distinction is largely one of dosage and method of intake, as the psychoactive ingredient in the coca plant is still cocaine (Biondich & Joslin, 2016). These facts suggest that the ethical factors differentiating conventional from unconventional CE extend beyond simple physiological considerations.

Research Question and Methods

If so, what exactly are the ethical differences between conventional and unconventional CE? To help answer this question, public discourse surrounding two CEs were analyzed categorically through the frameworks of ARC and NAN. The two CEs considered were prenatal supplements (PNS) as the conventional enhancement, and germ line gene therapy (GGT) as the unconventional enhancement. PNS includes anything a pregnant mother ingests to improve the cognition of her future child. Broadly speaking, PNS can include dietary and lifestyle choices. However, many of these choices are for the sake of general health and not exclusive to CE. In order to look at CE specifically, only dietary supplements perceived to improve intelligence or cognition in some way were considered, namely those containing folic acid, choline, iodine, or iron (Barclay, 2001; Blusztajn et al., 2017; Leung et al., 2011; Taylor et al., 2017). By this definition, PNS need not be a pill. Intentional dietary changes leading to greater consumption of these nutrients are also considered PNS.

GGT is any technology that makes changes directly to a fertilized zygote's genetic makeup. In contrast to somatic gene therapy, changes made to the germline in this manner are inheritable. Human GGT was made possible largely by the 2013 development of CRISPR as a gene editing technique, although cases of human GGT were reported as early as 2001 (Ferriman, 2001; Mali et al., 2013; Wolf et al., 2019). Despite GGT being an established technology in industries such as agriculture and bioremediation, GGT for human use is outright banned in many countries (Detwiler, 2018; Wadman, 1998). Furthermore, application of this technology for human CE is still prospective due to deficiencies in the current understanding of cognition and the human genome (Brune & Bayer, 2012; Gao, 2018). The complex natures of both cognition and gene expression suggests that GGT as a reliable CE modality is quite a few years away. Nevertheless,

the fact that the technology exists and has already been implemented for other ends necessitates a proactive look towards the ethical considerations surrounding CE.

The two enhancements were selected to be as similar as possible in order to limit potential confounding factors. In both cases the enhancement is a permanent biochemical treatment, i.e. reversibility is not a factor, as it has been shown that reversibility of decisions in general can affect attitudes towards that decision (Shiner, 2015). Furthermore, the recipients of both enhancements have absolutely no agency. Both PNS and GGT are decisions on the part of the parent to enhance the offspring. While it is true that GGT, as a new procedure, is subject to concerns about safety not present in PNS, safety is hardly the only factor affecting CE convention, as was shown in the example involving drug classification in the U.S.

Sampling Methodology

In order to identify ethical factors differentiating conventional and unconventional CE, systematic literature reviews of PNS and GGT were conducted on the public discourse via news articles. Since CE convention depends on cultural backgrounds, only American news sources were selected. New sets of 9 articles each were iteratively reviewed until no new ethical considerations were raised. These 9 news articles were selected evenly with 3 from a reputable, relatively objective news source (*The New York Times*), 3 from a techno-progressive news source (*Science Daily*), and 3 from a conservative religious news source (*Christianity Today*). These choices were made in order to encompass a wider set of values within American society and to mitigate the effects of bias inherent within each individual news source.

The ethical considerations raised in these articles were classified based whether they supported or opposed the modality in question, then further classified based on the ethical

framework they fall under. Deontological concerns were classified as NAN due to the framework's assertion that deontological ethics implicitly defers to human virtue or human nature. The considerations were then broadly categorized based on the type of concerns. The full catalog of articles and concerns is listed in Appendix A1-A3. Since articles often raise multiple ethical concerns, a separate entry was listed for each additional concern within the same article. Repeat concerns were tallied as a quantitative measure indicating an approximate prevalence of the issue in question. In this manner, the ethical considerations separating conventional and unconventional CE can be shown explicitly. Analysis of these qualitative and quantitative differences can then be used as a starting point to formulate a formal hypothesis, theory, or model regarding the differences in conventional and unconventional CE, and to better understand the ethical factors by which treatment modalities eventually become convention or taboo.

Results

For GGT, no new considerations were raised after two rounds of sampling, resulting in 45 concerns across 18 articles (see Appendix A1). For PNS, there were barely enough relevant articles for slightly more than a single round of sampling, resulting in 11 concerns across 11 articles (see Appendix A2). The concerns raised in the public discourse surrounding CE could be broadly categorized into 11 different groups. Concerns surrounding better outcomes, unintended consequences, safety, social inequality, discrimination, other means, and efficacy fell under the ARC framework, while those surrounding a duty to help, human dignity, human nature, and religion fell under the NAN framework. These ethical considerations were then further categorized based on framework and support (Table 1). Quantitative analysis was done based on frequency of the considerations raised (Figs. 1-3).

	Prenatal Supplements		Germline Gene Therapy	
	Support	Oppose	Support	Oppose
Acceptance Rule Consequentialism	Better Outcome	Safety Efficacy	Better Outcome	Unintended Consequences Safety Social Inequality Discrimination Other Means
Neo-Aristotelian Naturalism			Duty to Help	Human Dignity Human Nature Religion

Table 1. Categorization of ethical considerations found in the public discourse

Categorization of Ethical Considerations

Concerns around "better outcomes" are those that involve the possibility of the technology in question leading to better lives, such as better health or making people happy. Unintended consequences and safety are related in that they both deal with risk, but concerns categorized as "unintended consequences" deal with risks stemming from lack of human foresight, whereas "safety" concerns deal with risks associated with heath. For example, risk of complications during surgery would be a safety concern, but not an unintended consequence. Unforeseen issues with an aging demographic as a result of life-prolonging surgeries, on the other hand, would be an unintended consequence. In a similar vein, concerns around social inequality and discrimination also have some overlap. Discrimination might even be thought of as a form of social inequality. However, the two are separate categories to reflect the fact that the nature of the public discourse also seems to make a distinction between the two, or at the very least highlights discrimination as a noteworthy case of social inequality. Thus, in this context, "social inequality" deals primarily with concerns around access and the potential for the creation of classes based on CE. "Discrimination" deals with concerns around the marginalization of a group on the basis of CE. An expensive enhancement that promotes compassion and empathy, for example, may lead to social inequality based on wealth without necessarily leading to discrimination. Concerns around

"other means" simply claim that the goals of CE can be better achieved through other means such as better education or healthcare. "Efficacy" is a self-explanatory category that deals with whether or not the technology in question does what it is purported to do.

On the NAN side, a "duty to help" is a deontological claim that people have a duty to develop technologies that can help people, and parents have a duty to provide their child the best life they can. This duty stems from virtues based on human nature and is therefore categorized under NAN. Concerns categorized as "human dignity" and "human nature" were typically explicitly stated as such. Issues surrounding commoditization of children were also categorized as "human dignity." Ethical considerations categorized as "religion" were those that made explicit religious statements involving terms such as "divine boundaries" or "God" (Collins, 2001; Gushee, 2017).

Therapy/Enhancement Distinction and Human Nature

The vast majority of support for both modalities was based on the potential for better outcomes. Only Belluck's article, which points out that people may be "…duty bound to explore what [GGT] can do in a safe, reliable manner to help people," supports enhancement on a basis not grounded in ARC (2017). Discussions of GGT as a form of CE were often linked to discussions surrounding therapeutic use. Most proponents refer to GGT's use in combating genetic disorders and either draw a firm line between GGT for therapy and GGT for enhancement, or dodge the enhancement issue entirely by focusing on its potential therapeutic benefits. Of 9 articles supporting GGT on the basis of better patient outcomes, only Haberman (2018) explicitly mentions the possibility of supporting GGT for enhancement.

Thus, it is clear that a difference in ethical attitudes exists between therapy, correcting a defect, and enhancement, improving the natural condition. Furthermore, many patients and physicians see pharmacological enhancements as unnecessary or outside the role of medicine (Banjo et al., 2010; Bostrom & Sandberg, 2009; Lipsman et al., 2009). However, what constitutes normalcy or pathology can often be unclear. Homosexuality, for instance, was listed in the Diagnostic and Statistical Manual of Mental Disorders as a mental disorder until 1973, showcasing the socially constructed nature of many pathologies (Drescher, 2015; O'Reilly & Lester, 2016). Furthermore, many human traits are not binary, but instead lie on a continuous distribution. These traits include weight, height, blood pressure, and, of course, cognition. For these continuous traits, the distinction between normalcy and pathology is also typically socially constructed: traits above or below a certain threshold are categorized as pathology. For example, the medical community simply determined 130/80 mmHg to be the cutoff point for hypertension based on a similarly constructed acceptable level of risk for pathologies such as cardiovascular disease. Likewise, a person with an intelligence quotient below a socially constructed threshold is considered to have a learning disability. Thus, for a continuous trait like intelligence, no meaningful distinction can be made between therapy and enhancement in the context of CE. A treatment to prevent or counteract a learning disability is an improvement upon the patient's natural condition in the same way a treatment to artificially boost intelligence is an improvement upon the patient's natural condition.

Despite the extremely vague line between therapy and enhancement, the fact remains that a difference in attitudes does indeed exist between treatment framed as therapy and treatment framed as enhancement. The reason for this difference is complex and is likely the result of a number of factors such as views on the traditional role of medicine, concerns about inequality and

social justice, various physiological factors, and perhaps even status quo bias. However, clarifying the social construction of pathology in cognition and its relation to the therapy/enhancement distinction is outside of the scope of this study. For the purposes of the current study, concerns related to the therapy/enhancement distinction and the role and scope of medicine were categorized as "human nature" as a part of the NAN framework based on the simplified analysis that treatment as therapy restores human nature, whereas treatment as enhancement alters human nature.

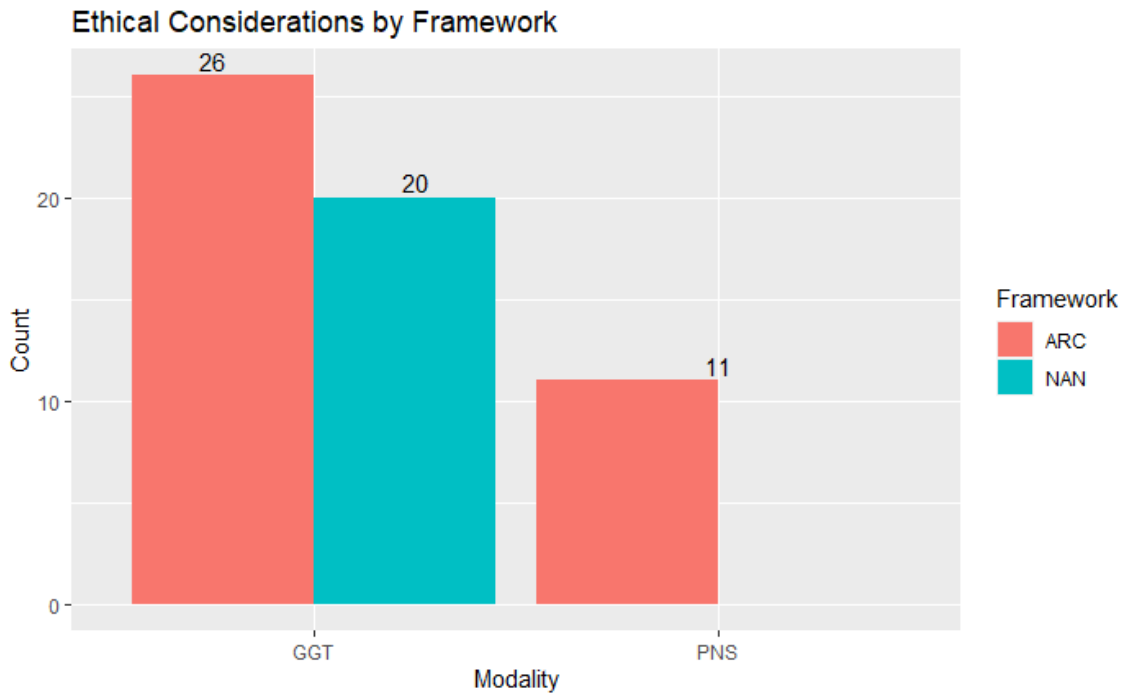

Figure 1. Breakdown of ethical considerations by framework

Quantification of Ethical Considerations

Quantification for each modality was done first by framework, then by category (Figs. 1 & 2). Public discourse was then further broken down based on support (Fig. 3). Public discourse around PNS was focused solely around ARC, with no NAN concerns. Public discourse surrounding GGT was roughly evenly split between ARC and NAN (Fig. 1). For GGT, NAN

ethical concerns based on human nature were the most common, followed by ARC concerns around safety and unintended consequences (Fig. 2). Public discourse was almost universally against GGT for enhancement (Fig. 3).

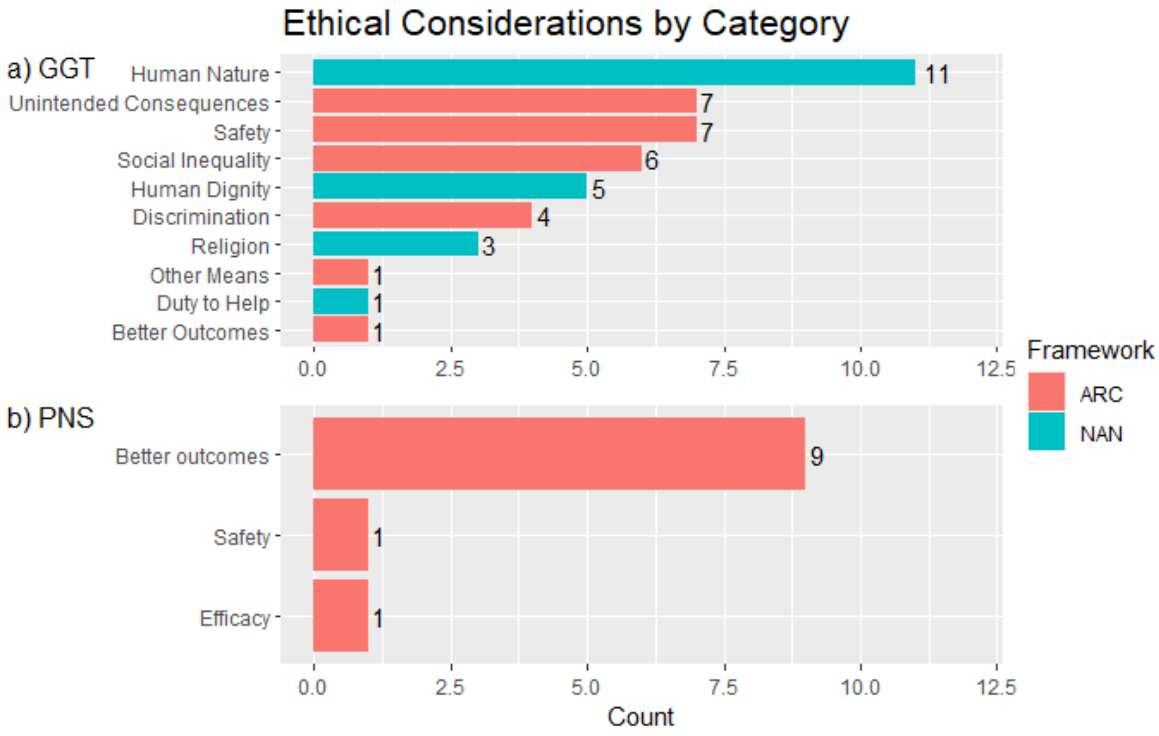

Figure 2. Breakdown of ethical considerations by category

Comparison of ARC Considerations

In contrast to the lack of discussion surrounding PNS, the discussion surrounding GGT was filled with ethical considerations of all sorts. ARC concerns around GGT were largely practical ones based on implementation rather than inherent opposition to GGT. Questions about safety and unintended consequences made up the largest categories within ARC at 7 each, meaning the primary ARC concern facing GGT is uncertainty surrounding a prospective technology (Fig. 2a). How do we know it's safe? What if GGT use unintentionally causes a drop in genetic diversity?

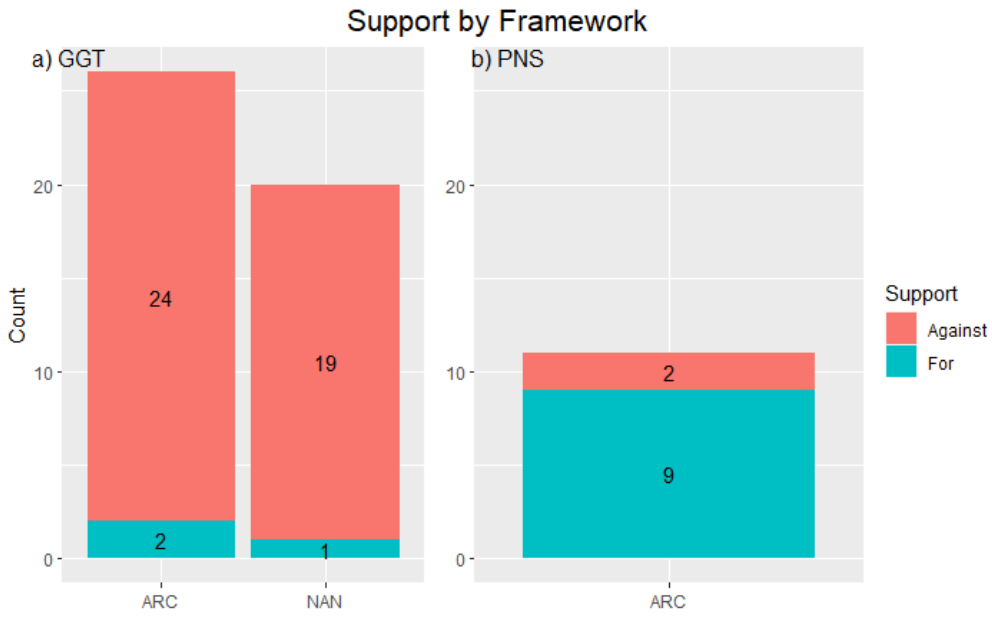

Figure 3. Support for each modality

Genetics is complicated; what if we remove beneficial genes in our quest for enhancement? Fortunately for GGT proponents, these questions can largely be answered empirically. As our understanding of the genetics improves, it is possible that these concerns surrounding safety and unintentional consequences will be allayed, as was the case with PNS.

As for discrimination, any form of enhancement is essentially a normative claim as to what traits a human should be. Thus, CE of any form is necessarily discriminatory against people with lower cognitive ability. Most considerations from this perspective take some form of the question "who decides what counts as an improvement?" In addition, concerns were raised about society's history of discrimination against people whose image doesn't fit the contemporary ideal. Ideals that inevitably change over time. However, these concerns were not raised in PNS; smarter babies are good as a matter of course. Thus, it can be said that the public generally considers better cognitive ability to be desirable. Bostrom writes:

"Many extant regulations are intended to protect and improve cognitive function. Regulation of lead in paint and tap water, requirements of boxing, bicycle, and

> motorcycle helmets, bans on alcohol for minors, mandatory education, folic acid, fortification of cereals, and sanctions against mothers who abuse drugs during pregnancy all serve to safeguard or promote cognition. To a large extent, these efforts are a subset of general health protection measures, yet stronger efforts appear to be made when cognitive function is at risk…By contrast, we know of no public policy that is intended to limit or reduce cognitive capacity. Insofar as patterns of regulation reflect social preferences, therefore, it seems that society shows at least an implicit commitment to better cognition." (2009)

The question then becomes "how is GGT more discriminatory than PNS?" The current methodology makes it difficult to say for certain, but this difference may be due to perceived differences in efficacy. GGT may be perceived to lead to a much greater boost in cognitive ability compared to PNS, in which case these concerns would actually fall under NAN and questions of human nature. In other words, the level of enhancement from PNS is within the limits of nature, whereas the level of enhancement from GGT is not. Further research is needed to confirm this hypothesis.

Objections in the "other means" categories are relatively straightforward. The same goals of GGT can be achieved through other ends. Chiang points out that many geniuses are likely being squashed by circumstance and poverty. If the goal is smarter, more cognitively capable humans, the best course of action would actually be to focus on poverty, education, and nutrition. He further writes:

> "Our goal should be to ensure that every individual has the opportunity to reach his or her full potential, no matter the circumstances of birth. That course of action

would be just as beneficial to humanity as pursuing genetic cognitive enhancements, and it would do a much better job of fulfilling our ethical obligations." (2019)

While this sort of pragmatic view is valid from a public policy and resource management perspective, it does not account for the fact that resources in one area are not always transferrable to another. Geneticists likely won't be much help in alleviating poverty or fixing public education. Furthermore, this view reverses cause and effect, and does not account for individual preferences and autonomy. Geneticists and engineers are typically not working towards the express goal of improving human cognition. Rather, CE technologies such as GGT arise out of an application of their knowledge, skillset, and passion.

Considerations related to social inequality, on the other hand, are much more complex. The primary criticism from social inequality is one based on access, typically due to economic resources. A treatment only available to the rich will only serve to exacerbate the gap between the haves and the have-nots. On a superficial level, disproportionately enhancing the rich increases overall utility. Everyone is still better off, after all. Rejecting GGT on the basis of social inequality requires that the reduction in utility due to inequality be greater than the added utility from enhancement. Thus, embedded within this criticism is the underlying assumption that equality itself has value. Based on the fact that CE is viewed more favorably for individuals with low-performance baselines, it is clear that the general public does indeed place value on social equality when considering CE (Dresler et al., 2018). What is less clear is to what extent equality and fairness are valued in determining CE convention. Empirical evidence from economic studies on the ultimatum game may shed light on this issue. In the ultimatum game:

"One player, called the "proposer", is handed a valuable good, say 100 €. She is to offer any part of it to the second player, called the "responder". The responder can

> choose between two strategies: to accept or to reject. If she accepts, the money is shared according to the offer. If she rejects, neither of the players receives anything." (Schuster, 2017)

Studies have shown that raising the stakes in the ultimatum game leads to the acceptance of more unequal offers, with rejection rates approaching 0 as the stakes increase (Andersen et al., 2011; Cameron, 1999). These findings imply that the value of social equality as perceived by the public does not grow proportionately with the stakes involved. People might value equality more than $1, but not more than $1M. Therefore, assuming unequal access, the process of a CE technology becoming convention will likely depend on the magnitude of the perceived benefits of the technology. This effect can already be seen in adoption of new, expensive medical treatments. Expensive cancer treatments and imaging modalities are accepted as convention despite unequal access due to the magnitude of perceived benefits.

Furthermore, the assumption of unequal access may not necessarily be the case. Part of the reason PNS is accepted despite low perceived benefits likely has to do with the fact that it is readily available. GGT may also end up becoming convention if it turns out to be affordable and readily available. In this regard, discussions based on unequal access are similar to discussions based on safety and unintended consequences. They are questions of uncertainty surrounding a prospective technology that will eventually be answered as the technology gets developed. If it does turn out that access to GGT is limited, adoption and convention of the technology will then depend on the value of the perceived benefits relative to its perceived inequality.

However, even if GGT is readily available to everyone, adoption can still lead to greater social inequality. As Chiang puts it, even though intellect is only a weak indicator for leadership, GGT may be used as a biological justification for what amounts to a caste system:

> "It has long been known that a person's ZIP code is an excellent predictor of lifetime income, educational success and health. Yet we continue to ignore this because it runs counter to one of the founding myths of this nation: that anyone who is smart and hardworking can get ahead. Our lack of hereditary titles has made it easy for people to dismiss the importance of family wealth and claim that everyone who is successful has earned it. The fact that affluent parents believe that genetic enhancements will improve their children's prospects is a sign of this: They believe that ability will lead to success because they assume that their own success was a result of their ability." (2019)

Despite the tone of his op-ed, Chiang seems to be using GGT to criticize the flawed assumption of meritocracy rather than criticizing GGT outright. He even notes that CE would indeed be useful in a society based on merit. In this view, pursuing better cognition itself is a flawed goal and any CE with unequal access, conventional or not, would offer little benefit at the cost of added social inequality.

Comparison of NAN Considerations

The most striking difference between the conventional and unconventional modalities was the presence of NAN considerations. The largest subgroups within NAN were "human nature" and "human dignity." Based on the NAN framework, they are two sides of the same coin. Human dignity is a direct result of human nature. In this case, the difference between conventional and unconventional becomes a matter of degree. Unconventional enhancements might do the same thing as conventional enhancements, but they push the envelope too far. Hook writes:

> "But is there really anything wrong with enhancing our attributes? Each of us engages in various forms of augmentation. We go to school. We train to improve

> our endurance and agility. We take vitamins. We use corrective lenses, false teeth, and hearing aids.
>
> True. But none of these items and activities seeks to transcend our species' normal capabilities. They are accepted because they merely optimize performance within the natural constraints of homo sapiens." (2004)

The majority of concerns around human nature were about therapy versus enhancement. However, a few articles referred explicitly to human nature and dignity, claiming people "cannot casually alter or enhance the nature of life," that GGT "[touches] on the essence of mankind," or that GGT is an "affront to human dignity" (Gushee, 2017; Université de Genève, 2019; Zimmer, 2018). Statements like these imply that the nature of a human being either consists of, or are fundamentally linked to, a person's genes. If this is the case, then the reason GGT is unconventional may simply be because it alters a person's genes, which are perceived to be key to that person's nature as a human being. However, the fact that in vitro fertilization faced similar concerns, coupled with the fact that somatic gene therapy is relatively less controversial, seems to suggest otherwise (Bostrom & Sandberg, 2009; Garreau, 2006; Haberman, 2018). Thus, the difference between conventional and unconventional enhancements is likely due to their perceived effects on human nature. The fact that Asian cultures are more open to enhancement also supports this idea. Asian cultures typically see humans as more continuous with the natural world, with no universal human nature to impinge upon in the first place (Macer, 2012). The transition from unconventional to conventional CE would therefore imply a shift in what the general public considers human nature. In the end, however, the bulk of the concerns relating to human nature were based on the therapy/enhancement distinction, which is a complex issue that was simplified

for this study. Further research into opposition based on the therapy/enhancement distinction is necessary.

Religious considerations were relatively straightforward. Christians largely saw GGT as "transgressing divine boundaries" and "incursions into an unholy realm," jeopardizing their relationship to God (Gushee, 2017; Haberman, 2018). Interestingly, a few articles with religious objections to GGT weren't against the technology per se, but rather felt that the focus of GGT was flawed, or that it was outside the scope of human beings. On the topic of human nature, Mitchell writes:

> "From conception through eternity human beings persist as human beings. It could only be through altering what it means to be an image of God that you can alter what it means to be human." (2004)

According to Andrews:

> "Cloning, artificial intelligence, genetic enhancement: all these are evidence of our nature as subcreators. They suggest that we have not previously realized how deep in us the image of God goes." (2001)

Thus, many Christians are not necessarily against GGT in and of itself, but feel that the knowledge and wisdom necessary to properly use GGT are limited to a divine being. Although religion is typically considered dogmatic, religious dogmas are still open to interpretation. As a result, NAN ethical considerations based on religion will depend largely on cultural and sectarian backgrounds.

Discussion

Based on a systematic review of the public discourse surrounding GGT and PNS, the key factors differentiating conventional and unconventional CE are issues of uncertainty, social

inequality, and human nature. Concerns involving uncertainty such as safety and unintended consequences are inherent in new and prospective technologies and can typically be addressed as the technology develops. For modalities with unequal access, the transition from unconventional to conventional depends, at least in part, on the magnitude of perceived benefits and the degree of inequality. Larger perceived benefits are required to justify higher degrees of inequality. However, issues surrounding social inequality are dependent largely on implementation and distribution rather than the modality itself. Thus, the defining difference in ethical considerations between conventional and unconventional cognitive enhancement modalities is how the modality is perceived to affect human nature. A commonly accepted, conventional cognitive enhancement such as prenatal supplements is not viewed as impinging upon human nature, resulting in a lack of discussion based on NAN. Cognitive enhancement via prenatal supplements is framed as an assumed good based on the consequences: smarter babies are good as a matter of course.

Furthermore, based on the ethical discussions surrounding PNS, a characteristic of conventional CE may be that conventional enhancements, and perhaps conventional technologies more broadly, disappear from the public discourse, as can be shown by the difference in quantity of concerns raised (Fig. 1). When something is normalized, there is no reason to discuss the ethical consequences of something that the public universally agrees is good. As a result, discussions surrounding conventional CEs are limited to ARC concerns around efficacy and safety: does this CE work, and what are the side effects?

Limitations

The primary goal of this study was to lay the groundwork and identify avenues for future research. Thus, any broad interpretations should be taken with a grain of salt. Furthermore,

categorization was done by a single person. Many ethical considerations were not raised as one distinct category or another, and a different person doing the categorization could end up with vastly different results. The data was also limited to news sources within the United States, and the conservative religious source was limited to a single religion. It is unclear how applicable these findings are to other cultures. In addition, only two modalities were compared due to resource limitations. Comparisons with additional CE modalities are needed to draw any definitive conclusions. Furthermore, academic and public perceptions of CE differ quite a bit. The academic definition of enhancement is very broad and even includes methods that aren't typically viewed as enhancements by the general public such as education and diet. This difference may cause discrepancies when looking at public discourse surrounding enhancement ethics. A follow up study would include additional sources and modalities, followed by interviews and surveys based on the findings from the initial systematic literature review. This would allow for clarification of some of the issues presented previously, such as potential status quo bias, as well as avoid many of the limitations in the current study.

Conclusion

Although further research is needed, this study suggests that the process by which new CEs become convention largely involves a shift in the public perception of human nature. However, the nature of this shift and the actors and processes involved are unclear. Perhaps human nature is wholly socially constructed and what it means to be human completely changes over time. Perhaps human nature is as Fukuyama (2002) suggests: fluid, but not perfectly so. In this case, the question then becomes what aspects of human nature can be changed and whether or not specific modalities fall under this category. Perhaps public perception of human nature is not reflective of human

nature at all, and a different exploratory research method is necessary. In any case, this study identifies future avenues for exploration and lays the groundwork for a more robust theory on the ethics surrounding cognitive enhancement convention.

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Appendix

A1. Categorized data for GGT

ID	Source	Framework	For/Against	Type of Concern
Barczi 2017	CT	ARC	Against	Discrimination
Collins 2001	CT	ARC	Against	Discrimination
Mitchell 2004	CT	ARC	Against	Discrimination
Collins 2001	CT	ARC	Against	Safety
Gushee 2017	CT	ARC	Against	Safety
Gushee 2017	CT	ARC	Against	Safety
Gushee 2017	CT	ARC	Against	Social inequality
Mitchell 2004	CT	ARC	Against	Social inequality
Gushee 2017	CT	ARC	Against	Unintended consequences
Hook 2004	CT	ARC	Against	Unintended consequences
Barczi 2017	CT	ARC	For	Better outcome
Collins 2001	CT	ARC	For	Better outcome
Gushee 2017	CT	ARC	For	Better outcome
Gushee 2017	CT	ARC	For	Better outcome
Barczi 2017	CT	NAN	Against	Human dignity
Barczi 2017	CT	NAN	Against	Human dignity
Barczi 2017	CT	NAN	Against	Human dignity
Gushee 2017	CT	NAN	Against	Human nature
Crouch 2004	CT	NAN	Against	Human nature
Collins 2001	CT	NAN	Against	Religious
Gushee 2017	CT	NAN	Against	Religious
Belluck 2017	NYT	ARC	Against	Other means
Proulx 2018	NYT	ARC	Against	Safety
Belluck 2017	NYT	ARC	Against	Social inequality
Chiang 2019	NYT	ARC	Against	Social inequality
Haberman 2018	NYT	ARC	Against	Social inequality
BOARD 2019	NYT	ARC	Against	Unintended consequences
Haberman 2018	NYT	ARC	For	Better outcome
Zimmer 2019	NYT	ARC	For	Better outcome
Belluck 2017	NYT	ARC	For	Unintended consequences
Zimmer 2019	NYT	NAN	Against	Human dignity
Haberman 2018	NYT	NAN	Against	Religious
Belluck 2017	NYT	NAN	For	Duty to help people
NASEM 2017	SD	ARC	Against	Discrimination
Uotago 2019	SD	ARC	Against	Safety
ResearchSEA 2015	SD	ARC	Against	Safety
NASEM 2017	SD	ARC	Against	Safety
NASEM 2017	SD	ARC	Against	Social inequality

Uotago 2020	SD	ARC	Against	Unintended consequences
ResearchSEA 2015	SD	ARC	Against	Unintended consequences
UdeGeneve 2019	SD	ARC	Against	Unintended consequences
Oregon Health and Sci 2019	SD	ARC	For	Better outcome
Salk 2017	SD	ARC	For	Better outcome
ResearchSEA 2015	SD	ARC	For	Better outcome
UdeGeneve 2019	SD	NAN	Against	Human nature
NASEM 2017	SD	NAN	Against	Human nature

A2. Categorized data for PNS

ID	**Source**	**Framework**	**For/Against**	**Type of Concern**
Callahan 2017	NYT	ARC	For	Better outcome
Brody 2007	NYT	ARC	For	Better outcome
Robin 2011	NYT	ARC	For	Better outcome
Belluck 2010	NYT	ARC	For	Better outcome
Ukansas 2018	SD	ARC	For	Better outcome
Texas A&M 2016	SD	ARC	For	Better outcome
Becker 2010	CT	ARC	For	Better outcome
Dyer 2016	CT	ARC	For	Better outcome
Ramirez 2016	CT	ARC	For	Better outcome
Belluck 2010	NYT	ARC	Against	Efficacy
APS 2017	SD	ARC	Against	Side effects

A3. Dataset

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