

Future Consequences for Potential Persons and Our Parental Obligations Regarding Human Germline Engineering

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The eventual availability of human germline engineering (HGLE) for the treatment of Huntington's chorea raises the question of whether prospective parents will then have a moral obligation to undergo the procedure. UCSC senior Alexis Rojas, a double major in biology and philosophy, has applied the principle of autonomy that underlies the United States legal system to the question of whether technology that would prevent the expression of Huntington's chorea must be used when it has the potential to save a life.

Huntington's disease is a fatal genetic disorder characterized by progressive dementia and other neurological effects that typically begin in early adulthood. As the disease progresses, quality of life diminishes; a person loses the ability to make and act on choices. There is no known cure.

Rojas contends that parents have obligations to their children, even in the zygote stage, to do whatever is easily within their ability that will promote the autonomy of the adult the zygote will eventually become. With the development of modern HGLE, many potentially negative consequences have been solved. For example, it is now possible to apply germline treatment in a way that is not heritable for future generations. Assuming that the procedure is available, safe, and effective, Rojas concludes that parents would be morally obliged to undergo the treatment to prevent Huntington's chorea in their offspring.

Abstract

This paper explores the moral permissibility of human germline engineering for the treatment of Huntington's disease. The widely accepted obligations that people have for each other and that parents have towards their children act as the premises for a logical conclusion regarding parental obligations towards their unborn child or "potential persons". It is concluded that the use of human germline engineering is morally obligatory for the treatment of Huntington's disease in virtue of the future consequences that will result from a parent's negligence to take such action.

Introduction

When morality is the subject of philosophical discourse one is often a skeptic as to what logical conclusions may be drawn. Moral theory seems to be so dependent upon culture, religion, or just plain personal opinion that a common ground necessary for philosophical discourse is often difficult to find. Philosophers are often inclined to establish basic principles that they can agree upon from which any logical conclusions must be accepted. Immanuel Kant followed this methodology and presented a moral theory that has had a significant impact on modern morality. As sound as Kant's moral theory seems to be it is still unable to escape the controversy that

philosophical theories are so notorious for. I no doubt could use a commonly accepted moral theory such as Kant's, to come to my desired conclusion, but for the completeness of my argument I would in turn have to defend the moral theory utilized. This would prove to be a laborious task as can be seen by the dense and lengthy text of Kant.

Rather than start down the unending road toward the proof of a rigid moral theory, I will simply find what common principle underlies all of the laws in our legal system that govern actions in our society. If this common underlying principle is sufficient to determine all of the laws in our legal system, then we can consider this principle to be our moral law. This logic relies on an important assumption. We must assume that our legal system is just a practical application of what we agree on as being an acceptable moral theory. We need not agree on the law in all of its applications, we need only agree upon the grounds by which the law is determined. Ultimately this common ground should apply to all cultures in the world, but again for the sake of the formulation of a complete argument in a manageable amount of text I will find this common ground within American culture only. To clarify some of the terminology I will use in this paper consider the following: when I refer to the legal system, I am referring to the United States legal system, and when I say "we" I mean to informally include the reader in hopes that he or she will take this argument to heart.

Foundation

We may not agree with every law in our legal system, but we can at least agree on the basic principles these laws set out to preserve. The major underlying principle that laws set out to preserve is autonomy. Before I show how other principles are derivable from what I will call the Principle of Preserving Autonomy (PPA), let me make clear how this is a common underlying principle. First of all we can see that all rational beings are compelled to act according to their own reasoning. That is if a person rationally decides to build a house of straw based on his own cost-benefit analysis or otherwise reasonable basis, he is compelled to act on this and strongly resists or at least feels constrained by an outside party who attempts to keep him from carrying out his self determined actions. The person's independence in rational choice is constrained, thus his autonomy is sacrificed. No one will deny his or her inherent desire to be free. Constraining one's ability to act from self-determined rational decisions directly denies this freedom. In fact any compromise of what we commonly refer to as our freedom can be simplified to a constraint of one's autonomy. It can be seen by the seemingly innate compulsion toward autonomy that humans have, that any moral and thus legal system should respect this autonomy.

One might jump to the conclusion to say that the underlying principle for moral law should be one that allows all individuals to act in any way that exercises their own autonomy. However, it is easy to see the contradictions of autonomy that would result from this conclusion in practice. For example one might be lead to act, from self-determined rational thought, to take a loaf of bread from his neighbor's windowsill. Indeed this act may be based on a line of reasoning concluding in a necessitation for the action as a means for survival, thus the act is in fact an exercise of one's autonomy. However, we quickly see that the act constrains the autonomy of the person acted upon, the neighbor. The neighbor makes the rational decision to let the bread cool on his windowsill, but in order to achieve his desired end, he must act on a line of reasoning that ultimately relies on the actions of the thief. The neighbor comes up with a line of reasoning suitable for his end of cooling the bread for consumption, but must take into consideration its possible theft and cannot put the bread on his windowsill, as he otherwise would have. Ultimately his decision is constrained by something other than his own rationale. He is no longer independent and thus his autonomy has been sacrificed as a consequence of the act of theft. We can thus agree that the underlying principle for moral law must be one that preserves the autonomy of everybody at the same time. In other words an individual may act in accordance to his own

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autonomy as long as it does not constrain the autonomy of another.

This concept of the preservation of autonomy bears a striking resemblance to the concept of justice. The common understanding of justice might be understood as having two meanings. There is the meaning that people must be treated fairly and the meaning that people should get what they are due (Resnik et al. 129). The first meaning is what directly follows from the Principle of Preserving Autonomy. For a person to act unfairly towards another is just for that person to act in a way that constrains the autonomy of the other. It is obvious that in practice people act unfairly, so by the Principle of Preserving Autonomy it is necessary to implement a practical rule that acts to maintain this principle.

The practical law that acts to indirectly preserve the autonomy of individuals is what we consider to be the second meaning of justice and it works in two ways.

The first way that it works is to counteract a compromise of autonomy, in the most reasonable manner. If a person's bread is stolen he should get that bread back, thus acting to restore his state of affairs to how it might have been had the compromise of autonomy not taken place. Secondly, the thief should receive reasonable punishment. Sometimes the act of returning the stolen item and thus consenting to the fact that he is a thief may be reasonable punishment in itself, but the majority of the time reasonable punishment involves putting the

perpetrator in a state of affairs in which he is worse off than before he committed the crime. That is, make him give the bread back and fine him monetarily or for harsher offenses he may be put in prison. This concept of punishment acts to indirectly preserve the autonomy of all individuals because it acts as a deterrent from acting in opposition to the Principle of Preserving Autonomy. It is sort of a preventative way of preserving autonomy. A reasonable punishment for a crime would thus be one that acts to adequately deter one from committing that crime, which in turn reflects the severity of the crime itself.

The concept of punishment may seem contradictory to the Principle of Preserving Autonomy; after all it compromises the autonomy of the criminal. However, punishment acts to restore the autonomy of individuals on a whole. If there were no crime, punishment would not be necessary. If there were crime, as there realistically will always be, but there were no punishment then the Principle of Preserving Autonomy would soon bear no practical utility. Punishment allows a realistic society to maintain a balance in the preservation of autonomy in spite of acts that compromise this principle.

The claim that the Principle of Preserving Autonomy is sufficient to establish all laws in our legal system is clearly problematic as we might come up with

numerous special cases in which some action may be in accordance with this principle yet clearly something that is or should be illegal. For example, someone may spread slanderous rumors about another person without that person ever experiencing any negative consequence at all. However, we still hold defamation of character to be illegal. Let us grant that the Principle of Preserving Autonomy is not sufficient for determining our laws, but is only necessary. By necessary I mean that if an action is not in accordance with the PPA then the action is not moral, and if the action is in accordance with the PPA it may or may not be moral. By granting this we are not compromising the utility of the PPA. The PPA is not meant to be a solid law like the law of gravitation or Kant's categorical imperative that can be used as a foundation for determining an entire moral theory; it is merely an application of a fundamental concept common to all people that brings to light those actions that are obviously immoral. It may be the case that some actions are in accordance with the PPA, but are immoral for some other reason. Nonetheless, the PPA is a necessary condition for morality and is sufficient to determine further principles, therefore these further principles whatever we may find them to be are also necessary conditions for morality.

Morality → PPA

PPA → Principle X

Morality → Principle X

We can see how the PPA and the concept of justice are necessary conditions for all laws in our legal system. However, there is something extra that is needed to determine a large subset of laws, namely those pertaining to parent-child relations. By parent I mean to include "parent, guardian or other person who has the permanent or temporary care, custody or responsibility for the supervision of the child" (Ramsey 99). This new concept necessary to determine many of these laws is the concept of beneficence. Beneficence is a new concept in that we have not discussed it yet, but it is in fact just the positive sense of the Principle of Preserving Autonomy. We can refer to the positive sense of this principle as the Principle of *Promoting* Autonomy (PProA). The PPA is a principle in the negative sense in that it says that we should *not* do certain things, namely those actions in which the autonomy of another individual is constrained. The Principle of Promoting Autonomy is a principle in a positive sense in that someone acting in accordance with it is obligated *to act* in ways that promote the autonomy of others as well as refrain from constraining it. For the most part our legal system is based on the PPA; for example, it is illegal to murder, steal, speed in cars, or scream "fire" in a crowded concert hall. Laws based on the PProA strictly apply to specific groups of people, including parents.

Parent-Child Obligations

What is special about the parent-child relationship that holds it subject to the principle of autonomy in its positive sense? It is easy to see how it is necessary on a biological perspective. The human species has evolved such that children need the support of an adult in order to survive. If infants were left to fend for themselves they would certainly die. However, a 17 year old may have the physical capacity to survive on his own, but under law is considered to be a child. A problem arises when trying to determine the principles, if any, that determine the age at which a child is considered an adult. Unfortunately this problem arises frequently in law. There is an obvious difference between a 4 year old child and an adult, while the differences between a 17 year old and an adult are less obvious. There seems to be a line drawn arbitrarily on the age spectrum that distinguishes children from adults. Nevertheless, the line is drawn at age 18 in the United States, most likely because this is when people reach physical maturity and are considered mentally mature. For the sake of argumentation in this paper we will say that there is a black and white distinction between children and adults. The distinction is that children have not yet fully developed rationally and physically, thus depend upon adults for varying levels of support, whereas adults have reached what is considered rational and physical maturity. The majority of argumentation in this paper will pertain to very young children so we will soon see that the arbitrary point at which this distinction is made does not weaken the argument.

We will now see how it follows from the Principle of Preserving Autonomy and the nature of children's immaturity that the Principle for Promoting Autonomy applies to parent-child relations. Once we establish this Principle of Promoting Autonomy we may find that in application parents have more obligations to younger children than older, but we will find it is the same principle applying at varying degrees due to variation in dependence of the child. Given adequate support from an adult, children will mature into a fully rational and potentially autonomous being. Under our previously established application of the Principle of Preserving Autonomy, we can see that parents are obligated to not act in ways that constrain the autonomy of their children. We cannot consider children to be autonomous until they are fully developed rationally, i.e. when they are adults. So the actions that adults are obligated to refrain from in relation to their children are those that upon the child's maturity will constrain the child's autonomy. For example, a parent is obligated to *not* physically abuse their child because of the possible physical or mental effects toward the child that may permanently constrain his potential for autonomy. (The responsibility of parents toward children in virtue of a future state of affairs is problematic and will be addressed later in this paper).

We are still left to show how the Principle of Promoting Autonomy applies. We can see that certain things must be done to promote the proper maturation of a child. A child must avoid physical abuse, but he must also obtain food and shelter in order to properly develop. Thus the failure to provide certain things can be seen to constrain the potential for autonomy as well. The jump we must make from the PPA to the PProA may seem to lack a solid foundation. However, we need only agree, on whatever basis, that children should be given the opportunity to reach maturity in order to exercise their autonomy. We can see that without promoting this “right” a realistic society would not be possible as there would be no perpetuation of a mature population. Thus we can hold it to be a practical necessity that people grant this “right” to children. Therefore, the PPA is sufficient to determine that parents are obligated to act according to the Principle of Promoting Autonomy with regards to their children.

By obligating parents to act in accordance with the Principle of Promoting Autonomy they are bound to both the positive and negative sense of the principle as we have just seen. In legal discourse we refer to those actions that the negative sense prohibits as abuse and those actions that the positive sense prohibits as neglect. In a Kentucky court case, *Sierveld V. Conn.*, these terms were defined as follows:

“Abused or neglected child” means a child whose health or welfare is harmed or threatened with harm when his parent, guardian, or other person who has the permanent or temporary care, custody, or responsibility for the supervision of the child: inflicts or allows to be inflicted upon the child physical or mental injury to the child by other than accidental means; commits or allows to be committed an act of sexual abuse upon the child; willfully abandons or exploits such child; does not provide the child with adequate care and supervision, food, clothing and shelter, education or medical care necessary for the child’s well-being.” (Ramsey 99)

At this point we have laid sufficient reason to conclude that a zygote should be considered subject to the Principle of Promoting Autonomy for the same reasons that an extremely dependent child would be subject to the principle. This conclusion is of the utmost importance so I will reiterate my reasoning applied to the condition of being a zygote for the sake of thoroughness.

Parent-Zygote Obligations

I will now spend some time showing how the Principle of Promoting Autonomy applies in virtue of the parent-child obligations just described to actions by parents towards their developing zygote and more generally towards anything in the causal chain of zygote

development. So far I have argued that parents have certain obligations towards their children, namely those that follow from the PPA. I arrived at this conclusion basically from the following reasoning: certain actions if not taken by parents towards their children will result in a constraint of the child’s autonomy upon reaching adulthood. It seems that by this reasoning parents also have obligations to their unborn children and even to a developing zygote. However, many find this to be an illogical step on the basis that the zygote or unborn child is a different kind of “thing” than a born child and has no more moral relevance¹ than a rock. Also the reasoning I use may lead me into a slippery slope argument that concludes parents have obligations to anything in the causal chain of human development including rocks. However, I will show that based on the PPA these two potential problems are not problems at all.

Certain actions if not taken by parents towards their children will result in a constraint of the child’s autonomy upon reaching adulthood.

Let us grant that the human zygote is just a clump of cells and has no more moral relevance than a rock. The difficulty is to now prove that despite the moral irrelevance of the zygote at time X, parents have moral obligations toward it in virtue of the autonomous being that it will develop into at time Y. Let us call this

seemingly problematic obligation the “future consequence obligation”. You might say that if the zygote does not achieve moral relevance until time Y, then parental obligations do not apply until time Y. However, we can see that this is not the case by the following example: we would say that a person is obligated to *not* pick up a rock and throw it at a person’s head at time X if the consequence of that action were extreme pain at time Y followed by permanent injury. In this case a person clearly can have moral obligations in the actions they take towards morally irrelevant objects at time X in virtue of the consequences those actions will have on morally relevant person’s at time Y. So we see that even if the zygote has no moral relevance and even if it is a completely different “thing” than the adult it develops into, all people have obligations towards it in accordance with the Principle of Preserving Autonomy and parents have obligations toward it in accordance to the Principle of Promoting Autonomy.

It is true that by this reasoning we potentially have obligations towards anything that stands in the causal chain of human development including things such as rocks. We might say that according to future consequence obligations a man, Claude, has obligations to the cup of water his pregnant wife drinks

¹ *Something is morally relevant if actions toward it can be considered morally permissible or impermissible in virtue of the effect that those actions have upon the object. A rock is morally irrelevant which essentially means that actions taken toward it can only be considered morally impermissible in virtue of the effects they have on some other morally relevant “thing”.*

or to the soil used to grow the tomatoes his wife eats. This seems absurd and its apparent absurdity increases as we go further along the causal chain. Let us first investigate special cases where obligations to inanimate objects might not be so absurd and then see how these are the only cases we really have to take into account. Suppose Claude kicks a rock on the ground as he walks to the mailbox one morning; later that day his pregnant wife trips on the rock due to its new location and falls on her belly, thus resulting in abnormal fetal development further resulting in a constraint of autonomy in the developed adult. According to the understanding of future consequence obligations presented, Claude acted immorally when he kicked the rock. However, this case illustrates an important factor necessary to determine the moral value of a given future consequence obligation. This factor involves the ability to know at time X the consequences resulting at time Y. In Claude's case we can only label his action at time X morally impermissible because time Y has already passed and we know for certain the consequences of the action of kicking the rock. However, there is no way that Claude could have known at time X the consequences of his action so we must conclude that at time X the action of kicking the rock was morally permissible. Similarly if Claude knew at time X what the consequence of his action was going to be, then that action would have been morally impermissible. This allows us to live a normal life without going around wondering if our everyday actions are morally permissible.

I would like to point out that I have purposely argued that there is "no way Claude could have known" and not just that Claude did not believe or Claude did not know what the consequences of his actions would be. Take the case where Claude does not know that cyanide is a deadly poison and feeds it to his wife. This action is still morally impermissible because it is possible for Claude to have known the consequence of his action. If he had merely consulted a knowledgeable chemist he would have known for certain the consequence of his action. Only when there is no way to know, regardless of what book you reference or professional you ask, is the seemingly morally impermissible action permissible.

Future consequence obligations can be considered in three separate categories. For each category the PPA may be used to determine if the associated action is immoral. The first category is all cases in which the person acting at time X "knows"² for certain at time X the consequences of his action at a later time Y. For example; a person, Zane, knows that throwing a rock at time X at his friend's head will injure him at time Y. So we can say that if Zane carried this action out it would be immoral. The second category includes all cases in which the person acting at time X has no way

of knowing the consequences at time Y. As before, there is no way Claude could know his wife would trip on the rock he kicked, so that action is not necessarily immoral. The third category includes all cases in which the person acting at time X knows that a certain consequence is probable at time Y. Say Zane rigs a nuclear bomb to detonate depending on an internal coin flipping mechanism. This way he is responsible for creating a 50% chance that the bomb will detonate. Certainly we can agree that this action is immoral even if the bomb does not detonate. But now consider this example: A routine surgery has a 99% probability of successfully separating Siamese twins, but as with any surgery there is a small probability that the twins will not survive the surgery. In this case the probability for positive consequences seems to outweigh the probability for negative consequences, thus making the action moral.

The moral value of each of the preceding actions relies on the probability of negative consequences. So the point at which we say an action is immoral is arbitrary and varies among actions. The lack of an algorithm to determine which category three future consequence obligation actions are immoral does not mean that these actions have no definitive moral value. There may be an algorithm or at least a practical way to determine whether a category three action is immoral. Nevertheless, we can agree on the moral value of certain cases such as Zane's coin flipping nuclear bomb. For the purposes of this paper we will find that when we address the moral value of the action of germline engineering in the next section, the case will always fall into category one or two so the problem with category three does not present itself.

Human Germline Engineering Obligations

We can clearly see that allowing an action that negatively affects the development of one's zygote is morally impermissible when that negative act is easily within one's means to prevent. Certain genetic diseases can be seen as negatively affecting the development of a zygote, thus the autonomy of an adult. In the event that technological procedures allow these negative consequences to be avoided in a safe, effective, and efficient manner, these procedures will be considered morally obligatory. There are many factors that influence the moral obligation a parent has to use genetic technological procedures and in many cases the moral impermissibility inherent in these factors supervene the obligation to carry out the procedure. I am not arguing that it is obligatory to treat all genetic diseases, nor am I offering criteria to influence value judgments as to which genetic diseases qualify as affecting autonomy negatively. I will merely show that there is at least one case in which genetic intervention is not only morally permissible, but is obligatory. Once we understand the obligations we have in this specific case we may find that these obligations apply to other similar cases.

² We must assume that we "know" P with certainty if P can be concluded using logical or inductive reasoning. We can say that we "know" that this paper is white and that water is composed of H₂O.

The case we will examine is that in which professionals are able to determine that the adult a zygote will develop into will have Huntington's disease (HD). For genetic intervention to be obligatory, this genetic disease must be considered an obvious constraint to one's autonomy. Let us look at the pathology of Huntington's disease in order to fully grasp the severity and horrendous nature of this disease. Huntington's disease is a fatal neurodegenerative disorder expressed in early adulthood that results from an "autosomal dominant mutation in the Huntington gene" (Resnik et al. 11). There is no known treatment for this disease. In the first stages of the disease, chorea symptoms are present, including involuntary tics and movement leading to walking difficulty and falling. A number of symptoms follow, the type and severity of which vary among individuals. Symptoms generally include the following: personality changes, difficulty understanding information, difficulty reading and writing, diminished memory, difficulty controlling inappropriate behavior, difficulty controlling physical movement, and poor reasoning and judgment. Some common personality changes include apathy, hostility and even manic depression or schizophrenia. Victims of HD are often irritable, lack energy and are unable to find pleasure in life. Psychotic behavior is common including delusions, hallucinations, paranoia, and inappropriate behavior. (Neurology Channel) Victims of HD have a severely constrained capability for acting autonomously and they become completely dependent on others for survival.

...active direction of human evolution could be disastrous due to problems associated with low diversity in the human gene pool...

It should be clear that HD severely constrains the autonomy of those inflicted with it. Victims of HD are physically incapable of acting from their own rationale. Even before their mental capacity diminishes they simply are not capable of performing certain physical tasks that might be required for the fulfillment of a rational decision. For example, a person with HD may rationally decide that he wants to go for a walk, but cannot act on this decision because he is physically unable to. In the later stages of the disease mental derangement affects the capability of rational thought itself. In this diminished mental state those affected are deprived of the chance to even *experience* rational thought, let alone to act from it. Even if the thought process that the mentally deranged experience *seems* rational to them, their diminished mental capacity prevents them from acting from this rationale. The victim of Huntington's disease lives a life where not only his ability to *act* from the choices he makes is constrained, but his ability to *make* choices is also constrained. The final consequence of Huntington's disease is death, which some might consider the ultimate constraint of autonomy.

Human germline engineering is a genetic technology that offers the only treatment for Huntington's disease. If it qualifies as safe, effective, and efficient then its use should be considered morally obligatory to treat

genetic diseases that result in a constraint in autonomy, such as Huntington's disease. The fact that Huntington's disease is a constraint of autonomy is hardly the controversial issue regarding human germline engineering (HGLE). If there were no other issues associated with HGLE it would be easy to conclude that its use is obligatory to treat diseases such as HD. However, the real controversy looms around the possible moral impermissibility of the act of HGLE itself. There are many strong arguments that perhaps ten years ago would have provided sufficient reason to conclude that the negative consequences

inherent in HGLE supervene the moral obligations to use it. It is important that these arguments be addressed, though we will see that given modern germline engineering technique, the negative consequences these arguments address do not exist.

One such argument pertains to the potential consequences of passing on genetically altered genes to future generations. This active direction of

human evolution could be disastrous due to problems associated with low diversity in the human gene pool and a lack of foresight pertaining to decisions made as to how the human genome is altered. In addition to these biological possibilities is the general feeling that manipulation of the human genome is something that ought to be left to god and nature. A feeling of fear arises when we consider the potential for eugenic practices to occur as a result of the very likely *arbitrary* decisions as to what will be allowed to be passed on through the generations. These are just a few of the much-debated problems and fears inherent in the heritable nature of germline engineering. Rather than spend time arguing around these problems I will merely strike down their foundation by showing that modern HGLE technique is not heritable.

Mario R. Capecchi, Professor of Human Genetics at the University Of Utah School Of Medicine, has developed a method of non-heritable germline engineering we will call the CRE-loxP recombinase system. This system follows all of the standard procedures involved in germline engineering with the exception that additional information is included when the genetic alteration is made. Let us first get a basic understanding of the standard germline engineering procedure. The process begins with in-vitro fertilization. The single cell resulting from this fertilization is allowed to divide into four cells. One of these four cells is allowed to divide into a million cells, a small subset of which is selected for genetic alteration. The DNA of this subset of genetically altered cells is carefully sequenced to verify that the proper alteration was made. At this point one of the mother's oocytes is enucleated and replaced with a nucleus from one of the cells from the genetically altered subset. After one or two cell divisions occur, the resulting embryo is re-implanted into the mother's

womb where normal development of the embryo will proceed. (Campbell and Stock 34)

The CRE-loxP recombinase system involves adding information to the genetic alteration to allow the alteration to be deleted or reverted to original upon administration of a drug. The drug can be administered at any point in a child or adult's life. The drug activates what are called loxP sites, which are an artificial addition to the DNA sequence at the genetic alteration stage. LoxP sites are placed on both sides of a gene of interest. When the loxP sites are activated, the gene in between the two sites is cut out of the DNA sequence. This use of loxP would be effective to get rid of a defective gene; however many times a properly functioning gene must be put in place of the defective gene that is removed. This is accomplished by adding, in addition to the loxP sites flanking the defective gene, loxP sites flanking an inactivated properly functioning transgene. The transgene is inactivated by reversing its orientation on the DNA sequence such that it appears "backwards" to the enzymes responsible for "reading" the DNA sequence. Activation of the loxP sites flanking a "backwards" gene results in the flipping of that gene, thus rendering it active. The defective gene and the transgene are both flanked by loxP sites, but they share the same loxP site that is between them. This description of the CRE-loxP recombinase system merely demonstrates its basic functional capabilities. Any combination of loxP sites and transgenes can be used. The only rule is that active genes flanked by loxP sites are deleted and inactive genes flanked by loxP sites are activated. (Campbell and Stock 34)

The CRE-loxP recombinase system seems to have all of the positive features of germline engineering with none of the negative consequences such as heritability. It allows a genetic alteration to be made in every cell of the body while still allowing germ cell alterations to be reverted back to original. The activator drug could be taken during childhood so that the genetic alteration is reverted to original only in germ cells. This means that the person would still benefit from the genetic alteration because it would still be in every somatic cell, but the genetic alteration would not be passed on to potential children. The activator drug could also be used to activate a genetic alteration in somatic cells and deactivate the "natural defective gene". This way a person could be allowed to choose whether or not he or she wanted the genetic alteration. Rather than leave the decision to the parent as to what genetic alterations their child should have, the decision can be made by that child when they become mature enough to make an informed decision. This option of waiting until a mature age to activate or deactivate genes only works with certain genes depending on the stage of development that they are

expressed. If the gene is expressed in early development, say before age 2, then deactivating the gene at age 20 would be useless because it has already been expressed. Similarly if a gene is activated after the stage of development in which it is expressed then the activation will not have any effect. This method would be an effective solution to the problem with informed consent for many, but not all genetic alterations. At the very least those who are given genetic alterations can choose whether or not they pass that alteration on to their children. (Capecchi 17 March, 2004)

It may be determined that the risk of allowing genetic alterations to be passed on to future generations is too great due to the consequences previously discussed. This is an important debate that must be addressed before HGLE legislation is made. However, even if this determination is made it would be conceivable to require the activator drug to be administered to young children so that the genetic alteration cannot be passed down to future generations.

The CRE-loxP recombinase system seems to be a miraculous technology, but we should realize that it is still being developed. It has been proven to work in mice, but is in no way ready to be used on humans. The principles and procedures utilized in this system should theoretically be just as effective in humans, but it should be understood that it is not yet a fully developed system (Capecchi 17 March, 2004).

This system essentially solves the problems with informed consent and the

heritability of germline engineering. However, there are other strong concerns with the use of germline engineering that pertain to possible social consequences. One concern with germline engineering is the possible social division that might occur as a result of unequal access to germline engineering procedures among class. It is likely that germline engineering will be a relatively expensive procedure when it is first introduced, just as any new technology. This would result in a disproportionately high number of people of higher socioeconomic status being able to benefit from this technology. It seems hardly fair for only the rich to benefit from this technology. Furthermore, a genetic divide could be constructed between those able to purchase HGLE and those who cannot. This genetic division might not result if HD were the only genetic alteration being treated due to the rare nature of the disease, but if heart conditions were treated it might cause those of higher socioeconomic status to have on average better health. There certainly are many possible negative consequences to society that HGLE might have if it were offered only to certain groups such as the rich. However, the dismissal of HGLE as morally impermissible on these grounds says nothing of the true moral value of the act of HGLE itself. It is

One concern with germline engineering is the possible social division that might occur as a result of unequal access to germline engineering procedures among class.

important that we establish the moral standing of the procedure itself given that these social consequences do not apply. That is, we should assess the moral permissibility of HGLE assuming that when it is offered to the public it is free and easily accessible for all to benefit from it. This does not mean that all of the societal implications should not be considered, only that we do not need to consider those that result as a consequence of the disproportionate use of HGLE due to cost and availability.

An additional concern many have is that HGLE may not be completely safe. This is an important concern to raise as many new technologies have unforeseen negative consequences due to a lack of extended research on their clinical effects. Obviously, HGLE should not be permitted unless it can be proved to be a safe and effective procedure. For this reason we should assume that the procedure is 100% safe and effective when assessing its moral value. This may seem like an idealized situation and useless for any practical conclusions to be made about the moral value of HGLE, but in fact it is a necessary assumption if the true essence of the moral value of HGLE is to be assessed. For one, these considerations warrant so much discussion that our attention is distracted from the real concern; whether or not there is anything inherent in the act of HGLE that is morally impermissible. Furthermore, it is conceivable and even probable that HGLE will be a safe and effective procedure in the near future, so in anticipation of this event we must determine the inherent moral value of HGLE.

Alternate Identity Theory: Existence Argument

At this point we have established that HGLE would be morally obligatory for the treatment of HD if safe, effective, and non-heritable. However, even if we assume HGLE to be obligatory in this case there is an apparent paradox that has not been addressed. This paradox has to do with the nature of existence of persons and potential persons and is addressed in the much-debated topic of “wrongful-life”. One might argue that altering the genetic code of a zygote with HD is preventing the existence of the potential person with HD that would have developed from that zygote. Instead it is allowing another person, one without HD, to exist. This seems to be an acceptable proposition. If we are our mind and body, and the development of our mind and body is determined by our genetic code, then a change in our genetic code prior to development would result in a change in our identity.

If we take this “alternate identity theory” into consideration when determining the obligation to use HGLE, we find the possibility of the following two courses of action. One course of action is to not use HGLE and allow the HD person to exist in a life of suffering. The other course is to use HGLE preventing the HD person from existing and allowing the existence

of the non- HD person. In the argumentation provided in this paper HGLE was obligatory to treat HD only because allowing a person to develop with HD was seen as a constraint on their autonomy. However, in the alternate identity theory this state of constrained autonomy is the only possible way that person can exist. Thus, the use of HGLE does not make the person’s state of autonomy any less constrained, so its use cannot be considered obligatory. It is important to note that this argument does not conclude that HGLE is morally impermissible. It merely concludes that HGLE is morally neutral which means that one cannot be obligated to use HGLE, but its use is still permissible.

When a paradoxical concept such as existence is at issue it is difficult to derive solid conclusions. Problems arise in virtue of our inability to conceptualize non-existence and attribute potential existence to non-existent persons. Our minds get tangled in the web of existence, time, and potentiality. Rather than risk getting stuck in this conceptual web of confusion I will discredit the alternate identity theory objection by showing that the logic it is derived with also derives some very counterintuitive conclusions.

Consider the following thought experiment. Hank intentionally fires a shot into a crowd and grazes Tom’s head. The trauma to Tom’s head results in permanent brain damage and a diminished capability for reason. Clearly Hank caused Tom to be in a state of constrained autonomy. “Injured-Tom” leads what any reasonable person would call a more constrained life than had he not been shot. However, consider the counterfactual case in which Tom had not been shot. In this case Tom would have led his regular life, enjoying his capability for autonomy.

The objector, who claims that HGLE can have no effect on the autonomy of potentially existent persons in virtue of the alternate identity theory, would be forced to make the claim that Hank’s action of firing the gun can have no effect on the autonomy of Tom. The alternate identity theorist must say that Tom and Injured-Tom are two different people. After all, such a life changing alteration of mind and body must result in a change of identity. Consider what you might have been like had you moved to the moon when you were 18. The alternate identity theorist would say that you would be a different person. Let us think as an alternate identity theorist for the remainder of this paragraph. We can say that Tom and Injured-Tom are two different people, the existence of whom depended upon Hank’s action of firing the gun. If Hank fired the gun, Injured-Tom’s existence was allowed and Tom’s existence prevented. However, actions that result in that person’s existence cannot affect that person’s autonomy, so neither Tom nor Injured-Tom’s autonomy was affected. We must conclude that Hank did not act immorally.

The conclusions derived from this reasoning may seem disturbingly problematic, but they are nevertheless logical conclusions based on the alternate identity

theory and the objection that actions that determine a person's existence cannot have any affect on the autonomy of that person. Let us see how this conclusion logically follows by considering the following metaphorical interpretation of the alternate identity theory. If my identity is the cumulative result of the paths that I take in life, then any action affecting the direction of that path directly alters my identity. If we consider the two potential people of divergent paths to truly be different people, then the action that led to the existence of one identity also prevented the existence of another. This means that every action toward me brings into existence a new person such that I am perpetually coming into existence and the person I was is perpetually going out of existence. If actions that determine the existence of a person can have no affect on that person's autonomy, then all actions towards any person are morally permissible, including Hank's action of firing the gun at Tom.

This theory, as interesting as it seems, is extremely counterintuitive. That is, we *can* act in morally impermissible ways to other people. It may be the case that I am perpetually coming into existence and the person I just was is perpetually going out of existence, but we cannot conclude that this frees people from the responsibility they have for their actions. There *is* some way that an action that determines the existence of someone can be considered a constraint to his or her autonomy. I cannot provide a logical explanation for what this is, but we can intuitively see that it must be the case. The act of HGLE is this sort of action. It determines the existence of a person and must also be considered to affect that person's autonomy.

Having reestablished the *possibility* for obligations to potential persons we see that parents in fact *are* obligated to use HGLE for HD when the PPA is taken into consideration. It was previously concluded that an act cannot be considered morally impermissible if there is no way of knowing the consequences of that action. For this reason, HGLE is not obligatory when the consequences of its use cannot be known. However, this is never the case because genetic technology is such that it can be determined whether or not a zygote has HD and it is known that HGLE is an effective treatment for HD. I am tempted to conclude that obligations to use HGLE always fall into category 1 future consequence obligations (obligations pertaining to actions in which the consequences are known for certain), but we can also consider them to be category 3 future consequence obligations by claiming that the consequences are probable, but not known for certain. However, the technology available is not able to determine with certainty future consequences of HGLE can at least determine with sufficiently high probability for it to be considered a practical certainty. Thus parents are obligated to use HGLE because we are capable of knowing with significant probability that refraining from using HGLE to treat HD would result in a severe constraint of autonomy. We must hold parents responsible for this knowledge just as we

would hold Claude responsible for knowing that cyanide is a deadly poison.

By now it is probably obvious that HD is not the only genetic disease this argument can be applied to. There are many genetic diseases that constrain autonomy just as severely as HD, such as Tay-Sachs, and by the argument presented it would also be obligatory to use HGLE to treat those genetic diseases as well. However, it is easy to find genetic diseases that constrain autonomy in a less obvious way or to less of a degree than HD. Should it be obligatory to use HGLE if the genetic disease constrains autonomy in a minor way? What set of values determines if autonomy is constrained by a genetic disease? We might say that a mole on someone's face constrains autonomy if they feel self-conscious about it, but we could also say it just builds character. It could be argued that genetic "defects" are constructed by society's inability to accept differences. Many deaf people consider their "defect" to be like a culture. To them being deaf is analogous to being Greek or African-American. We should not look at differences as "defects" we should embrace them for what they are. They are simply a part of us and not something to be considered good or bad. However, symptoms of genetic diseases such as HD are not merely differences, they are clearly an undesirable state of constrained autonomy.

Clearly the controversy lies in determining which genetic diseases are constraints on autonomy and which are not. This will be a potentially dangerous debate in HGLE legislation. I can see personal opinion and values influencing the decisions that are made resulting in the obligation to make cosmetic genetic alterations or use "genetic enhancement". The argument I have presented says nothing of the moral permissibility of genetic enhancement. Though my intuition tells me that HGLE would be morally impermissible for "treatment" of trivial features such as hair color, I only conclude that HGLE is morally obligatory for treatment of HD.

Conclusion

From the intuitive concept of being obligated to preserve people's autonomy a series of logical steps followed that ultimately concluded that human germline engineering is morally obligatory for treatment of Huntington's disease. We saw that the Principle of Preserving Autonomy gave rise to the Principle of Promoting Autonomy which held that parents have obligations to children and zygotes to do whatever is easily within their ability that will promote the autonomy of the adult the child or zygote will eventually become. The logic in this step of the sequence was harder to see due to the paradoxical nature of time, existence, and potentiality. We were not able to establish that a valid objection pertaining to these paradoxical issues does not exist. However, we were able to discredit the objection commonly held that: actions effecting one's

existence cannot have any effect upon that person's well-being, so cannot be considered to have any moral relevance. It may seem as though I have successfully avoided any relevant argument pertaining to the moral permissibility of HGLE by assuming HGLE to be safe, effective, readily available, and non-heritable. However, I have taken this approach to focus on the permissibility of the act of HGLE itself as opposed to the consequences resulting from problems with the act.

We should be aware of the assumptions made in this paper and not apply the conclusion when these assumptions are false. HGLE should only be morally obligatory when the genetic disease at issue is “obviously” a constraint on one’s autonomy. Caution must be taken as to what genetic diseases this argument is applied to.

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