WHAT JUSTIFIES THE UNITED STATES BAN ON FEDERAL FUNDING FOR NONREPRODUCTIVE CLONING?

ABSTRACT: This paper explores how current United States policies for funding nonreproductive cloning are justified and argues against that justification. I show that a common conceptual framework underlies the national prohibition on the use of public funds for cloning research, which I call *the simple argument*. This argument rests on two premises: that research harming human embryos is unethical and that embryos produced via fertilization are identical to those produced via cloning. In response to the simple argument, I challenge the latter premise. I demonstrate there are important ontological differences between human embryos (produced via fertilization) and clone embryos (produced via cloning). After considering the implications my argument has for the morality of publicly funding cloning for potential therapeutic purposes and potential responses to my position, I conclude that such funding is not only ethically permissible, but also humane national policy.

KEYWORDS: nonreproductive cloning, somatic cell nuclear transfer, science policy, clone embryo, human embryo, stem cell research

INTRODUCTION

The nucleus of a somatic cell can be transferred to an enucleated egg cell, or oocyte, resulting in a unicellular product that can be activated by electrical stimulation to undergo some of the developmental processes typical of a human embryo. This process is called somatic cell nuclear transfer (SCNT). In theory, after a few days of subsequent development, under laboratory conditions the resulting cellular material can be used to derive stem cells matching the genetic profile of the initial somatic cell. Stem cells produced in this fashion could be used to derive tissue that matched donor tissue well enough to circumvent the immunological responses that serve as major barriers to successful transplant and regenerative medicine (Hochedlinger and Jaenisch 2003). The products of SCNT might also be used for reproduction – to create human beings whose genomes would be nearly identical to the genomes of the donated somatic cells from which they originate.[1]

Like all stem cell research, SCNT is controversial because it appears to deliberately create and destroy entities of the utmost moral concern, human embryos. But SCNT is also controversial because of its theoretical potential to be used for the cloning of human beings. For these reasons, United States federal funds are prohibited from supporting research employing SCNT, even though it is a biotechnology touted for having great potential to treat myriad human diseases, such as Parkinson's disease, diabetes, and congestive heart failure (Lanzendorf, Boyd, and Wright 2004).[2] It seems a choice must be made between protecting the sanctity of life at the expense of potentially lessening suffering or striving to lessen suffering at the expense of crossing a bright moral line prohibiting the killing of innocent human beings (embryos). The purpose of this paper is to challenge this apparent dilemma by questioning the justification for the current ban on federal funding of SCNT for research purposes, also known as nonreproductive cloning. My thesis is that the justification for the ban rests on the false assumption that the product of SCNT is a human embryo or an entity deserving of the moral status of a human embryo. If

one rejects this claim, as I do, then this challenging dilemma dissolves. I conclude that the funding of biomedical research employing SCNT aids the fight against human suffering without allowing the destruction or desecration of human life. If my argument is sound, then *even those who believe that life begins at conception*, rather than at a later stage in human development, can endorse SCNT without choosing to protect some human beings at the expense of others.

In the first section below I trace the historical origins of the ban on the federal funding of SCNT and demonstrate that the ban was originally justified on the grounds of what I will call *the simple argument*: that funding SCNT is tantamount to funding research that harms human embryos. In the next section I argue that the simple argument is unsound because it rests on a false premise stipulating an identity relationship between human embryos and the products of SCNT. The remainder of the paper anticipates and responds to objections to this criticism of the simple argument. One might respond that, irrespective of the soundness of my position, the product of SCNT deserves the same moral status as a human embryo and hence it also deserves our protection – including a ban on such research. Or, one might argue for an alternative approach to justifying the prohibition, by appealing to the political realities of policymaking. I consider and counter these objections in the final two sections, and conclude that the current prohibition on funding remains unjustified. If my argument stands, a novel justification for the ban on federally funding SCNT is required; otherwise, the potential for relieving suffering provides a sufficient justification for aggressively funding research employing SCNT.

JUSTIFYING THE CURRENT BAN ON FEDERAL FUNDING OF SCNT

For decades, philosophers, politicians, and policymakers have debated the merits and ethics of scientific research upon human embryos. Historically, these debates have been tightly linked to deliberations over reproductive rights, where participants frequently invoke positions on abortion and artificial reproductive technologies (Henig 2004). More recently, these debates have also focused on a new issue, human cloning, which has culminated in the current ban on federal funding of SCNT. In this section, I will describe how these political debates have led to the ban, demonstrating that a common view pervades policymaking on cloning and embryo research: that it is unethical because it involves the destruction of human embryos.

The Origins of the Current Ban

From 1975 to 1993, federal law permitted using public funds for research on in vitro fertilization (IVF), provided it was first approved by an Ethics Advisory Board (EAB). However, political constraints entailed that no such funding was ever available: by failing to charter an EAB during their administrations, the Regan and (first) Bush administrations circumvented the only lawful mechanism for

approving federal funding for IVF research (Fletcher 1995). In 1993, the Clinton administration repealed a federal moratorium on fetal tissue research. This signaled that administration's commitment to liberalizing federal regulations of scientific research set in place by the prior two administrations. Shortly thereafter, Congress repealed the EAB requirement for federal IVF funding and the National Institute of Health (NIH) created the Human Embryo Research Panel (HERP) to provide guidance on other types of research employing human embryos.

In 1994, HERP issued its report on embryo research. It distinguished three categories of embryonic research, one being research that was *prima facie* unacceptable, and hence for which funding was prohibited; another being research that was *prima facie* acceptable, and hence for which funding was permitted; and another for research whose acceptability was unclear, which would require further examination before funding decisions could be made. Notably, research on parthenogenesis and somatic cell nuclear transfer both fell into the second category, of acceptable research (Riley and Merrill 2005, pp. 22-26).[3]

The HERP recommendations never became federal policy or found their way into legislation. Indeed, HERP received a considerably negative reaction because of its inclusion of embryos created expressly for research in its third category. Such research seemed patently impermissible to many Congressional conservatives, prompting them to rail against the HERP guidelines. After strong conservative gains in the elections of November 1994, the fate of the HERP report was sealed; on the day it was announced, President Clinton issued a statement barring funding for research that created embryos solely for research purposes (*ibid.*, pp. 26).

The idea that scientists might begin creating embryos and destroying them for research purposes was anathema to many in Washington. Two Congressmen in particular, Jay Dickey and Roger Wicker, added what has become known as the Dickey-Wicker Amendment to what would become the *Balanced Budget Down-Payment Act* (Maienschein 2003, p. 3). The amendment reads, in full:

> None of the funds made available by Public Law 104–91 may be used for—(1) the creation of a human embryo or embryos for research purposes; or (2) research in which a human embryo or embryos are destroyed, discarded, or knowingly subjected to risk of injury or death greater than that allowed for research on fetuses in utero under 45 CFR 46.208(a)(2) and 42 U.S.C. 289g(b). For purposes of this section, the phrase ''human embryo or embryos'' shall include any organism, not protected as a human subject under 45 CFR 46 as of the date of enactment of this Act, that is derived by fertilization, parthenogenesis, cloning, or any other means from one or more human gametes. (Public Law 104-99 1996)

While this amendment clearly prohibits funding the creation of human embryos for research purposes, it is unclear whether it precludes funding research on entities whose status as human embryos is uncertain.

Consider, for example, cells *derived from* embryos. Seeking to comply with federal law, in 1998, the NIH requested that Harriet Rabb, the general counsel of the Department of Health and Human Services (DHHS), give legal counsel regarding whether the amendment permitted funding human embryonic stem cell research. Her response (known as the *Rabb Doctrine*) was that the Dickey-Wicker amendment "would not apply to research utilizing human pluripotent stem cells because such cells are not a human embryo within the statutory definition" (Rabb 1999). The Rabb Doctrine initially paved the way for federal funding of stem cell research utilizing cell lines that were derived from human embryos; however, it never permitted funding research on the derivation of those cell lines, which requires the destruction of embryos. Moreover, whatever clarity the doctrine initially provided was soon altered by the statements of President George W. Bush.[4]

A year before Rabb's work, scientists announced the cloning of a sheep named Dolly (Wilmut et al. 1997). This announcement animated members of the United States House of Representatives, who sought to pass the *Human Cloning Prohibition Act* in 2001. Though it passed the House, the Senate never took up the bill. Yet, it is important because it shows that by 2001, members of Congress had identified human cloning via SCNT as a target for their opprobrium. Perhaps because of the maneuvering of the NIH, the House sought to be explicit in its prohibition of cloning. The bill prohibited any public or private person or entity from engaging in a number of activities related to human cloning, defined as:

> …human asexual reproduction, accomplished by introducing nuclear material from one or more human somatic cells into a fertilized or unfertilized oocyte whose nuclear material has been removed or inactivated so as to produce a living organism (at any stage of development) that is genetically virtually identical to an existing or previously existing human organism" (quoted in Maienschein 2003, pp. 288-289).

Less than two weeks after the U.S. House passed the cloning prohibition act, President George W. Bush gave his first major televised address to the nation. The President said he must decide "whether to allow federal funds, your tax dollars, to be used for scientific research on stem cells derived from human embryos." For Bush, this was a moral issue: "research on embryonic stem cells raises profound ethical questions because extracting the stem cell destroys the embryo and thus destroys its potential for life" (White House 2001). Bush decided to permit funding research on preexisting cell lines and to prohibit funding for any additional research involving the destruction of human embryos. He said this approach allowed Americans "to explore the promise and potential of stem cell research without crossing a fundamental moral line by providing taxpayer funding that would sanction or encourage further destruction of human embryos that have at least the potential for life" (*ibid.*).

With his speech, the President set the terms of debate over embryonic stem cell research. He also announced a Presidential Order superseding much of the Rabb Doctrine, including the prohibition of federal funding of any research involving new stem cell lines, even after their derivation. Finally, Bush also announced the creation of a President's Council on Bioethics (PCBE), which was charged with proposing guidelines and regulations for biomedical research and, in particular, cloning and stem cell research.

The result of the council's inquiry was published in July of 2002. It offered two distinct recommendations to the President and policymakers, with the majority of the council members (10/17) voting for "a congressionally enacted ban on all attempts at cloning-to-produce-children and a four-year national moratorium (a temporary ban) on human cloning-for-biomedical-research" (President's Council on Bioethics 2002a, p. 205), where, "cloning-for-biomedical-research" is synonymous with nonreproductive cloning, or SCNT for the purpose of research (*ibid.*, pp. 42-46).[5] The PCBE emphasized that the moral issue at hand was whether the federal government should fund research designed to create and destroy human embryos, including research utilizing somatic cell nuclear transfer (*ibid.*, p. 201).

With the conclusion of its deliberations and the publication of its report, the President's Council on Bioethics added yet another powerful voice to the chorus of opposition against federal funding of somatic cell nuclear transfer for the purpose of deriving cellular material for stem cell research. By the middle of 2002, two of the three branches of federal government had spoken out against federal funding of SCNT, and President Bush had adopted the PCBE majority recommendation.

With the election of President Barack Obama, advocates for stem cell research had high hopes that the new administration would change these policies. On March 11, 2009, their hopes were partially met when President Obama issued an order revoking the Presidential Order of August 2001 (White House 2009). For many this move was unsatisfying because it failed to lift the ban on federal funding of SCNT and parthenogenesis put in place by the Dickey-Wicker Amendment (Robertson 2010).

A Simple Argument for Prohibiting Federal Funding of SCNT

Since 1996, politicians and policymakers who argue against the morality of federally funding somatic cell nuclear transfer have favored one line of reasoning in particular. It holds (i) that federal funds should not be used for scientific research that harms human embryos, and (ii) that SCNT is a member of this class of research methods. The PCBE claimed that cloning via SCNT should be permanently opposed because "it is immoral to create human embryos for purposes that are foreign to the embryos' own well-being and that necessarily require their destruction" (President's Council on Bioethics 2002a, p. 201). President Bush stated that the moral dilemma brought about by the prospect of funding stem cell research was precisely that such research required the destruction of human embryos. And, though it did not prohibit

SCNT explicitly, the Dickey-Wicker amendment prohibited any technique that destroys or discards human embryos, specifically those derived by cloning.

In each of these cases, a prohibition on federal funding for nonreproductive cloning is justified by the following argument:

1. The federal government should be prohibited from funding unethical scientific research.
2. Research that harms human embryos is unethical because human embryos have a moral status that makes them deserving of our respect and protection.
3. If somatic cell nuclear transfer creates and destroys human embryos then it harms human embryos.
4. Somatic cell nuclear transfer creates and destroys human embryos.
5. Somatic cell nuclear transfer harms human embryos. [3, 4]
6. Somatic cell nuclear transfer is unethical because it harms human embryos. [2, 5]
7. The government should be prohibited from funding research utilizing somatic cell nuclear transfer. [1, 6]

For the purposes of this analysis, I will call this argument the Simple Argument From Identity or *the simple argument*.[6]

The simple argument is simple because it rests on four claims, two of which are fairly uncontroversial (1, 3) and two of which are not (2, 4). Thus, the soundness of the simple argument may be said to come down to the plausibility of just two claims.

Although one might challenge Premise 1, here it will be treated as uncontroversial. Premise 3 also seems acceptable: whether creating something harms it or not, destroying something certainly harms it. Out of the two contentious premises, it is common to attack Premise 2, which may be rejected on the grounds that human embryos lack a moral status and are not deserving of our respect and protection (*e.g.*, DeGrazia 2002).

In this analysis, however, the strategy will be different: I grant the truth of the first three premises for the sake of argument and instead target the fourth premise. I will that somatic cell nuclear transfer does not create human embryos, and consequently it does not destroy human embryos.[7] Rather, SCNT creates clone embryos, which are ontologically and morally distinct from human embryos. Demonstrating the very probable falsehood of the fourth premise entails that the inference to the fifth premise fails, and, therefore, the rest of the argument fails to go through as well. If my argument is sound, then it is also significant because it shows one's intuitions about the moral status of human embryos produced by fertilization (and their derivatives)[8] should be independent from, and have little or no bearing on, one's

intuitions about the moral status of embryos produced by SCNT for the purposes of deriving cellular material for therapeutic research.

A Response to the Simple Argument

To engage with the proponent of a ban on federal funding of SCNT, I have fairly explained the recent history of this policy and I have also reconstructed the argument justifying its institution given by philosophers, politicians, and policymakers. This section demonstrates this reasoning is flawed because it is based on a premise that is very likely false; consequently, proponents of prohibition ought to revise their argument or invoke an alternative.

The Prohibition is Unjustified Because it is Unreasonable

My response to the simple argument relies on assumptions about the nature of policy justification, the contours of which warrant brief description. To put it succinctly, I contend that *justified public policies must be reasonable*. Thus, if a public policy is unreasonable, then it is unjustified; and, if a public policy is unjustified, then there is an imperative that it be revoked or refashioned such that it becomes reasonable. I understand reasonableness to entail certain norms of public discourse, which, when followed, lead to justified policies. I contend that if my interlocutor shares this commitment to reasonableness, and the simple argument is shown to be unsound, then my interlocutor must reject that argument.

As a criterion for justification, reasonableness is meant to be a generic one, meaning that it should not have features that lead it to prejudge the debate over a particular issue, such as the morality of federally funding SCNT for scientific research. Rather, reasonableness may be defined in terms of generally agreed-upon principles for public deliberation, including coherence, consistency, fairness, and soundness. The inspiration for this sense of reasonableness comes from John Rawls. For Rawls,

> Persons are reasonable in one basic aspect when, among equals say, they are ready to propose principles and standards as fair terms of cooperation and to abide by them willingly, given the assurance that others will likewise do so. Those norms they view as reasonable for everyone to accept and therefore as justifiable to them; and they are ready to discuss the fair terms that others propose. […] Reasonable persons, we say, are not moved by the general good as such but desire for its own sake *a social world in which they, as free and equal, can cooperate with others on terms all can accept.* (2005, pp. 49-50; italics added)

Adopting the standard of reasonableness provides an avenue for fairly criticizing the simple argument without requiring a foray into the issue of where human life begins. Rather, all that is required

is to successfully challenge the identity claim encapsulated in Premise 4, between the referent of "human embryo" and the referent of "the product of somatic cell nuclear transfer." In order to do this, it is necessary to define the meanings of the terms "human embryo," "clone embryo," and "parthenote" in a way that they are seen as "terms all can accept" when taking part in policymaking deliberations. I submit that these terms refer to biological entities best described in terms of the steps necessary for their persistent development. Once these defining features have been made explicit, it will become clear that the products of SCNT may be distinguished from both human embryos and parthenotes. Thus, the simple argument is shown to be unsound, because the identity relation it posits is shown to rest on shaky ground. Consequently, the dilemma between protecting life and curing suffering dissolves.[9]

By arguing in this fashion, I aim to sever the identity between human embryos and clone embryos or at least to shift the burden of proof on to those who claim these entities are identical. Of course, critics of using public funds to support cloning for research purposes may nevertheless feel that such research is immoral irrespective of whether clone embryos are identical to human embryos. I respond to this objection below.

The Human Embryo as The Product of Fertilization

The first term in need of clarification is "human embryo." In order to be precise about the referent of this term it is necessary to review the cellular biology of fertilization and embryogenesis. The formation of a human embryo via natural or artificial fertilization begins with the fusion of male and female gametes, or sperm and egg, and ends with a two-celled zygote. In natural fertilization, this process occurs in the fallopian tube and takes about a day to complete. It is depicted in Figure 1.

In the first step of fertilization, the female *haploid* nucleus undergoes duplication to form the female *pronucleus*. The pronucleus has 46 chromosomes; however, in the pronucleus these 46 chromosomes stem from only one parent. As shown in Figure 1-A, the female pronucleus forms when gametic chromosomes duplicate. After a single spermatozoon passes through the protective shell surrounding the oocyte (the *zona pellucida*), the sperm and egg membranes fuse and the male haploid nucleus is released into the cytoplasm, where it then duplicates to form the male pronucleus (Figure 1-B,C). Toward the end of fertilization, the male and female pronuclei briefly come into contact and exchange chromosomes (Figure 1-D). The pronuclei then undergo *syngamy*, a poorly understood process whereby the two haploid sets of parental chromosomes organize together, merge, and migrate (Figure 1-E) to prepare for the initial division of the fertilized egg. The steps of fertilization are also called *zygosis*, because their culmination results in the formation of a *zygote* – a two-celled entity that is the starting point of *embryogenesis*, a process including the formation and development of a human embryo (Figure 1-F).

INSERT FIGURE 1 HERE

Figure 1: Human fertilization (A-F) and early embryogenesis (G-H). See text for explanation. Adapted from Sadler (2000) and O'Rahilily and Müller (2001).

After zygosis, the human embryo undergoes the first stage of *cleavage*. In this process, the two-celled embryo grows via a special type of cellular division; wherein the number of cells, called *blastomeres*, increases geometrically while the total volume of the embryo remains constant. Within three days after fertilization, the embryo takes on a shape resembling a mulberry, which is a tightly compacted formation of growing blastomeres termed a *morula* (Figure 1-G). By the fourth or fifth day after the initiation of fertilization, the embryo is considered a *blastocyst*, the stage at which a cavity first appears inside the morula (Alberts et al. 2002, pp. 1139-1156; Guenin 2008, pp. 4-5). The importance of the blastocyst stage cannot be overstated; the late blastocyst stage marks the moment when embryonic cells exhibit their first differentiation, into three regions, as depicted in Figure 1-H: (i) *trophoblast*, the exterior cellular membrane of the blastocyst; (ii) *inner cell mass* (ICM), the group of totipotent and pluripotent cells in the interior of the blastocyst; and (iii) *blastocystic cavity*, the internal space distinguishing the ICM from the trophoblast (O'Rahilly and Müller 2001, pp. 38-39). Between the fifth and seventh days after fertilization, the blastocyst moves through the fallopian tube towards the uterus. In order for a human embryo to develop into a fetus, the blastocyst must hatch from the zona pellucida and implant in the uterine wall. Human embryos that fail to do this will not undergo *gestation*, the process in which embryonic cells specialize and take on distinct roles.

Fertilization naturally occurs within a fallopian tube over a few days, after which embryogenesis takes place in a woman's uterus. In light of this, I follow Lewis Guenin in referring to embryos that originate in or enter into a uterus and a connected fallopian tube as *enabled embryos*, because they meet the minimum environmental conditions necessary for beginning the development cascade into later stage embryos, fetuses, and neonates. There are two ways for an embryo to be enabled: by originating in a uterus, as in natural fertilization, or by being transferred into a uterus prior to the seventh day after fertilization, such as occurs in the case of IVF. With this vocabulary, we may also distinguish another category, of *unenabled embryos*, being those that never exist in a uterus and connected fallopian tube (Guenin 2008, pp. 21 and 27-31). This distinction is useful because it provides language for describing a difference in types of embryos that exists irrespective of their origins. Whether produced via artificial or natural fertilization, cloning, parthenogenesis, or some other means, all embryos may be separated into the classes of enabled and its opposite, unenabled. Moreover, with this distinction we may recognize that in the case of artificially produced embryos – whether by artificial fertilization, *in vitro* parthenogenesis,

or SCNT – those who donate the cellular material for manipulation and experimentation are the only persons with the moral authority to authorize enablement. Hence, any type of artificially produced embryo may be unenabled by the express prohibitions of cell donors, as Guenin urges should be a precondition for the ethical derivation of clone embryos.

The Clone Embryo as The Product of Somatic Cell Nuclear Transfer

In 2008, a team of scientists made the first, and only, successful attempt to produce a blastocyst-stage clone embryo to date (French et al. 2008).[10] In describing their work, French et al. state that producing a blastocyst via SCNT requires four major steps, which I take to describe the origins and developmental stages of the product of SCNT.

The first two steps are to prepare the nucleus and oocyte to fuse together to become the entity from which the clone embryo is derived. In the first step, the *cumulus matrix* of the oocyte is removed, followed by the removal of the oocyte's nucleus. To remove the cumulus matrix, an enzymatic solution is gently pipetted into the viscous matrix surrounding the oocyte, breaking it down and dislodging it. After the oocyte is incubated for forty-five minutes, the nucleus is removed, either by aspiration through a pipette or by extrusion through a small slit cut in the zona pellucida. After the second step of SCNT, wherein human skin cells (*fibroblasts*) are selected according to the likelihood they are in the ideal phase of cellular development for nuclear transfer, G1 or G0, the enucleated oocyte and fibroblast are ready to be fused. In the third step, the somatic cell is inserted underneath the zona pellucida so that it comes into contact with the internal membrane of the enucleated egg cell. Introduced into a buffer solution in which they receive rapid, repeated electrical stimulation, the fibroblast and oocyte are stimulated to fuse. After fusion, the resulting entity is an enucleated egg cell containing a single somatic cell nucleus. This new product must undergo *parthenogenetic activation*, whereby the cell is chemically stimulated to undergo the symphony of genetic events which initiate duplication and division. Parthenogenetic activation occurs when cells incubating in fusion buffer are rapidly moved into a second buffer for four minutes and then incubated in a third buffer for three to four hours (*ibid*).

If each of the four steps of SCNT has been carried out successfully, then in another six to seven hours the fused cell will have been *remodeled*, meaning that its nucleus will have been returned to a pronuclear state. This results in a single-cell entity undergoing *parthenogenesis*, the growth of an embryo without fertilization. In another day, after *initial cleavage* has occurred, the product of successful SCNT will be a clone embryo, a two-celled embryo created by the four major steps of SCNT. In theory, after a clone embryo reaches the blastocyst stage, the inner cell mass can be removed and cultivated further, creating an autologous stem cell line for use in scientific research (Vats et al. 2005). However, this has proven to be difficult to do in practice.[11]

Clone Embryos and Human Embryos are Not Identical

I propose to distinguish among different types of embryos which have (1) different origins, (2) different developmental pathways, and consequently, (3) different *developmental potentials*. Doing so suggests clear reasons for the reevaluation and reinterpretation of existing public policies for funding stem cell research, including policies governing the funding of somatic cell nuclear transfer. Additionally, distinguishing among classes of embryos will shed light on some ethical problems brought about by current and future advancements in biotechnology.

On my account, *human embryos* are entities that originate via fertilization, whether *in vivo* or *in vitro*, as described above. Although the process has not been described in full mechanistic detail here[12], what we do know about fertilization suggests that the following are necessary moments in a human embryo's developmental path: the formation of the female pronucleus, the activation of the oocyte by the fusion of the sperm membrane with the zona pellucida, the formation of the male pronucleus, and zygosis, which immediately results in a *two-celled* zygote and includes syngamy and the first division. After the first division, a human embryo undergoes cleavage sequentially until it reaches the blastocyst stage. An enabled embryo may then undergo gestation, after which it has the developmental potential to become a fetus, and ultimately, a neonate.

A clone embryo is an entity that originates from somatic cell nuclear transfer.[13] There are four major steps to SCNT, which suggests that the following are necessary moments in a clone embryo's developmental path: the donor cells are altered from their native states in order to prepare them to be capable of embryological development, the somatic nucleus is introduced into the oocyte after fusion, the immediately resulting *single-celled* entity is stimulated to undergo parthenogenetic activation, and the donated nucleus undergoes remodeling. After remodeling, a clone embryo undergoes its initial cleavage, which results in a two-celled entity that can in theory be used for research or reproductive purposes.

My proposal to distinguish between different classes of embryos is not a novel one. For example, in the PCBE Report, the President's Council on Bioethics represent the different entities they discuss by distinguishing among their origins (Figure 2). The PCBE Report employs terminology that is almost identical to my own; it refers to the process from which embryos originate as "fertilization" and refers to the process whereby clone embryos originate as "cloning." In cloning, an egg cell is enucleated, a donor cell is fused to that egg cell, the resulting cell is activated, and the result is a "cloned embryo" (President's Council on Bioethics 2002a, p. 61).

The PCBE is perhaps the most thoughtful governmental body to have considered the morality of federally funding cloning for therapeutic research – that is, for research rather than for reproduction. For precisely this reason, it is all the more troubling that their reasoning is flawed, as it is encapsulated in Figure 2. To see their error, recall that the earliest stage of embryological development, a zygote, is a

two-celled stage, which, in total, contains 92 chromosomes, or two copies of the entity's 46 nuclear chromosomes. Yet, in the PCBE diagram we see that their third stage of fertilization is a *single-cell* zygote containing 46 chromosomes. Comparing this diagram to Figure 1 reveals that the PCBE made a false assumption: that embryos undergo a single-cell stage of development, which they do not.

INSERT FIGURE 2 HERE

Figure 2: A depiction of different embryo types and their origins. From the President's Council on Bioethics report, *Human Cloning and Human Dignity*: "Diagram of early stages of human fertilization, cloning, and parthenogenesis" (President's Council on Bioethics 2002a, p. 61).

The importance of recognizing this error stems from the fact that the diagram in Figure 2 makes no other errors: it represents cloning and parthenogenesis faithfully. Each of these processes includes a single-cell stage. These cells may undergo parthenogenetic activation, and under laboratory conditions may develop further, perhaps even to the blastocyst stage. *But, the embryo does not undergo parthenogenetic activation, because it does not originate in a single-cell stage.* Rather, the embryo undergoes *zygotic activation*, which is a distinct process that results in a blastocyst with high probability.

It is reasonable to ask whether parthenogenetic activation and zygote activation are simply two terms to refer to the same process. The honest answer is that we do not know. Embryogenesis and parthenogenesis are poorly understood, so a definitive answer remains unavailable. However, one very basic fact suggests they are very different: without intervention and under natural environmental conditions, human parthenotes *never* develop past the blastocyst stage, while the majority of human embryos do develop past that stage under the same conditions. Parthenotes that continue to develop do not "develop" per se: they become cystic and enlarge like cancerous masses. Recent experiments have shed light on why this might be.[14]

INSERT FIGURE 3 HERE

Figure 3: Zygotic genome activation of four types of embryos: human embryo, 761/761 transcripts; parthenote, 536/761 transcripts; clone embryo, 124/761 transcripts; inhibited human embryo, 62/761 transcripts (see Noggle et al. 2011).

To examine whether different types of embryos exhibit different patterns of gene expression, scientists mapped a set of 761 genes that are highly active during the very beginning of embryogenesis, at zygotic activation. They then compared the expression rates of three different types of embryos to this level of activation, which they termed *zygotic gene activation*. They found that parthenotes express 70% of the zygotic genome, clone embryos express 16%, and human embryos treated with alpha amanitin (which prevents DNA from being transcribed into proteins) express 8%. Using gene activity as a measure, parthenotes were shown to have significantly different expression rates than human embryos,

and *clone embryos were shown to express less than on sixth of the genes active in a human embryo* (Noggle et al. 2011, pp. 71-72).

The genetic expression profiles of clone embryos are markedly different than those of human embryos. In fact, they show far more similarity to human embryos whose development has been chemically arrested than to developing human embryos. Experiments were not done to see whether clone embryos and parthenotes exhibit similarities in a parthenogenetic activation genome; however, given that neither of these types of embryos develops past the earliest blastocyst stage, without intervention they seem far more similar to one another than either is to a human embryo originating from fertilization. Thus, clone embryos are *ontologically different* from human embryos because they have different developmental potentials, evidenced by their different origins and developmental paths and substantiated by genetic measures of potential.

The simple argument draws its support from two premises: Premise 2, the claim that research harming human embryos is unethical, and Premise 4, the claim that SCNT harms human embryos because the product of SCNT is identical to a human embryo. The imagery in Figure 2 captures the fourth premise better than words can express it. Through it, doubt may be cast on the claim that SCNT produces a human embryo. Human embryos have the developmental potential to produce human fetuses and neonates. Like parthenotes, clone embryos do not. Human embryos originate from fertilization. Like parthenotes, clone embryos do not. Given these differences, clone embryos and parthenotes should be distinguished from human embryos on account of the patent differences between their origins, developmental pathways, and developmental potentials. As such, one should conclude that clone embryos are not human embryos in the sense of that term necessary for the simple argument to be sound. Hence, the simple argument fails.

Should Clone Embryos Have the Same Moral Status as Human Embryos?

This response to the simple argument will provoke various responses, but I believe that two counterintuitions will occur most frequently. In this section I will face the first of these: that clone embryos deserve the same moral status as human embryos, and, consequently, the simple argument may be reasonably modified, irrespective of whether clone embryos are identical to human embryos.

The Retreat to Moral Status

I will call the response that clone embryos deserve moral status *the retreat to moral status*; as a response to my argument, it can be shown to be a move of considerable desperation. First, notice how much this maneuver concedes. As shown in the first section, the simple argument is not only *an* argument that would support a prohibition on federal funding, it is in fact *the* argument that has traditionally been used

to support the actual prohibition in place. So, while a retreat to moral status may be an alternative means for justifying the prohibition, it is one that is employed at the cost of conceding that the previous justification was unjustified. Despite this, the argument from moral status may succeed where the simple argument from identity fails. We must ask, then, what justifies an attribution of moral status to clone embryos?

For the present purposes, approaches to attributing moral status based on concepts other than harm will be excluded. Instead, I focus on arguments that ground assertions of moral status on an entity's ability to feel harm. For instance, consider the argument Peter Singer makes in his classic paper "The Moral Status of the Embryo." According to this approach, we may say that to harm an entity is to cause it pain; and if an entity can feel pain, and hence be harmed, then it is worthy of our moral concern. For Singer, "the minimal characteristic which is needed to give the embryo a claim to consideration is sentience, or the capacity to feel pain or pleasure" (Singer 1998, p. 89). To ground an attribution of moral status to clone embryos on their capacity to be harmed would require that they have the minimal characteristics necessary to feel pain.[15]

For a clone embryo to develop the capacity to feel pain, however, it would have to first undergo gestation and then a number of subsequent developmental stages culminating around the end of the second trimester, no earlier than 29 weeks (Lee et al. 2005). Subsequent to these events, one could say that it had attained moral status. However, there are a number of reasons why this is not even a theoretical possibility for clone embryos used for stem cell research. First, following Guenin's proposal, I contend that clone embryos should only be developed if cell donors (of oocytes and fibroblasts) have expressed preferences precluding the enablement of any resulting clone embryos. Thus, clone embryos would, as a class, be unenabled, and hence, could not enter a uterus. Therefore they would be incapable of developing past the blastocyst stage due to an explicit prohibition.[16]

Of course, prohibitions fail when people choose to flout them, so this reason will not be compelling to the skeptic. A second reason clone embryos used for research purposes will not develop the capacity to feel pain is that the process of isolating stem cells from a clone embryo destroys it, making the remaining tissue incapable of further development, even if it were transferred into a uterus. To isolate stem cells, the trophoblast of an embryo is destroyed and the inner cell mass is selected for using a specific nutritional medium (Lanzendorf, Boyd, and Wright 2004). Since the trophoblast is necessary for implantation, using a clone embryo to produce a stem cell line excludes the possibility of also using it for reproductive purposes: nothing remains that is capable of developing into an embryo, and hence, nothing remains that could undergo embryogenesis.

Stem cells are often described as being pluripotent, meaning that they can develop into any cell type, in theory. Moreover, recent research shows that human embryonic stem cells (hESCs) can be

engineered to produce trophoblast cells *in vitro* (Ezashi et al. 2012). This further suggests that with the right intervention, hESCs may become totipotent, meaning they would have the potential to form embryonic and extraembryonic tissues, and thus be capable of producing all tissues – including, perhaps, a healthy, functioning, whole embryo (see Denker 2006). Given this, one might wonder whether stem cells isolated from a single clone embryo could be manipulated into an embryonic form that could then regenerate *both* the trophoblast and early blastocystic structures, suitable organized such that a healthy, functioning, whole embryo results. If so, this would suggest that isolating stem cells from a clone embryo – that is, producing clone embryonic stem cells (cESCs) – does not preclude using it for reproductive purposes.

However, all that we know suggests this is simply not possible in the case of clone embryos, as distinguished from human embryos. Consider that embryos must develop within the zona pellucida, which they then hatch from before implantation. Developing cESCs would not have this structure: they would be developed in controlled laboratory conditions, without the presence of materials that might, in theory, produce a clone embryo with developmental potential. Moreover, even in theory, in order to engineer clone embryonic stem cells to have such properties would require manipulating them by introducing other cellular tissue that itself has some sort of developmental potential. This is seen in the example of induced pluripotent stem cells: in order to generate an embryo-like entity from them, two embryos must be expended by being fused, as described in the experimental protocol; consequently, it is not clear that attributing "potential" to developing stem cell lines is as morally innocuous as proponents of this response would suggest (Cunningham 2013).[17] Thus, no scientific evidence exists to suggest that clone embryonic stem cells may be engineered in ways that permit their reconstitution as embryos, once they have been isolated from the inner cell mass. And, although some evidence exists that this can be performed using hESCs, the moral importance of those experiments is ambiguous, given that they require the destruction of another embryo to derive a blastocyst or blastomere to aid in the development of the isolated hESCs.

This distinction is important, as without specific manipulation, embryonic stem cells have been shown to develop into various types of specialized *cells*, but not into teleologically organized *entities*. When isolated, murine stem cells naturally become cystic (Evans and Kaufman 1981), as do human embryonic stem cells. Evidence also indicates that the latter become *embryoid bodies*, disorganized spherical balls containing heterogeneous tissues (Desbaillets et al. 2000), which may predominantly contain neuronal cells if not exposed to extrinsic influences (Smukler et al. 2006). However, embryos also form embryoid bodies under similar experimental conditions, so this behavior of embryonic stem cells derived from human embryos may not carry moral weight if intended to distinguish between human embryos and hESCs.

Nevertheless, such issues are only relevant *if* we first conflate human and clone embryos, without appreciating the differences between them described here. Once we recognize clone embryos arise from distinct origins and developmental pathways and have different developmental potentials, then whether one believes hESCs are sufficiently like human embryos to warrant their protection does not bear on whether clone embryos warrant attribution of moral status. Indeed, as the genetic expression profiles of clone embryos are significantly more similar to human embryos whose development has been chemically suppressed, and thus which have no developmental potential, we should assume the same for clone embryos and their derivatives. Recognizing this may make clone embryos poor candidates for producing (clone) embryonic stem cells or other therapeutic cell tissues, but that is something that is unknowable without the appropriate experimentation,[18] and hence additional federal funding.

Thus, when a clone embryo is used for research purposes it is incapable of developing the capacity to feel pain, both because it is unenabled and incapable of developing past the blastocyst stage. Therefore, the claim that clone embryos deserve moral status cannot be supported on the basis of their ability to feel pain.

Status and Potentiality

There is another sense of harm that may appear apt for attributing moral status to the clone embryo. One might say that it is not *actual* sentience that grounds the capacity to be harmed, but rather the *potential* to feel pain. Such intuitions have been foreshadowed by our discussion of hESCs, and they deserve additional care and scrutiny. In a classic argument against abortion, Don Marquis suggests that embryos and fetuses have moral status because they have the potential to be harmed. He claims that abortion is morally impermissible because it would cause "the loss to the victim of the value of the victim's future" (1989, p. 190). Applying this to clone embryos, one might say they are capable of being harmed because they are capable of having a future of a certain sort, and to destroy them is to rob them of this future.

With this argument, the retreat to moral status becomes a familiar retreat to potentiality. Taking this argument seriously at least requires distinguishing between different senses of *potential*, which is understood best in terms of either *producing* or *becoming* (Buckle 1988). To have potential in the sense of becoming – or being capable of developing into something – a target entity must maintain its identity through a developmental process; it must *persist* despite its change from one state to another. Attributing moral status to an entity based on its potential to become implies deontological reasoning, that the target entity should be granted moral status because it may become something that already warrants our moral concern without the need for additional argument. Clearly, proponents of prohibition contend human embryos deserve special moral status because they become fetuses and neonates, not because they produce them. Hence, in order to rescue the view that cloning should be prohibited, the same must be

said of clone embryos, that they can *become* fetuses and neonates, and as such deserve to have special moral statues. As just explained, however, clone embryos used for research purposes are incapable of developing past the blastocyst stage both because they are unenabled and because the process of isolating stem cells from them destroys the trophoblast. By consequence, they cannot become sentient, nor can they become fetuses or neonates.

However, one could extend this objection persuasively by appealing to the aforementioned scientific data indicating hESCs may be capable of realizing totipotency subsequent to certain interventions. That is, if this is so, then would it not show that clone embryos can be manipulated to *produce* sentient entities, and thus, to have sufficient potential to warrant attribution of moral status?[19] There are two significant weaknesses to this response, as an objection to the current argument. First, it fails to appreciate the distinction between the two types of potentiality distinguished above, producing and becoming. This response rests on the former, but it is important that the capacity to produce an entity deserving of moral status is not a capacity that is itself morally salient. If that were the case, then, assuming that SCNT could be used to reproduce an extant human, we would be compelled to say that all of our skin cells (fibroblasts) would have the potential to produce a human being, and hence would deserve moral status (Charo 2001; cf. Disilvestro 2007). This worry is exactly why distinguishing between producing and becoming is philosophically useful, because it aids in describing conditions where an entity does not itself have sufficient capacities to become a morally salient entity itself (or perhaps under typical environmental conditions that do not require significant technological intervention). If such an entity could be engineered to develop into a being deserving of moral status (or having it based on stipulation), then it is not the properties of that entity that are morally salient, but the properties of the technological interventions and *those who are responsible for them* that are morally salient.

Moreover, secondly, extending the argument from potentiality fails to appreciate the important differences in how hESCs are produced and how cESCs could be produced in theory. Clone embryonic stem cells would in theory be derived from clone embryos. Thus, again, absent experimental evidence to the contrary (performed on cESCs and not hESCs), we should expect cESCs to lack anything near the developmental potential of parthenotes, and thus anything near the potential required to warrant attribution of moral status based on the productive sense of potentiality.

Now, a reasonable response is to ask whether, if they were not used for research, and were enabled, clone embryos could develop into an entity of moral significance, such as a later stage embryo, a fetus, or a neonate. Before giving an answer, it should first be made clear that this is to change the discussion: we are now considering whether performing SCNT for *reproductive* purposes might create an entity of moral worth, and therefore, whether the potential of creating such an entity would delegitimize cloning for the purposes of researching cell therapies. Again, even if this were the case, it must be

recognized that the proposal defended here – that SCNT is a tool for producing immunocompatible stem cells that should be federally funded – is independent from the proposal that we should fund research into SCNT for reproductive purposes. Nevertheless, this line of argument must be taken seriously.

There is absolutely no evidence that reproductive cloning is possible in human beings. This may of course be because experiments designed to show this are almost universally forbidden, and thus would not be reported. Nevertheless, proof of concept experiments in other species are telling. Reproductive cloning (production of live offspring via SCNT combined with other artificial reproductive technologies) has been successfully attempted in six mammalian species, yet despite considerable attempts by teams who have cloned other species, it has never been achieved in primates (De Sousa et al. 2004; Lee et al. 2005). Across mammalian species, the success rate of reproductive cloning is 1-4%, and once born, "despite apparent physical well-being," these offspring "still have genetic or epigenetic abnormalities" (De Sousa 2004, p. 353). Early embryonic development varies widely across species, including fundamental differences between humans and all of the cloned mammals thus far (cf. Stern 2004), and these differences are hypothesized to explain why human clone embryos develop poorly when compared with human embryos (as shown in Figure 3).

Lacking evidence that reproductive cloning is possible in human beings, one might nevertheless appeal to the fact that it has occurred in mammals to argue by analogy that it is possible in humans. It must be admitted that this response simply cannot be decisively defeated: it is true that reproductive cloning has successfully been performed in mammals. But, there are good reasons to think that this argument from analogy is unpersuasive. Consider that our best estimates suggest in healthy women natural conception has about a 68% success rate for producing a live offspring (Wilcox et al. 1999). Once a woman has conceived, the chances that zygote will develop and she will bring it to term are quite good. Even if a woman conceives using artificial reproductive technologies, the chances she will bring a child to term are quite good. In 2009, the last year for which there is data, 41% of IVF cycles resulted in a live birth (CDC 2011). These statistics suggest that even if, for the sake of argument, we suppose that cloning was possible in human beings, and that the rate of success was similar to that seen in other mammals, it would still remain unclear that clone embryos have the same intrinsic potential to become an entity deserving of the special moral status attributed by many to human embryos. Evidence suggests that enabled human embryos have a good chance of developing into neonates. Even granting a number of contentious assumptions and absent any evidence, it seems that, in theory, enabled clone embryos would have an *extremely* poor chance of developing into neonates. Indeed, without granting those assumptions, they should be said to have no chance at all.

In sum, clone embryos produced for reproductive purposes may be said to be capable of developing into a neonate only in a very limited sense, which we might call *logical possibility*.

Hypothetically, granting many contentious and evidentially unsupported assumptions, it is logically possible that clone embryos might, with very low probability, be capable of producing human offspring, if enabled. Yet, we may distinguish among logical and *nomological possibility*,[20] where the latter is actual possibility, grounded in empirical observation, or perhaps by reference to scientific laws, if such laws are available. No evidence exists to support the claim that it is nomologically possible for enabled clone embryos to develop into neonates, or any other stage of development past the blastocyst. Thus, as this is necessary for establishing the claim that clone embryos may have the potential to be harmed, and hence are deserving of a special moral status, that position is unsupported by the available evidence. Moreover, as the thesis here is that the simple argument fails as a justification of prohibiting funding for nonreproductive cloning – to develop cell therapies using protocols that preclude the use of clone embryos in reproductive cloning – the remote logical possibility that a clone embryo could, in theory, develop into a neonate is a pyrrhic victory for the proponent of prohibition.[21] It underscores how different human embryos and clone embryos are, and hence, that the moral status of the former hangs on different assumptions than the latter.

Clone embryos and human embryos are ontologically distinct, and this distinction carries moral weight. Even if one holds that human embryos have a moral status that precludes federally funding research upon them, accepting this position does not entail the same view of clone embryos. To defend a prohibition of federal funding for SCNT for research purposes requires additional assumptions, ones that should be doubted in light of the argument given here.

THE POLITICAL REALITIES OF POLICYMAKING

If the high-road retreat to moral status is indefensible, one might instead opt for a lower route to justifying the ban on federally funding cloning for biomedical research, via an appeal to the bearing of political realities on policymaking. On such an account, what justifies the ban would not be the claim that SCNT produces human embryos, nor would it be that clone embryos have a moral status. Rather it would be justified by claims about the political nature of making science policy, which, when added to the simple argument, make it sound. Two such attempts are considered below.

To Explain the Ban is to Justify the Ban

One might say that what justifies policy is not a logically sound argument, but political will and capital. Thus, to explain the ban on cloning requires an analysis of the political forces leading to the passage of the Dickey-Wicker Amendment and subsequent political events. The ban on cloning would be *explicable* by reference to historical political events, which would justify the ban by explicating the means by which it occurred. On this account, the standard of reasonableness bears little weight. The ban is justified by the

sheer fact that it happened via some confluence of political events, irrespective of whether these events hold up to philosophical scrutiny.[22]

The force of this alternative approach to justifying the existing ban on cloning rests on one's intuitions about philosophy and criticism in policy formation. One might believe that no amount of deliberation can alter the entrenched moral foundations of individuals' dispositions to support one or another policy. Under this purview, the exercise performed here is solely an academic one. Analyzing the logic underlying policy is not only quixotic, but also beside the point, because what justifies new political actions, like creating and enacting policy, are prior political acts.

Although a lesson worth learning is expressed by this response – that philosophical argument alone is insufficient to affect policy change – as an objection to the argument of given here, the response fails because it overreaches in redefining justification. To justify something is to show that it is right or reasonable in accordance with some accepted standard or norm, rather than simply to show how it happened. To treat justifying the prohibition synonymously with explaining its political history is to replace the standards of justification with those of description. This is unacceptable because of its significant consequences. On such an account, how would political decisions be open to criticism? How could one ever question the credibility of governmental policy? One could not. Rather, faced with incredible policies, one would be reduced to accepting them as the product of some explicable political process, and hence justified. This will not do. Policymaking should be accountable to standards over and above political expediency. Justification by appeal to commonly accepted norms is one of these, and on this account of justification as reasonableness, the ban on funding SCNT remains unjustified.

Simplification Justifies the Use of Falsehoods in Policymaking

Recognizing the political realities of policymaking may justify the ban on funding nonreproductive cloning in another way: one might reply to my argument by claiming that appealing to a simple fact about policymaking rehabilitates the simple argument. That is, one could say the consideration of numerous scientific details, as is done above, is inimical to the activity of policymaking. Rather, since making policy requires agreement between individuals of varying intellectual backgrounds and political loyalties, *policymakers must simplify scientific information when creating policy*. Moreover, in some cases, such simplification entails that the depiction of scientific information used for forming policy will prove false if compared with a richer depiction from unsimplified scientific information.

What justifies the ban under this account is not the simple argument per se, but the simple argument with the additional premise that simplification is necessary in policymaking, even to the point of falsehood. The current ban is then justified not despite its reliance on an identity claim between clone

embryos and human embryos, but *because* of it: because a simplified and false representation of science is necessary for policymaking in today's political climate, arguments based on it are justified.[23]

This is an interesting response to the arguments given here, and simply articulating it is to advance our understanding of the logic of science policy formation and the role that philosophy can play in that process. Notably, the response has gained some support from well-respected bioethicists involved in policymaking. For example, while discussing his time with the President's Commission for the Study of Ethical Problems in Medicine and Research, Alan Weisbard writes that even when philosophical analyses of policy options were given during deliberations, they were not helpful. Rather, at the level of macro-policy, "philosophical analysis tended to invoke standards for justification that few real world policy initiatives (including those likely to command widespread political support in a 'mixed' society like our own) could meet" (1987, pp. 781). Dan Brock agrees that there is a deep tension between academic philosophy and policymaking, which he believes arises out of the philosopher's commitment to truth on the one hand and the policymaker's commitment to enacting policy on the other. By his lights, the virtues of philosophy simply do not translate well to policymaking (Brock pp. 1987, 786-787; cf. Wickler 1991).

If the political realities of policymaking are inimical to philosophical criticism, and hence, to fruitful contributions by scholars whose policy work is consistent with the professional standards of philosophy, I believe it is a problem for policymaking, not for philosophy. Thus, though we may recognize that the political realities of policymaking may likely require a participant to alter his or her standards in order to effectively contribute to the process, acknowledging this need not equate to a call for *lowering* those standards, which is, in effect, what the justification of the simplification of scientific information comes down to. That tactic would entail that we not only accept, but also in fact encourage, our leaders and policymakers to make policy decisions on the basis of far less knowledge than is available. This would amount to encouraging policymaking from ignorance, a perverse endeavor for the philosopher committed to characterizing and articulating justified knowledge. While we must accept that our leaders and policymakers are at times ignorant of the subtleties of the science their regulations target, philosophers should not enshrine this ignorance by using its inevitability as a premise for the justification of policies based on falsehoods.

CONCLUSION

When performed for research purposes, somatic cell nuclear transfer does not require the destruction of human embryos; it requires the creation and destruction of clone embryos to produce cell lines. Therefore, I claim that the longstanding bipartisan ban prohibiting federal funding of SCNT is unjustified because it rests on an unsound argument that assumes SCNT does destroy human embryos. Two types of

responses to my position have been anticipated. First, that it fails because it sidesteps the ethical question of whether clone embryos deserve moral status, and second, that it fails because alternative sources of justifying the ban may be given by appealing to the political realities of policymaking. I hope that the argument given here will persuade others that federal science policy is a topic worthy of philosophical analysis, and exposing the reasoning that grounds our policies is a useful application of philosophical criticism. More attention to the particular topic of somatic cell nuclear transfer may reveal additional reasons to doubt the conclusions argued for here; however, the effort of analyzing science policy is one that I believe will continue to have substantial payoffs for both the scholar and the broader community, which must pay the costs for regulations of the means for pursuing the quintessentially humane end of relieving suffering.

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ENDNOTES

[1] In theory, a human reproduced by cloning would at most have only *nearly* identical DNA to the nucleus from which it originated because his or her mitochondrial DNA would come from the oocyte used in SCNT, rather than the somatic cell. Additionally, polar bodies and epigenetic mechanisms of inheritance would also influence what genes are expressed as that person develops, creating another source of genetic diversity.

[2] The therapeutic potential of stem cell research (SCR) is extremely controversial and uncertain, and will remain so for the near future. Currently, it is only a theoretical potential, as few randomized controlled trials are underway for stem cell therapies, which would show its actual feasibility. Notably, a biotechnology leader in stem cell research has recently ceased all efforts in the field (Pollack 2011); however, recent preliminary results from another leading company suggest that some patients benefit from therapies derived from SCR (Schwartz et al. 2012). While currently stem cell therapies are unfortunately primarily the province of speculation and unethical treatment (see Enserink 2006), it is possible that with funding, federal oversight, and national and global regulation, ethical therapies could be developed that will benefit many suffering individuals.

[3] The history of politics, philosophy, and embryo research policy during this era is fascinating and worthy of considerations, but beyond the scope of the present discussion. See Riley and Merrill (2005) and Green (2001) for detailed discussions.

[4] The Rabb Doctrine has survived several Federal court challenges and remains in effect today. See Robertson (2010), Cohen and Adashi (2011), and Annas (2011) for recent discussions of the doctrine, this litigation, and its implications for federal funding of stem cell research. The most recent decision affirming the Rabb Doctrine came on August, 24, 2012 (*Sherley vs. Sebelius* 2012).

[5] Consistent with the view argued for here, the minority recommended a total ban on reproductive cloning and federal regulation of nonreproductive cloning.

[6] One might add another premise to the argument defining what constitutes harm to embryos, such as: To harm a human embryo includes such acts as destroying, discarding, or knowingly subjecting it to certain levels of risk of injury or death, as defined by United States law. For the sake of this analysis such a premise is assumed but suppressed.

[7] It is important, at this point, to clarify a potential ambiguity. As stated here, the simple argument may be ambiguous in terms of how it defines SCNT, in that it could simply mean the singular act of nuclear transfer and none of the steps in the process of cloning that come thereafter. To define SCNT thusly would be to evade the reasons given for opposing it rather than to challenge them. To prevent this interpretation, it should be made clear that by SCNT, I mean not only the act of nuclear transfer, but also the following, discussed in detail below: the preparation of donor cells (removal of nuclei from somatic cell and oocyte), the combination of somatic nucleus and oocyte (nuclear transfer), the activation of the reconstituted oocyte, and the initial divisions of this cell to the clone blastocyst stage, all of which are performed *ex vivo*. Thus, following a successful act of SCNT, clone embryonic stem cells could in theory be isolated from the inner cell mass of the clone blastocyst and used for the research of cell therapies for transplant and regenerative medicine.

[8] This includes human embryonic stem cells, which will be discussed below, when we consider objections to the argument presented here.

[9] I thank Kathryn Tabb for clarifying the structure of my argument here.

[10] Infamously, a team of researchers led by Hwang Woo-suk first published a report claiming to have successfully performed SCNT in humans in 2005, though this report was later retracted due to scientific misconduct. For citations to the original paper and information on this controversy, see Cho, McGee, and Magnus (2006) and the special online section devoted to it by the journal, *Science*, which originally published the fraudulent research (Science 2011).

[11] While researchers have created stem cells from SCNT produced blastocysts (Noggle et al. 2011), these stem cell lines showed developmental and transcriptional defects (as discussed below). Thus it remains unclear whether such lines are well suited for the purposes of developing novel cellular therapies.

[12] For such detail, see O'Rahilly and Müller (2001).

[13] Following Guenin (2008), I propose to call the product of SCNT a *clone embryo*, as in a 'mouse embryo' or 'mammalian embryo'. This locution is preferable to a similar one, cloned embryo, because it accurately implies that the embryo is the product of cloning by SCNT, rather than that the embryo is a copy of its progenitor. Saying 'cloned' embryo is incorrect because clone embryos contain DNA from both their gametic and somatic sources.

[14] For further discussion of teratoma formation as a marker of embryonic development, see pp. PAGE ## [now 15-16] below.

[15] This argument might be taken as suggesting that the same reasoning holds for embryos produced via IVF, i.e. that they only have, or also have, moral status if and only if they are capable of feeling pain (or as discussed later in this section, have the potential to develop this property). However, this is a misinterpretation of the argument given here. It is assumed that any and all embryos produced via fertilization – i.e., *human embryos* – have moral status merely by stipulation, which is entailed by the strategy of accepting Premise 2 of the simple argument. The question this analysis targets is whether granting moral status to human embryos entails that clone embryos must also have moral status. Thus, the claim that moral status may be attributed by reference to pain (or later the potential for pain), does not commit us to the claim that it may only be so attributed, or that it is the route by which the products of IVF are said to warrant moral status. I thank an anonymous reviewer for suggesting this worry.

[16] This point may also be raised as regards its application to human embryos produced via IVF. One might wonder, does this mean that left over IVF human embryos also do not have moral status, presuming they are prohibited from enablement, and hence, do not have the chance to develop further to gain the capacity necessary to be attributed moral status? It is important to recognize that by accepting Premise 2 of the simple argument these issues are thereby muted. It is accepted that all human embryos, including those produced by IVF, have moral status. Thus, whether they are unenabled or not, they still have that status, merely by stipulation. Now, important controversies might result from accepting this stipulation, *e.g.*, regarding the morality of freezing or destroying leftover IVF embryos. And, these are no doubt important issues. However, they are not the issues that concern the current argument, which is not about all of the many ethical issues that would follow from accepting for the sake of argument that human embryos have moral status.

[17] As H-W Denker concludes, given contemporary *human* embryonic stem cell science (not cESC science), this would require taking hESCs and combining them in certain ways with other blastomeres or blastocysts that have themselves been manipulated. Thus, although it is in some sense possible to reconstitute an embryo from some hESC lines, this require manipulating *another human embryo* in order to derive the tetraploid helper cells necessary to engineer the initial hESCs to form a complemented human embryo. Though Denker concludes this means hESCs warrant moral protection and perhaps moral status, he is careful to note that this "has not been reported in the literature and does not seem possible" for "somatic cells" (2006, p. 669) which are the source of the nucleus of clone embryos and most likely the reason for their insignificant developmental potential. It it is unclear why Denker attributes potentiality (and thus moral status) to the hESCs, rather than the blastomeres that must be manipulated to produced tetraploid helper cells in the experiments he describes. Perhaps this is because related research in mice shows live pups can be produced via tetraploid complementation, though with extremely low efficiency, and in most cases late term and live-birth pups were not healthy (Nagy et al. 1993). Moreover, in these experiments one of the only two healthy pups to reach adulthood was chimeric, *i.e.*, up to 15% of its somatic DNA originated in the tetraploid embryo used in the procedure to stimulate the mouse ESC. Thus, remains unclear how to draw the analogy from such mouse models to human beings in a morally significant way, given the genetic and morphological differences between mouse ESCs and hESCs. Nevertheless, as has been discussed above, the developmental potential for human embryos and their derivatives is vastly different than it is for clone embryos, so even if the analogy were clear, such considerations would not apply *mutatis mutandis* to the case of clone embryos.

[18] One such experiment might be to repeat the experiments done by Noggle et al. (2011) to see whether the zygotic gene activation of hESCs was at all similar to zygotes, parthenotes, or clone embryos, and likewise, to compare these expression patterns to those of cESCs. But of course, first the latter would have to be isolated and reliably cultured, which has yet to be reported.

[19] I thank an anonymous reviewer for carefully suggesting this argument and for suggestions of important scientific literature relevant to it.

[20] See Singer and Dawson (1988) for an expression of this distinction and application of it to embryo experimentation.

[21] Stated thusly, this argument suggests the questions, what threshold for potentiality (possibility) is sufficient to warrant moral status or protection; and likewise, how should we respond to the fact that there is some, albeit only logical, possibility that a clone embryo could develop into a neonate? By distinguishing between logical and nomological possibility, we can appreciate just how low, yet uncertain, these possibilities are, which is an important advance in our accounts of what justifies science-funding policies. Nevertheless, even this minimal possibility suggests that the correct stance regarding funding is one that is cautious, such as using strict, adaptive funding policies that respond to science quickly as we learn more about the entities under discussion (see Mitchell 2009). I thank an anonymous reviewer for posing these important questions.

[22] I thank Jane Maienschein for suggesting this response. It could be stated in a less extreme form that emphasized the contingency of policymaking on many other factors than just philosophical ones.

[23] I thank Mark Wicclair and Douglas White for suggesting this alternative source of justification.