The Praxis of Scientific Epistemology

Establishing common understanding in the debate over human embryonic stem cell research

Nathan J. Palpant
University of Michigan Medical School
and the Ford School of Public Policy
Ann Arbor MI 48109-0622

OUTLINE

Abstract

The debate over research using human embryonic stem cells (hES cells) continues to engage scientists, politicians, and the lay public alike. Molecular cell biology researchers stand at the focal point of this dynamic and vigorous discussion. As public opinion becomes increasingly polarized, we ask why the debate over hES cell research is so intractable? This intractability is, in part, the consequence of our epistemic differences in understanding and validating scientific truth claims. Recognizing this common source of division, is there a feasible framework by which this controversy can move toward common understanding? To address this question, this paper sets out to describe the epistemological narratives that define the social, political, and scientific domains of interpretation regarding this issue. Why are these groups important and necessary for the formulation of this controversy and inextricably tied to the progress of this debate? Furthermore, what characteristics of these groups inhibit their potential for establishing a common substrate of knowledge? In conclusion, scientists as originators and purveyors of technical knowledge are uniquely positioned to provide important and beneficial contributions to this controversy that could translate into more effective debate publicly and politically.

Introduction

> Because of the heterogeneous character of scientific work and its requirement for cooperation, the management of this diversity cannot be achieved via a simple pluralism or a laissez-faire solution. The fact that the objects *originate in*, and continue to inhabit, different worlds reflects the fundamental tension of science: how can findings which incorporate radically different meanings become coherent? ~ Star and Greisemer (1989: 392)

Over the course of the past several decades, the debate over human embryonic stem cell (hES cell) research has evolved into a controversy characterized and formed by diverse knowledge and value systems set against a backdrop of discursive scientific claims. More than the science itself, this debate has gained complexity with the emergence of vocalized and

impassioned interest groups and widespread political and social division. Beginning with the 1973 *Roe vs. Wade* decision regarding abortion, we witnessed the emergence of a complicated relationship between scientists, politicians, and the general public regarding use of cells or tissues derived from the early stage embryo or fetus for research purposes.[1] Human ES cells are of significant interest to scientists for the purpose of understanding stages of early human development. Furthermore, scientists are looking eagerly at the potential application of these cells, which have the capacity to differentiate into all cell types of the adult body, for therapeutic treatment of numerous tissue pathologies.[2] This unique cell has been impressed upon society as the archetype of the modern scientific project. The current policy for hES cell use established by President Bush in 2001 states that "federal funds [should] be used for research on these existing stem cell lines, where the life and death decision has already been made."[3] This policy holds the National Institutes of Health responsible for requiring that all federally funded research grants invoking hES cells in the proposal use cell lines derived prior to August 9th, 2001.

The question of why this controversy is so intractable perplexes members of society, politicians, and scientists alike. Each of these groups continues to engage this debate with no overall evidence of effective movement. Historically, political efforts[4] addressing this controversy have aimed for some degree of unification but were met with dichotomous responses. There was tremendous support on the one hand reflexively countered by significant dissent on the other. In other words, there is a juxtaposition of hyperbole and uncertainty suffused within prominent lines of argumentation – a semblance of civic power-play. Writing on the AIDS controversy, Steve Epstein articulates that large-scale social, political, and scientific controversies are characterized by "the dispersal of fluxes of power throughout all the cracks and crevices of the social system; the omnipresence of resistance at every site; and the propagation of knowledge, practices, meanings, and identities out of the development of power" (Epstein, 1996).[5]

Considering these structures of power and identity, this paper argues that the way we think about scientific assertions, how they are validated and how we understand them, significantly impacts how scientists, members of society, and politicians are able to engage effectively in this debate. At its root, this paper is a study on epistemology. That is, it is a study on the limits and validity of knowledge using the hES cell controversy as a case in point. This paper argues that epistemological differences regarding scientific information are *the* primary

underlying source of division in this debate. One may raise the red flag of moral differences which have received so much public attention. Although significant in its own right, our ability to understand and discuss matters at the level of morality, ethics, or politics is dependent on an establishment of equal understanding on the basis of scientific information. The science that underlies this controversy, specifically how it is understood, is the ground work for all other observed issues.

Setting scientific knowledge as the "obligatory passage point" for this conflict, it is important then to understand by what means common understanding can be achieved in this seemingly unresolvable debate (Latour, 1987). Recognizing that society, politics, and science each participate in the instantiation and legitimation of argumentation in this debate, what are the specific characteristics that inhibit these groups independently from forming an effective substrate for argumentation? Importantly, *is* there a reasonable means of establishing some kind of common knowledge system in this controversy?

Before moving forward it is important to clarify what is meant by "common understanding". Again, this study is about epistemology. To reflect this framing, this paper ultimately seeks to define the source by which the social, political, and scientific actors are able to formulate arguments derived from some common understanding or common knowledge system. What is meant by this? Common understanding is *the* substrate of knowledge useable by all groups in this controversy that enable them to formulate and articulate legitimate and coherent lines of argumentation which will lead to more effective deliberation and arbitration.

Epistemological Narratives

> To achieve practical wisdom, one needs enough fear to be vigilant of error and enough daring to risk it in pursuit of truth, to hold onto such wisdom, one needs enough fear to dread its loss and enough daring to risk contempt in its defense. ~ J. Budzizsewski (1999: 47)

Transformations within society, politics, and science make analysis of this debate challenging. Roles shuffle, questions are altered, science evolves, decision makers change.

Looking more broadly at these groups, however, reveals that they exist in situated constructs that, generally speaking, define the ways each engages with this debate. What is it, specifically, about science or politics or society that creates our understanding of their involvement in this debate? The characteristics that illustrate this question can be seen as each group's culture, norm, politic, or system of knowledge that enables each to contribute to the tapestry we perceive as this controversy.

As J. Budzezsewski has noted above, there is tremendous risk involved in seeking out and coming to regard a position, normative or alternative, as worthy of defense. To achieve this end, actors in this debate make significant efforts at formulating arguments based on a constructed knowledge base of scientific truth claims. From this position, it is a tug-of-war in every direction trying to convince all others of some defined semiotic episteme under which to unite. These efforts at effective argumentation play a central role in shaping the way in which these groups approach the table of deliberation. Right now, however, there is the appearance that we are all sitting alone at our own table, or perhaps with a few others sympathetic to our cause. What could be the reason of such disjunction? A significant contributor to this disarray is the varying understandings of scientific information which form the foundations of each argument or position. Given that such division results from the lack of a consensual scientific knowledge, what could be the cause? To address this, Lucy Suchman has noted "…artifacts are produced, reproduced, and transformed through ongoing 'labours of division'… that involve continuous work across particular occasions and multiple sites of use. This work of production and reproduction across time and space results in very diverse assemblages, involving participants with different histories, relations of familiarity or strangeness, and the like" (2007: 268).

But it is not simply the social dynamics of this controversy that require attention. The terminology, such as how we understand the phrase "human embryonic stem cell", is dynamic. As Sheila Jasanoff has articulated, objects of scientific innovation such as hES cells are not ontologically inert; they have stories and biographies that have implications and require explanation. "They are for all practical purposes not only scientific objects," she goes on to say, "but also social objects, produced in indiscriminate acts of synthesis out of a society's epistemological, esthetic and instrumental striving" (2004: 21). Taken together, the interplay of science, society, politics and the object of their common dissent, hES cells, appears as a vague choreography of "hybrid languages" engaged in a culture of divisiveness (Jasanoff, 2004: 21).

This incongruence reflects different frames of understanding and circumstance. Claims of reliance and conclusiveness on the part of one argument often do not reflect the questions, concerns, interests, or cares of alternative positions. Values shape the questions. To carry this issue further, Sandra Harding has written,

> Moreover cultures have different interests in the environments with which they interact. Even what is apparently the same environment… can be the object of different questions by different cultures…. Cultures' different locations in nature's order and their different interests in their environments will lead them to…develop different repositories of knowledge about nature's order. Since a culture's preoccupation with one set of environmental issues can lead it to ignore others, bodies of systematic knowledge are always accompanied by bodies of systematic ignorance: the two are always co-produced (2000: 130).

This discussion of knowledge systems and cultures of difference that perfuse this controversy has set a background onto which a core set of questions need to be addressed. What is it that dictates how each of us validates, relates with, or uses scientific fact claims? Or, how is scientific information practically realized among the actants involved in this controversy? Who is empowered through knowledge, and to what ends? What are the component parts of these groups that shape the way they engage with this debate? Ultimately, what is the Archimedean point from which this behemoth controversy is able to move constructively toward a framework of common knowledge? Who holds the fulcrum? These questions formulate the social, political, and scientific constructions of knowledge, what I will come to refer to as their "dimension of interpretation", in this controversy over hES cell research. Admittedly broad in scope and inherently incomplete, these perspectives provide insight into important normative reference points used by these groups as they engage this scientific controversy. The following analyses are an attempt to clarify and ameliorate the pathologic understandings in this controversy over hES cell research.

The Social Domain of Interpretation

> Science is but another word for hope and hope stands on tippy toes
> looking for healing, looking for cures, searching for the ideal.
> ~ Immanuel Cleaver, Methodist minister from Missouri

As technological advancement continues to escalate in potency and impact, the consequent involvement and interest by ever increasing segments of society has become evident. Although scientists as well as politicians take on aspects of social engagement in this debate, their personal (scientific or political) interests, positions of influence, and localized bodies of knowledge separate them significantly from the lay public. The lay public engages this controversy through varying venues, from discussions around the dinner table to involvement in social advocacy groups. At the forefront of these debates are several non-profit interests groups seeking to educate and persuade the public as well as engage legislators on policy-related matters at the national level.

The Center for Genetics and Society, a pro-choice group advocating hES cell research, has attempted to summarize public opinion regarding hES cell research in a recent survey. According to this report, polls indicate that 56% "strongly support embryonic stem cell research in general." Furthermore, 68% "strongly support expanded federal funding of human embryonic stem cell research," and 52-63% expressed "strong opposition to President Bush's veto [of HR 810]."[6] These statistics were supported by a recent study of infertile couples who used IVF in which it was observed that "more than half of the couples in the present investigation were open to the idea of embryo donation for… stem cell research (56.5%)" (Bangsboll, 2004). Set with a backdrop of over thirty years of history filled with deliberations about hES cells, society still finds itself seeking clarity among the complex dilemmas raised by the tensions of moral and ethical values as well as scientific and medical hopes. Adding to this various social evolutions (e.g. access to knowledge by the internet and media) have changed society's engagement with science and politics to the extent that it is now a significant force of influence in matters of decision making. Rather than simply a receptacle of scientific and political output, society has become actively engaged in formulating decisions in these arenas (Epstein, 1996).

Society and the Modern Scientific Project

The motivation for science to engage in hES cell research is reflected in the grand human endeavor of the scientific project. Human ES cells provide the potential for researchers to investigate potential cell based treatments for numerous pathologies, carry out assays for drug discovery, and understand important mechanisms of human development. In other words, the driving force motivating this research is found in the purposeful end of understanding the earliest stages of human development and potentially allaying human maladies. The issue of hES cell research strikes a common nerve in the indelible desire to address questions of human corporeal identity and the desire to protect human health. Whether in support or opposition to this type of research, few if any would argue with this noble goal. Similarly, in writing on the importance of grasping the larger purpose of scientific innovation, Langdon Winner writes, "If our moral and political language for evaluating technology includes only categories having to do with tools and uses, if it does not include attention to the *meaning of the designs* and arrangements of our artifacts, then we will be blinded to much that is intellectually and practically crucial" (1986: 25).[7] Sheila Jasanoff similarly writes, "increasingly, the realities of human experience emerge as the joint achievements of scientific, technical and social enterprise. Science and society, in a word, are *co-produced,* each underwriting the other's existence" (2004: 17). At this juncture, it is important to recognize the central position society holds relative to the ultimate purposes of hES cell research. The question then stands, if society is so important in the goals of this research, what potential does it hold for steering this controversy toward common understanding? Are society's hands gripping the fulcrum of change?

A Brief Historiography of Science and Society

Dealing with this challenging question requires stepping back into history to derive a holistic understanding on which to establish this social narrative. As far back as the seventeenth century Bacon and Descartes touted science as the "the primary good and the foundation of all other goods of this life." These Enlightenment thinkers together with Jefferson and Voltaire engaged the modern scientific project with optimism, presuming that all good (social, economic, medical etc.) would naturally flow from continued innovation. This mentality was evident even

during the great depression. “The prestige of science was colossal,” writes Frederick Allen (1931). “The man in the street and the woman in the kitchen, confronted on every hand with the new machines and devices which they owed to the laboratory, were ready to believe that science could accomplish almost anything” (Kleinman, 1995: 54). Motivated by significant advancements in science during the Second World War, this ideology underwent an official modern reframing in 1945 when Vannevar Bush published his famous report S*cience, The Endless Frontier*. The program prescribed the linking of scientific endeavor on one end with beneficial outcomes for humanity on the other. Over the course of time the culmination of this project has been witnessed in various forms: the polio vaccine, the Hubbell telescope, the cloning of Dolly the sheep. Speaking of the seemingly unavoidable connectedness between human affairs and science-based technology, Daniel Sarewitz writes,

> There are optimists who view this achievement as the salvation of the specifics and pessimists who portray it as a disaster-in-progress, but few if any would argue with the observation itself. Neither would many suggest that we have arrived at utopia. But the idea that some desirable type of steady-state if metastable condition for humanity may actually be within reach has in fact taken hold of optimists and pessimists like, as embodied in the environmental and economic concept of sustainability, the political ideal of “the end of history,” and the technologists vision of nature as infinite cornucopia and the human life span as infinitely extendable. That such ambitions can be taken seriously and exist simultaneously in our jaded and hypersophisticated age is strong confirmation that the Enlightenment program for science has fulfilled its ambitions (2000: 90).[8]

This Enlightenment mentality has continued to pervade social thought regarding the role of scientific research in society. In the current case, some consider hES cells as the panacea of all human maladies. Reflecting this ideology in a recent appearance before Congress, Reverend Cleaver articulated the widespread understanding in society that science is “but another name for hope”, a discipline or domain of practical art capable of delivering the human race from the threat of disease and death. Such optimism is not universally accepted. Those of the alternative persuasion, fearing the negative social impacts of scientific innovation, affirm the Shakespearean

exclamation from which Aldous Huxley derived his novel's title, "O brave new world that has such people in't!" In either case, Enlightenment mentalities have formed society's conceptions of scientific innovation. Taking this narrative into consideration, it is important to ask how such a culturally embedded idiom as described in the Enlightenment project affects society's ability to engage controversial scientific issues. This question is of particular salience as we consider the debate over hES cell research.

The Epistemic Infrastructure of Science in Society

Taking this Enlightenment mentality into consideration there are several issues regarding how society understands and validates its knowledge concerning scientific data. What inhibits society from being able to introduce a table of common understanding in this controversy? Briefly, these social issues include a general lack of serious interest in scientific knowledge, dependence on deracinated scientific fact claims and susceptibility to scientific misinformation, and diversity in fundamental moral inclinations.

Scientific Ignorance

Recognizing the central position of scientific information in this controversy, it is important to start this discussion by addressing the larger picture of how society validates and determines the limits of scientific knowledge. To begin, how invested is society in acquiring scientific knowledge? How does society acquire and validate scientific information? Is society able to use scientific facts as a mechanism of formulating a system of common knowledge in this controversy? In general society lacks essential motivation for acquiring scientific knowledge in this controversy. Proper scientific knowledge is separated from the social understanding of this controversy causing a dramatic dislocation of valuable scientific information from the social domain of interpretation. It is a matter of irony, in fact, that gaining systematic knowledge in moral arguments, politics, or what have you is co-produced with systematic ignorance in basic and essential scientific knowledge (Winickoff, 2005). At the cost of being informed of basic science, society has been caught up in arguing on behalf of treating Alzheimer's, watching the political rigamarole, and empathizing with families of snowflake children[9]. Dorothy Nelkin, in

writing on scientific controversies, has articulated the dynamics of energy distribution within society regarding scientific issues, saying:

> …only about five percent of American adults are both attentive to science policy issues and sufficiently literate scientifically to understand and assess the arguments underlying the disputes. Thus disputes often have less to do with specific technical details than with broad political issues: They represent the growing polarization between those who see scientific and technological developments as essential to social progress and those who see these developments as driven by political or economic interests; between those with programmatic agendas seeking to implement specific goals and those with moral lenses concerned about accountability, responsibility, and rights….. Protests may be less against specific technological decisions than against the declining capacity of citizens to shape policies that affect their interests; less against science than against the use of scientific rhetoric to mask political or moral choices (1995: 447).

Society's attention has been shifted. Perhaps scientific knowledge is too esoteric and unpalatable. Diverting attention to matters of public policy or personal moral concern with a "good enough" understanding of the science is sufficient for members of society to feel engaged with this controversy. This is the epitome of differences in situated understanding, described by Joseph Dumit as "uneven flows of knowledge and contradictory versions of acceptability and legitimacy" (2004: 146). In contrast, I hope it will become increasingly clear that accurate scientific knowledge is an essential first step in attaining rights for involvement in this debate. Divergent diatribes on morality and policy are only beneficial when articulated within a proper framework of scientific knowledge. Society's negligence or, to be more generous, lack of access to properly construed scientific facts inhibits its ability to grasp the issues of this controversy with sufficient clarity. Clearly, society's scientific epistemology cannot be a catalyst for forming a system of common understanding.

Science Deracinated and Social Vulnerability to Misinformation

To explore this issue of society's inherent distance from the origins of scientific knowledge, it is worth exploring how society receives scientific information in the first place. Aside from the minority few who seek out authentic scientific data of their own volition, the lay public in general is dependent on sources of translation, primarily the media. Exploring the role of the media in this relationship is beyond the scope of this paper, but it can be fairly assumed that society's dependence on media sources for scientific information is unequivocal. Society is not particularly interested in the esoteric nature of the primary scientific literature. As a consequence of the inherent lack of scientific know-how on the part of the public, scientific data is necessarily stripped of context (e.g. the known limits and validity of such conclusions) in the process of simplification. Put succinctly, scientific facts claims are deracinated upon delivery to the public sphere. This brings us to one of Bruno Latour's well known observations regarding the dynamics of how statements (scientific assertions, for example) move from their point of origin into other contextual frameworks. "The *force* with which a speaker makes a statement is never enough, *in the beginning*, to predict the path that the statement will follow," he writes. "This path depends on what successive listeners do with the statement" (1991: 104). So the question is: can deracinated scientific information delivered through the media be trusted and, secondly, with the lack of scientific know-how, can society come to a proper understanding of the scientific information which underpins the core of this controversy? It is safe to say that there is a significant disjunction between the origins of scientific information (e.g. the primary scientific literature) and its decontextualized reception on the part of the public. As a consequence of this relationship, in order for members of society to engage in this debate they are inextricably forced to adhere to "trusted" sources of this translated information, the truth of which can at times be put into question.

An example of this transmuted scientific information emerged during in an interview with Dr. Sue O'Shea, director of the University of Michigan Center for Human Embryonic Stem Cell Research. She mentioned that on repeated occasions when speaking at public forums on hES cell research members of the community who opposed this research were outspoken about the problem of deriving these stem cells from human "abortuses" (2007). This is one of the widespread misconceptions. In fact, hES cells used in research are derived from donated *in vitro*

fertilization embryos. Whether or not opinions on hES cell research hinge on this particular point is beside the point. Looking at the broader picture Dr. O'Shea went on to say, "People have been really successful saying that hES cells come from aborted fetuses and cord blood makes every cell type and fat makes every cell type and it's just not true." General misunderstandings of this sort pervade social thought regarding this controversial issue.

Local and national media sources have also been a source of public misinformation regarding stem cells. In an article published by the San-Diego Union Tribune in May of 2006 entitled, "Words that Divide: Stem cell debate is semantical minefield" it was noted that "even after 30 years of research, successes with adult stem cells have been limited primarily to treatment of some blood cell disorders" (Kalichman, 2006). A recent article in the Wall Street Journal entitled "Six Stem Cell Facts" similarly wrote that "most treatments derived so far from ASC [Adult Stem Cell] research apply to blood-related diseases…." (George, 2007). The Tribune article ironically went on to say that "our choices of words serve to cloak substantive disagreements and create semantically driven disputes that could be avoided with careful attention to the subtleties of our vocabulary." Here we see poignant examples of the social vulnerability to misinformation. To set the record straight, there have been no clinically approved therapeutic applications (nor clinical trials) of hES cells to date compared to numerous accounts of clinical trials and instituted clinical therapies using adult stem cells to treat various tissue pathologies.[10]

More generally, Collins and Evans have looked at global cases where public misunderstanding of science led to unnecessary and unfortunate outcomes.

> When scientific advisers concluded that the battery additive AD-X2, launched in the mid-1940s, had no significant effect, there was an intense lobbying campaign, supported by both industrial and individual users. This campaign eventually led to the Director of the US National Bureau of Standards, Dr. Allen Austin, being fired. He was subsequently reinstated following protests from the scientific community, and the battery additive was finally withdrawn from sale in the mid-1960s. More recently, Greenpeace, probably feeding on public acclaim for its actions, blocked the disposal of the 'Brent Spar' oil platform, only to have to admit later that its scientific assessment was incorrect. Similarly, citizen groups,

> who campaigned in support of Laetrile, a purported cure for cancer that was labeled a hoax by the FDA, seem to have been fooled. More controversially, citizen groups in the USA continue to lobby for creationist science to be taught in schools, while, in the UK…vaccination levels for measles are falling as a result of an alleged link between the triple measles, mumps and rubella (MMR) vaccine and childhood autism which seems to find virtually no support among the scientific community. These observations merely indicate the kind of work and analysis that has to be done before 'the public' as a whole is attributed with expertise (2002: 271).

Even in these cases, where public "experts" were given authority to shape the outcome of scientific endeavors, we see their vulnerability to misunderstanding science. Translating this vulnerability to the generally uninformed lay public serves to amplify the problem. Society cannot be trusted to use its framing of scientific knowledge to formulate a common table of engagement in this controversy over hES cell research.

Considering Morality

Having established that an epistemological approach on the part of society is inappropriate, moving on to a matter more personally attuned to social engagement with this debate, specifically questions of morality, is a more effective approach. To continue from the previous discussion of Enlightenment ideology, it is reasonable to ask: how has society shaped the course of this controversy by means of interpreting the use of hES cell research through the lens of morality? Interestingly, unlike many aspects of scientific experimentation, research using hES cells in both the basic and applied domains of scientific work are situated within a socially constructed moral dilemma. What does it mean for scientists to manipulate the seeds of human potentiality? How do our conceptions of the moral worth of human life, in its nascent or mature state, impact our perspectives on the importance of this research for the sake of human health and wellness? Among the diversity of positions regarding research using hES cells, two moral questions dictate the social domain of this debate; first, what is the moral status of human embryos and, second, what is our moral obligation to the healing imperative? Although

simplified, there seem to be four major positions weighing these questions differently. First, some regard the early stage embryo as not morally equivalent to postnatal human life. Privileging the healing imperative, this group generally does not have moral or ethical qualms with using hES cells for biomedical research. Second, some believe that nascent human life holds "intermediate" moral status. In this case, research should be permitted using hES cells but only with strict regulatory governance to assure that research is conducted in a justified and responsible manner. Third, some believe that an embryo *in utero* has the potential for developing into human life and therefore requires protection (pro-life) whereas the *in vitro* embryo does not have the potential for life and therefore should be justifiably used for research purposes. Fourth, some feel that human life begins at fertilization and therefore any deliberate destruction of an embryo, *in utero* or *in vitro,* is morally unjustified.[11]

These varied positions argue for the fact that scientific questions regarding technical innovations such as hES cells are often framed in the context of moral paradigms within the social dimension of interpretation. The central enigma regards moral constructs of scientific innovations that tie the hands of the lay public, effectively disabling their capacity to establish a substrate of common knowledge in this controversy. Putting aside overt moral differences, we must look at the way human values influence moral arguments. In other words, what usually under girds moral argumentation regarding scientific innovation? One way to address this is by returning to the formulation of "hope" in science expressed by Reverend Cleaver and shared by much of society regarding scientific innovations. This picture, unfortunately, is incomplete. Hope in this context is deceptive optimism and is not the basis for framing moral arguments in the context of scientific innovation. A much more inclusive descriptor is hope's antithesis, fear. Supporting hES cell research, some fear the inability to provide life-saving therapies for loved one's afflicted by tragic diseases. Others opposing this research fear that infringing on the ultimately vulnerable human embryo will guide humanity along the path toward tragic indignities. We are witnessing the increasing power of scientific and medical advances which has brought humanity into what Steve Epstein refers to as "a tight nexus of need and fear" (1996). This tension is accentuated in high stakes science research where governance over the core motives of science (e.g. human health and wellness) may be restricted. Addressing this issue in an excellent analysis of the role of morality in modern science, Yuval Levin writes:

> Avoiding the worst, rather than achieving the best, is the great goal of the moderns, even if we have done a very good job of gilding our gloom with all manner of ornament to avoid becoming jaded and corrupted by a way of life directed most fundamentally to the avoidance of death. We have gilded it, above all, with the language of progress and hope, when in fact no human way of life has ever been more profoundly motivated by fear than our modern science-driven way. Our unique answer to fear, however, is not courage but *techne*, and so our fear does not debilitate us, but rather it moves us to act, and especially to pursue scientific discovery and technological advance (2006: 37).

But this is only the half of it. The emergence of new scientific and technological innovations reflexively allays human fear while raising concern among those who are averse to such solutions (Kass, 1993: 5). What all this comes down to is whether morality and, more essentially, fear are effective ways of engaging this controversy over hES cells to help form a framework of common understanding. Clearly, morality is a central paradigm used in the social domain of interpretation to deal with this debate. Is this a valuable substrate on which to build a system of common understanding? However legitimate these moral arguments may be, they tend to polarize than establish common ground. In fact, moral *diversity* is the consequence of a constant re-construction of our generational moral conceptions. Religious persuasion, personal values, and tradition taught in civic contexts to renew and instruct our moral paradigm are tools by which each generation re-configures its understandings of morality. The convolutions of social convention, in there vast array, are impressed upon us from the same crude beginnings that underlie the ongoing "Sisyphean task" of our social moral education (Levin, 2006: 42). This diversity perfuses social controversies. In a civil society, "there can be no ultimate closure," writes the social theorist Philip Selzinick, "because values reflect existential conditions, which are always subject to change…..Reason takes into account the temptations and limitations of human conduct; therefore it is self-critical and self-limiting. This moderating outcome is also a source of indeterminacy….Certainty is sacrificed to the altar of reason" (1992: 61). To make this issue more complicated, although moral diversity is well tolerated in this libertarian and egalitarian democracy, society becomes very intolerant of counter-arguments when such alternative conceptions of values and morality infringe on personal political goals. This is

especially the case when those goals regard important moral demarcations defining where science ought or ought not to go. Although important for informing public policy, such diverse moral judgments preclude the lay public from using value-driven paradigms of morality to derive a substrate of common understanding within this controversial topic.

Conclusion

Despite the important role society plays in providing purpose to the modern scientific project, there are several clear limitations on the part of the social domain of interpretation that prevent this group from creating a system of common knowledge in this controversy. These include its historically founded microutopian understanding of science, widespread ignorance of scientific issues regarding hES cell research, inextricable need for deracinated scientific information which makes them susceptible to misinformation, and complexities surrounding social moral diversity. "'Science' doesn't have the power to impose itself," writes Annemarie Mol in *The Body Multiple.* "If it spreads this is because there are actors outside the laboratory who associate themselves with it. And they may pick through what is on offer and take bits and pieces" (2003). These fragmented tapestries of conception generated by misrepresentations, misunderstandings, "systems of knowledge", "systems of ignorance"… society's situated knowledge of scientific fact claims limit the potential for the lay public at large to engage this controversy with any coherence.

The Political Domain of Interpretation

> …as a pro life member of congress I have not taken my decision to support this legislation lightly but I have come to the conclusion that being pro life also has to be about caring about those who are living among us with the most challenging conditions and diseases.
> ~ Rep. Jim Langevin (D-RI)

> You see I believe that life begins at conception and that the human embryo is a human life and I believe that it is morally wrong to

> create human life to destroy it for research but I believe that its also morally wrong to take the tax payer dollars of millions of Americans who believe that life begins at conception and use it to fund research that they find morally offensive.
> ~ Rep. Mike Pence (R-IN)

The national landscape of varied societal perspectives reflects the diverse opinions of our government and their legislative embattlements over hES cell research. Problems of moral diversity challenging personal political interests, an intrinsic separation from scientific knowledge creation, and, in some respects, the framing of scientific data in the light of political agendas are common ethnographic methodologies inherent within political culture. These commonalities illustrate the inextricable tether between the politician and the constituent illuminating the way in which the previous discussion of the social domain of interpretation melds significantly with that of the subsequent brief political analysis. Important issues within the political domain of interpretation which I intend to cover include the role of federal funding, political access to expert advice, and the role of language in politics. Despite their importance, these issues also contribute to misunderstandings and misguided judgments within this controversy.

Government, Polity, and Federal Funding

Political leaders are predominantly engaged with this controversy regarding issues of governance. How should embryonic stem cell research be regulated? How does one make legislative decisions regarding federal funding on an issue framed in moral argumentation? How do politicians generate a consensus statement on an issue that invokes language of antithetical absolutes (moral, scientific, ethical, religious, etc)? How effective are legislators in acting as liaisons between groups with vastly different conceptions of scientific knowledge when formulating decisions of science polity? A comprehensive attempt at answering these questions would be ominous, but they bring into focus the immense challenge politicians have in engaging with this highly contested, controversial matter.

Perhaps the issue that ties together much of the legislative engagement with this debate is that of federal funding. Federal funding can be seen as a kind of material-semiotic attribute characterizing a key component of political involvement in this debate. The statement by Rep. Mike Pence (R-IN) illustrates the difficulty of making decisions regarding the allocation of federal funding for matters that are "morally offensive". Furthermore, his thought represents the general absolutist idioms that pervade this controversy from all angles of this debate. Peter Berkowitz, Professor of Law at George Mason University and research fellow at Stanford's Hoover Institution, wrote on the topic of federal funding regarding the controversy of hES cell research in a publication by the President's Council on Bioethics entitled "Monitoring Stem Cell Research".[12] Berkowitz notes that "the debate over stem cell policy calls into question…how to *apply* our shared belief in the rights and dignity of the individual." From the lawmaker's point of view this "application" comes in the form of supporting or opposing the allocation of federal funding for hES cell research. These absolutes that typify arguments in this debate make the establishment of a "*public* policy" over hES cell research a tremendously challenging undertaking.

To address this issue of "public policy", we have to ask ourselves whether it is the aim of liberal democracy to legislate moral beliefs. Questions of morality after all are central to this controversy. The well publicized response to this question in the context of the hES cell debate has been a resounding "no". To the contrary, Berkowitz outlines numerous examples in which imposition of values via legislative enactments has been common place in the formation of governmental polity.[13] To exemplify this, President Bush has noted that his policy "lies at a difficult moral intersection, juxtaposing the need to protect life in all its phases with the prospect of saving and improving life in all its stages."[14] Bush has gone on to articulate how his personal convictions shaped his decisions on this policy:

> Stem cell research is still at an early, uncertain stage, but the hope it offers is amazing: infinitely adaptable human cells to replace damaged or defective tissue and treat a wide variety of diseases. Yet the ethics of medicine are not infinitely adaptable. There is at least one bright line: *We do not end some lives for the medical benefit of others.* For me, this is matter of *conviction*: a *belief* that life,

including early life, is biologically human, genetically distinct and valuable (2001: D13).[15]

Reflecting this discussion of federal funding in this debate over hES cell research, it is important to ask the central question: how does the role of the politician as policy maker and gatekeeper of federal funding affect the way in which this group is able to form a common knowledge system in this debate? Most straightforwardly, establishing a policy does not engineer common knowledge among the varying parties of this controversy. In fact, the absolute way in which sides of the controversy abide to their positions has caused widespread dissatisfaction regarding Bush's policy from groups both supporting and opposing funding for hES cell research. Most consider that the motivation for the policy was some kind of "Solomonic compromise" (Feiler, 2001) whereas the claimed basis of this policy was moral philosophy and "prudential decision-making"[16] as though the latter argument makes the decision somehow more justifiable. The fact is that establishing a policy does not generate occasion for a universally accepted system of understanding. Often, as in this case, it is the substrate for further divisiveness. We can conclude, then, that although politicians retain the definitive and necessary role as policy makers, this power is not engendered with a capacity for subjugating a unified knowledge system.

Experts and the Scientific Epistemology of Politicians

A necessary complement to the role of legislating policy is the access politicians have to expert advisors. When faced with the need to make decisions regarding controversial issues, this is a critical component of the political dimension that significantly separates it from the social dimension's dependence on translated and deracinated knowledge. In each case, people are forced to distill a plethora of information into a position. At face value, access to expert advice places politicians on better footing in making this type of decision. "…Technical expertise is a crucial political resource in all policy conflicts," writes Dorothy Nelkin, "for access to knowledge and the resulting ability to question the data used to legitimize decisions are an essential basis of power and influence" (1995: 452). In this regard, politicians drafting legislation on contentious scientific issues are able to consult directly with scientists engaged at this

research front. However, several matters need to be taken into account in order to understand whether this is really a legitimate foundation.

The first issue to consider is the type of information provided by scientists. In many cases gaining access to information that is not influenced by an agenda or personal interests is hard to attain. Rather than making a policy decision from democratized sources of scientific information, politicians are often strongly influenced by politicized scientific truth claims by scientists who are advocating a particular policy position. This problem was affirmed by Daniel Sarewitz in his writing about the ideal "civic scientists":

> While this ideal is certainly laudatory, as commonly articulated it is also rooted in the assumption that the feeding tube that delivers information from the scientific community to the public just needs to be widened, and it neglects the perhaps more fundamental issues of what type of nourishment, exactly, is being provided… (2000: 96).

Although there is much to be discussed regarding the integrity of scientific advice, it should be evident that the problem does not so much lie with the politician as with the scientist. For this reason, I make this case in brief because it will be a predominant component of my discussion to follow regarding the problem of science.

The second issue is whether politicians adhere to scientific advice when formulating legislation. One of the overtly touted mechanisms of deriving alternative sources of pluripotent stem cells outlined by Rep. Roscoe Bartlett in his legislation (HR 322) is by extraction of a single blastomere[17] from an early embryo, also called embryo biopsy. This technique established within the field of alternative reproductive technologies has been in place for quite some time and is used to carry out prenatal genetic diagnosis (PGD). Rep. Bartlett has been promoting this technique as a non-ethically problematic way of deriving hES cell lines, which indeed they have been found to do (Klimanskaya, 2006: 481). "…the first thing you do with that cell you take out," says Rep. Bartlett, "is to make a repair kit out of it."[18] However, extensive ethical analysis of this protocol has been carried out by scientists at the NIH (Battey, 2007) as well as by the President's Council on Bioethics (2005) who have raised issue with this technique. Specifically, although the technique itself in its perfected state bypasses the prominent ethical issues, that of

destroying human embryos to derive hES cells, this highly technical and very expensive procedure presents a risk to the viability of that embryo. Supporting this assertion, consent forms for PGD often carry the following statement, "We have given a full explanation of the procedure with its *possible benefits and risks* using appended written information to obtain informed consent from the couple desiring preimplantation genetic diagnosis, and we are convinced that the couple have fully understood the explanation" (Takeshita, 2004:19). This very apparent risk runs contrary to the stated purposes of HR 322: "It is the purpose of this Act to…promote the derivation of pluripotent stem cell lines, including from postnatal sources, without creating human embryos for research purposes or discarding, destroying, *or harming a human embryo or fetus*."[19] As a consequence, we are witnessing here a situation in which Rep. Bartlett has been informed by scientists and ethicists as to the incongruities of his legislation and despite this advice avidly continues to push the bill through Congress. If this bill were to pass, some of the core methodologies would not be viable for federal funding because they present some element of risk to the embryo.

The third issue is whether politicians even seek scientific advice when making policy statements. The question is: does a particular scientific finding support a particular policy? Sometimes assumptions are made in this regard which devalues political authority to the level of the social. Similar to the social vulnerability to misconstrued or misunderstood scientific information, politicians are also susceptible to using scientific data to promote an agenda without close regard for the stated conclusions of a study.

One example of this occurred recently when the new democratic congress began discussion on a modified version of the HR 810 legislation, denoted H.R. 3 which, again, sought to expand the number hES cell lines available for scientific research. On the eve of this debate a scientific paper was published in the journal *Nature Biotechnology* entitled "Isolation of amniotic stem cell lines with potential for therapy" by a collaborative group from Harvard and Wake Forest (De Coppi, 2007: 100). The report suggested that stem cells derived from amniotic fluid had similar qualities as hES cells. This study was cited extensively in a counter-report to H.R. 3 issued by the White House Domestic Policy Council entitled *Advancing Stem Cell Science Without Destroying Human Life.*[20] The report argued that "non-embryo destructive" techniques can be used to derive cell lines with similar potential as hES cells. In response to this, researchers involved in the scientific study responded by complaining of the "clear misrepresentation of our

work" in the document. They went on to say, "We are surprised to see our work on reprogramming adult stem cells used to support arguments that research involving human embryonic stem cells is unnecessary. Our work directly involves the use of human embryonic stem cells … [and] is precisely the type of research that is currently being harmed by the president's policy" (Holden, 2007a). This example substantiates the claim that politicians, although capable of generating political policies using expert advice, are vulnerable to manipulation of or inadvertently misunderstanding scientific information in the effort to promote a particular political agenda at the cost of paying close attention to the conclusions of the scientific data they cite. Other contexts in which the aforementioned *Nature Biotechnology* paper has been inappropriately cited include a congressional discussions by Rep. Phil Gingrey (R-GA) (who co-authored HR 322 with Rep Roscoe Bartlett)[21] and in a personal interview with Lisa Wright, Press Secretary for Rep. Roscoe Bartlett (2007). Are politicians really able to formulate proper consensus statements when given access to expert advice? The inherent limitations to the political dimension of interpretation outlined here question the foundation of political decision making.

The Language of Politics

Another example in the political domain parallels what we observed as a social problem: word choice as a mechanism of persuasion. Baltimore Sun reporter Tricia Bishop recently wrote an article entitled, "Word Choices: In the high-stakes world of stem cell research, success or failure can hinge on turn of a phrase" (2007). In this article she articulates how the word "embryo" had been exchanged for the phrase "certain material" in Maryland's 2006 Stem Cell Research Act supporting hES cell research. Sen. Paula C. Hollinger, a Baltimore County Democrat who sponsored the bill, said, "We substituted language that really meant the same thing… It was changed to get votes. ... It was a big win." The article goes on to quote James Greenwood, president of the Biotechnology Industry Organization in Washington and a congressman from 1993-2005 saying, "It's an age-old political tactic to choose words that advance one's cause and disadvantage one's opponent. Words have great impact emotionally and people use them, particularly in the political sphere, accordingly." These mechanisms of semantic manipulation foster distrust and significantly complicate this controversy. Political

power-play by word choice thus precludes the potential for any conflation to this debate via the political dimension of interpretation.

Conclusion

To conclude, political involvement in the debate over hES cell research is necessary and important. The element of policy making places politicians at an important intersection attempting to amalgamate societal and scientific value claims and interest statements into a cohesive polity governing hES cell research. However, formulating legislation is incommensurable with establishing a common frame of understanding in this controversy. In fact, added dimensions of division are often the result of legislated public policy. Second, despite access to expert advice, politicians, similar to members of society, are vulnerable to politicized scientific advice, at times do not adhere to expert advice, and are capable of misunderstanding raw scientific data when generating policy decisions. Lastly, deceptive language on the part of politicians fosters distrust and undermines long term political goals. Although other factors contribute to the political dimension of interpretation, these attributes contribute significantly to political engagement with this debate and consequently limit the capacity for a politically-mediated establishment of common understanding in the debate over hES cell research.

The Scientific Domain of Interpretation

> Recent sociology of science, following sympathetic tendencies in the history and philosophy of science, has shown that no experiment or set of experiments however large, can on its own compel resolution of a point of controversy, or acceptance of a particular fact. ~ Donald Mackenzie (1989: 412)

> On the scientific view of the world, there can be no knowledge…strictly speaking, about the purpose or meaning of human life, about human flourishing, or even about ethics.
> ~ Leon Kass (1993: 16)

What we have at this juncture is a recognition of the inadequacies of social and political domains of interpretation that prevent these groups from forming systems of knowledge for common engagement in this debate over hES cell research. Left with the scientists, we all await some glimmer of hope. But, unfortunately, it is not that easy. In this situation, we are faced once again with a group of experts struggling to understand what it means to engage effectively with this problem. Introducing this section are two quotes that reveal very clearly two of the major limitations in the scientific domain of interpretation that severely inhibit the potential for this field to effectively and beneficially engage this debate. Within the context of this controversy, what are the problems with science? What are the issues at hand at the nexus of scientific knowledge creation, the place from which this technological innovation of human embryonic stem cells was conceived?

Experimentation and the Non-corporeal

To begin, I would like to argue that experimentation, the core of scientific creativity, will not be the mechanism by which scientists are able to convince the political and the social domains regarding the primacy of scientific knowledge in this controversy. Neither those that are pushing for expansion of hES cell research nor those that support the use of alternative sources of pluripotent stem cells will have the fortunate opportunity of witnessing a universal embrace of scientific knowledge come as a result of an experimental finding. Although so much weight is placed on the publication of scientific studies in augmenting the power of argument, there is a growing corpus of literature that argues for the fact that resolving conflicts has never been the result of experimental data. Specifically, Donald MacKenzie notes that "because scientific activity cannot be reduced to an algorithmic set of instructions that can be followed automatically, and always involves tacit skills, the only way of knowing whether an experiment has been competently performed is to know whether it produces the right result. But when the right result is controversial, then the competence of experimentation becomes inextricably bound up with beliefs as regards results" (1989: 412). In the context of a controversy, scientific data can always be brought into question. Was it the right experiment? Was it performed competently? Is it consistent with the broader literature on the subject? Were the methods correct? Have

theoretical assumptions been appropriately applied? Are the artifacts being tested representative of the actually representative of the "thing in the context of reality"? In a controversy, the terms 'correct results' and 'successful' become subjective claims which can be devalued or hyperbolized by actants of contrary opinions. This finding significantly debilitates scientific involvement in this controversy. Experimentation, after all, is a core aspect of the ontology of the scientific project. If you take away experimentation what is left? Broadening our perspective of science, we are forced to look closely at the larger scientific engagement with society.

We have already established that some of the major issues related to the social and political domains of interpretation are connected to the issues of morality and ethics. If social adherence to moral arguments is one of the sources of divisiveness in this controversy and if science is our last crutch for generating agreement then how does the scientific domain of interpretation address this matter of moral disjoint? To echo the insight of Leon Kass, science in its intrinsic nature cannot speak to moral implications of scientific work. In other words, it cannot speak to those things that are inherent components of the social argument.

Looking holistically at the scientific project, it can be said that experimentation cannot solve non-empirically defined questions -- questions of morals, ethics, and the non-corporeal. "Science can only ascertain what is, but not what should be," Albert Einstein said, "and outside of its domain value judgments of all kinds remain necessary."[22] This is certainly not to say that science is morally neutral. Many argue that scientists "wear…neutrality as a badge of honor, presenting themselves as disinterested servants of truth who merely supply society with facts and tools" (Levin, 2006: 32). Taking science to mean '*members of society* engaged in the creative discovery of the empirical' brings into focus that morality, and the same absolute commitments to argument are alive in those people engaged in scientific work. In fact, their adherence to such moral arguments is supplemented by their unique niche of scientific knowledge and is often augmented by the significant interests scientists have in acquiring federal research funding. This is affirmed by Sarewitz et al who have noted that "science is *always* applied within a broader problem context. Put somewhat differently, when it comes to social problems, science cannot *solve* anything; science works within a broader set of social, cultural, political, and economic conditions in contributing to solutions and problems" (2004: 68). Taking the picture as a whole, we are left with a realization that science in its experimental phase cannot address matters of

moral significance in this controversy. Furthermore, scientists, as members of society, are also persuaded in an equally divisive way to arguments of morality concerning hES cell research.

The Politicization of Science

To make the situation worse, scientists have diminished the potency of their expertise as a consequence of direct politicization of scientific findings. What does this mean? Promoting scientific knowledge claims as the means to formulating policy, the so-called "linear model" (Pielke, 2006: 30), places the scientist at a privileged position. Although this approach is still common practice in science policy, ample evidence e.g. the environmental controversy (Pielke, 2007), has shown that this strategy does not work. The linear model generates a system in which politics is brought into science rather than the alternative approach wherein science shapes policy -- a subtle but very important difference. Roger Pielke, in his excellent work *When Scientists Politicize Science,* summarizes this idea well in writing,

> The problem exists when…scientists implicitly or explicitly equate scientific arguments with political arguments, and in the process reinforce a simplistic and misleading view of how science supports policy. In the process, they damage the potential positive contributions of their own special expertise to effective decision-making. Scientists seeking political victories through science may find this strategy expedient in the short term, but over the long run it may diminish the constructive role that scientific expertise can play in the policy process (2006: 30).

Indeed, there is a strong tendency for scientists to project interests from the social and political domains onto science and then to subsequently turn around and use science as a proxy for political and social persuasion. Unfortunately, decision makers involved with the practicality of policy are confounded by the inextricable connectedness of science, politics, and society. Seeing this weakness, scientists are prone to fall in line with political and social agendas and parochial interests, thus adding to the gridlock. "Such cases of conflation," Pielke goes on to say, "limit the role of science in the development of creative and feasible policy options. In many

instances, science…has become little more than a mechanism of marketing competing political agendas, and scientists have become leading members of the advertising campaigns" (2006: 28). Although scientists have an interest in the political and social outcomes of policy regarding hES cell research, their involvement often directly reflects the fray of controversy in their tendency to politicize science. Consequently, they limit their ability to engage effectively with the debate to help generate a system of common knowledge.

Integrity in Science

Although there seems to be a general understanding of science as the means to allay the threat of disease and death, there is a parallel sentiment of distrust concerning the scientific project. Cases such as the Tuskegee Syphilis experiments (1932-1972) to the discovery of fabricated data in publications by the Nobel Laureate David Baltimore in 1986 have contributed to the ongoing distrust of scientific autonomy. Scientific practice in the field of stem cell science, especially of late, has affirmed this concern.

In 2004 a research group from South Korea published a study entitled "Evidence of a Pluripotent Human Embryonic Stem Cell Line Derived from a Cloned Blastocyst", which as the title denotes was the first successful attempt at cloning human embryonic stem cells (Hwang, 2004). One year later this study was followed by a report entitled "Patient-Specific Embryonic Stem Cells Derived from Human SCNT Blastocysts" which claimed that this group was able to derive hES cell lines from diseased patients (Hwang, 2005). These studies were enormous breakthroughs in the field of hES cell research by generating ideal experimental models for studying disease pathogenesis and for screening novel therapeutic drugs. After further investigation from the scientific community, it was determined that both of these papers were comprised of fabricated data (Normile, 2005; Chong, 2006; Wohn, 2006).

At the edge of such a controversial issue, claims of this sort make members of the public wonder if the often touted 'self-governance' of science is reality or merely a façade. Is the peer-review process working as it should? Does science have the capacity to retain the integrity it has claimed for so long? If it's so easy to derive data to build on some scientific/political agenda, how are we to believe any other assertion formulated by science? Such events are not exclusive to the field of hES cell research.

Another example has recently been uncovered in the field of adult tissue derived stem cell research. A 2002 landmark report by Catherine Verfaillie in the prominent scientific journal *Nature* entitled "Pluripotency of mesenchymal stem cells derived from adult marrow" described a population of stem cells, termed multipotent adult progenitor cells (MAPCs) that have the potential of differentiating into most cell types in the body (Jiang, 2002). A recent investigation into this work found that data had "inadvertently" been duplicated between this *Nature* paper and a different paper from the same group published in the journal *Experimental Hematology* (Jiang, 2002). Within the scientific community there is controversy as to whether this finding changes the conclusions of the paper (Holden, 2007b, c). There is little question, though, that this type of news leaves an impression of concern and dismayed scrutiny on the part of public opinion.

The widely held perspective of science as the "neutral arbiter of truth" comes into question with these scenarios (Nelking, 1995). Is science as objective as it appears? In her analysis of controversy in science, Dorothy Nelkin has noted that "controversies over science and technology represent in part a loss of public trust, a declining faith in the ability of representative institutions to serve the public interest. Critics are asking about research priorities: Is science for the public or simply for the advancement of scientific careers?" (Nelkin, 1995: 450). It comes down to a matter of scientific credibility, which is vulnerably exposed in cases such as this. To what extent does the tacit relationship between science and society need a re-evaluation? In such high stakes science, there is a temptation to make the border between science porous to the diluting influences of political and social persuasion. In this debate over hES cells, scientific knowledge is commodified. It is a resource of power that can easily slip from the hands of its creators if political and social agendas dictate its formulations.

Scientists and Alternative Worldviews

Lastly, scientist's lack of proper regard for alternative viewpoints, at times construes them as uninformed or counter productive. Not acknowledging or respecting other worldviews is a way of devaluing traditions and cultures that significantly shape people's understandings of this controversy. It is an effort at subjugating these groups to what Sandra Harding refers to as the "universality ideal" (Harding, 2000). According to Harding, the universality ideal "asserts that it is desirable for everyone to acknowledge the legitimacy of one culture's… claim to

provide the one true account of the world." In the case of the scientists, one may consider the politicization of scientific conclusions as a larger symptom of an underlying issue – that of bias toward one particular viewpoint. To exemplify this, recent written correspondence with a prominent scientist[23] and activist in the hES cell debate responded to a question regarding public misunderstandings in the controversy saying that people "do not understand that a five day old blastocyst consists of about 200 cells, comprising the trophectoderm and the inner cell mass--*a far cry from a fully developed human being.*" Accepting the fact that there are misunderstandings of where hES cells are derived, what becomes evident in this articulation is the disregard expressed by the scientist concerning the larger moral conceptions of human life. More specifically, this statement does not recognize that some members of the public do actually understand the details of deriving hES cells and yet are oppose it on the moral grounds that nascent human life ought to be respected. The air of flippancy expressed in "a far cry from" illustrates the scientists own either misunderstanding or flagrant disregard for one of the major social concerns for the moral worth of the human embryo. At the same time, a reflexive sense of authoritarianism emerges in this statement supporting the universalistic advocacy position of the scientist. "The universality ideal promotes only narrow conceptions of both nature and science," writes Harding. "It blocks our ability to bring into focus the social elements – institutions, practices, meanings – in what are often presented as merely natural, scientific, and technological change." A public survey by the Virginia commonwealth University Life Sciences revealed science's moral disregard to be a wide spread public concern.[24]

Q. "Scientific research these days doesn't pay enough attention to the moral values of society."	All U.S.	Religious	Not Religious	Not Informed on Science	Very Informed on Science
Strongly or Somewhat Agree	72%	78%	54%	78%	55%
Strongly or Somewhat Disagree	23%	17%	39%	14%	40%

What is revealed by this survey is that regardless of religious affiliation or relative understanding of science, all groups have a majority who consider science to be morally deprived. Consequently, scientists as respected members of this controversy undermine the capacity for productive relationship building with other sectors of this debate by diminishing alternative worldviews and perspectives.

Conclusion

Despite their critical role as knowledge creators, scientists are also afflicted with numerous issues disabling their capacity to act effectively in formulating a common knowledge system. Scientists, after all, predominantly exist within the intellectual and practical domain of hypotheses, experimentation, and data analysis. This is the core of their expertise and one of the significant ways they shape social discussion over hES cell research. But we have come to see that experimentation is incapable of dealing with non-empirical questions of morality and ethics. In addition, scientists undermine their ability to engage with the public in this debate by politicizing scientific information on behalf of certain agendas. Their questionable integrity and general lack of regard for alternative worldviews further ostracizes the scientific community from the public. Finding the scientific domain of interpretation to be a world in itself struggling to impact this controversy, we are once again brought back to the question of how a common system of knowledge and understanding can be achieved.

A Universally Pathologic Episteme

The social, political, and scientific domains of interpretation in this debate over hES cell research are equally plagued by enormous problems that significantly inhibit their ability to formulate a common substrate of knowledge in this debate. At this stage, it should be clear that this is not an argument for any kind of scientific hegemony. The playing field, in fact, seems equal in undulations and perturbations between these three groups. Overall, this debate over hES cell research is plagued by diseased ways of thinking, validating truth claims, and arbitration. The social constituent is inexorably relegated to third hand deracinated knowledge claims, fettered by a bipolar love-hate relationship with scientific innovations, and divided in all directions by absolute adherence to incommensurable moral suasions. The political front, the elected voice of the public, is tethered to the unenvied act of formulating scrutinized and often universally disagreed upon legislation, but legislation nonetheless that is intended to meet *your* needs, fiscally and morally speaking. Lastly, scientists are a motley sort with social and political credibility under question, whose experimental ingenuity is impotent to address non-empirical

social questions of morality, ethics, and humanity, and whose self-interest in this debate provides easy access for social and political agendas. We can only improve from here.

What I propose next is not a wholesale revolutionary plan that will lead to the eradication of this debate from social, political, or scientific agendas. What is to follow is a modest effort at reconceptualizing the role of scientists in this debate with the hope of moving forward somewhat in the direction of forming an effective construction of common knowledge. Before proceeding, we are wise to listen to Descartes' insight to "go so slowly, and to use such caution in all things that, even if I went forward only very little, I would at least avoid falling" (1637/1998). In this quagmire we haven't got many other options.

The Praxis of Scientific Epistemology as a System of Common Knowledge

> The unknown threatens continually to engulf the known, and action becomes impossible unless ground rules are laid for how much and what kinds of evidence are needed to justify collective action. ~ Sheila Jasanoff (2005: 267)

In recent decades, efforts within the field of science and technology studies have effectively deconstructed the claim: "trust scientists because they have special access to the truth" (Kuhn, 1962/1996; Bloor, 1991; Collins and Evans, 2002). The Elysion[25] of scientific authoritarianism has been replaced by a more inclusive paradigm that acknowledges the contributive value of non-traditional experts (Wynne, 1996; Epstein, 1996). In larger social controversies such as that over hES cell research, this is undeniable. Expertise provided by social interest groups, policy makers, and the like are important and valuable in this ongoing dialogue.[26] Taking this into consideration, I return to my original premise: despite continual efforts at deliberation, different groups engaged in this controversy lack altogether an effective substrate of knowledge on which to build legitimate lines of argumentation. Thus, we are still in need of a common system of understanding.

Having already covered the broad scope of issues intertwined in the tapestry of this debate, I want to argue that it is the praxis of scientific epistemology that sits at the nexus of concord among the diverse constituents of this controversy. Returning to the fundamentals will

help make this clearer. Epistemology is defined as "the study or a theory of the nature and grounds of knowledge especially with reference to its limits and validity."[27] The latter portion of this definition is of significant importance because it is what enables scientists to distinguish the extent of validity and power in proposed truth claims. More specifically, scientists at the core of a research paradigm have exclusive rights to the practice of scientific knowledge creation, a situated knowledge if you will, which places them at a critical point of intersection between scientific innovations and public engagement.[28] The forthcoming discussion seeks to elaborate on the thesis that scientists, as a gateway to scientific knowledge, are positioned uniquely to disseminate a system of common understanding. From this substrate, groups involved in this controversy are enabled to engage more effectively in dialogue by formulating scientifically substantiated arguments. Daniel Kleinman has articulated the importance of finding this system of common understanding, "agreement on terms", when seeking productive debate:

> The exercise in clarification will, I hope, make evident that productive debate on the issues of citizen participation in the realm of science and technology depends on agreement on terms. It is certainly possible for debate participants to oppose any democratic involvement in matters of science and technology; however, if discussants are operating with different definitions then disagreement may be the result of misunderstanding rather than divergent values or assessments (2000: 139).

It is easy enough to recognize that scientists alone are unable to formulate this common table of deliberation. All groups have equal responsibility in this construction. However, I want to make it clear that in order to even have the potential for this common understanding a properly construed scientific basis regarding language and terminology of necessary fact claims stands as are pre-requisite. In order for this to occur, scientists need to take responsibility to act as honest intermediaries. Using this frame, the praxis of scientific epistemology will hopefully make evident the critical role of the scientist in generating our sought after common system of understanding. "Intransigent social problems," writes Sheila Jasanoff, "seldom yield to resolution without changes in existing structures of knowledge" (2004: 21). This is a proposal for a very specific change in the structure of knowledge surrounding the debate over hES cells.

Establishing a common system of scientific understanding will compel this debate in the direction of productive deliberation. Given this system of knowledge, we can then move outward in the direction of applied questions such as morality and politics, which then reflexively feed back on science in what Jasanoff refers to as the co-production of science and society. The integrity of this relationship, however, requires the emergence and stabilization of knowledge. How this is achieved will be made clear in this analysis of the praxis of scientific epistemology as a system of common knowledge.

The Role of Scientists as Honest Intermediaries

Before engaging in this discussion, it is important to start with acknowledging the reality that the conception of the scientist as "objective" or as "honest arbiter of truth" has joined the path of scientific authoritarianism in the grave of retired paradigms (Levin, 2006; Daston and Galison, 1992). What does this do to my premise that scientists need to take responsibility as honest intermediaries in this controversy over hES cell research? Perhaps what I have to say here is that the paradigm is not wholly lost, it is simply time for a re-evaluation of the role of the scientist in the context of public engagement.

Let me begin by overtly saying that deriving a common system of understanding in this debate *requires* a reconfiguration of the role of the scientist as an honest intermediary. Why, exactly, is this the case? In its basic framework, it is the epistemic authority of science that enables scientists to engage this debate at a crucial point of vulnerability wherein they are able to re-establish the veridicality of scientific knowledge in the public domain. In other words, scientists hold the unique capacity and responsibility to carry out the practical art of scientific knowledge creation *and* see it properly disseminated from the knowledge core. Again, this is not an argument for some hegemonic power claim on the behalf of scientists. This is a practical analysis of a crucial juncture in this controversy wherein I believe scientists are able to direct the debate toward deliberation within a system of common understanding.

The scientist understood as a 'moral' 'social agent', however, clearly deconstructs their formerly assumed ability to act as objective arbiters of truth. How is this discounted conception of the scientist different from my proposal for the scientist to act as an honest intermediary? As opposed to seeking absolute objectivity in the voice of the scientist, the honest intermediary

seeks to engage diversity with equanimity in the portrayal of scientific conclusions. Beyond simply understanding the limits and value of the core knowledge of science, the honest intermediary also recognizes the value of a properly construed or democratized basis of scientific understanding on the part of the public. To understand this more, we can use Collins and Evans depictions of contributive and interactional expertise.[29] Specifically, scientists, by nature of their role as creators of knowledge, have contributive expertise which must act in synchrony with their equally important role as interactional experts; that is: properly and effectively communicating scientific information to non-science actors. Before proceeding, let me say why exactly interactional expertise is of any importance in the idiom of the scientist as an honest intermediary. After all, my premise has predominantly focused on the importance of establishing a system of common *scientific* knowledge. However, even as scientists make efforts at accepting the limits and validity of emerging scientific data, such knowledge remains inert at the worst, or at least continually misconstrued and inappropriately decontextualized by the lay public in their continual efforts at translation. Furthermore, issues of 'politicization, 'credibility', 'politics', and 'morality' framed in the context of science or scientific innovation all assume some kind of interactional reciprocity in the relationship between science and the public. Thus, it is of equal importance that scientists engage the interactional component as honest intermediaries in order to fulfill the need of promoting a system of common understanding.

The Democratization of Scientific Facts

> Honest brokers of policy options can help to distinguish responsibility for the provision of information from the act of deciding on a particular course of action. ~ Roger Pielke (2006: 34)

To begin this discussion of scientists as honest intermediaries, I want to propose that scientists need to be equable in their analysis of emerging scientific data. Returning to the praxis of scientific epistemology, scientists need to ask questions concerning the limits and validity of scientific knowledge. Among scientists there is always variability in the weight each places on a particular conclusion. Questions arise around the value and power of specific methodologies and

the cumulative impact of the data all of which shape the final analysis of a particular investigator. Is such diversity counter-productive to forming a common system of knowledge usable by the public? I want to argue that diversity in this case, a perfect reflection of the humanness of scientists, brings scientific knowledge into relief. Scientific knowledge, after all, is not flat or "aseptic" -- objectively pure, if you will. The true democratization of scientific information by scientists forms a rich and dynamic portrait of scientific knowledge pertinent for proper understanding of and engagement with scientific innovations among all domains of interpretation engaged in this controversy. Roger Pielke has articulated this idea well in writing:

> …communication of what [a scientific] result means is not the same as assessment of what it signifies for alternative courses of action. The latter is the essence of policy advice…. For science, a *policy perspective* implies increasing or elucidating the range of alternatives available to decision-makers by clearly associating the existing state of scientific knowledge with a range of choices. The goal is to enhance freedom of choice. By contrast, a *political perspective* seeks to decrease the range of alternatives (often to a single preferred option) available to policymakers (2006: 34).[30]

Consider the approach of democratizing scientific knowledge by scientists in contrast to the approaches taken by members of society and political members engaged in this debate. Lay citizenry and policy makers alike aim toward *narrowing options* or *limiting the scope of choice* in order to take a specific position or to advocate a particular unifying policy, similar to the "political perspective" quoted above. In order for policy makers and society at large to accomplish this task in a way that honestly reflects the issues at hand, I am arguing for scientists to take on the role of being equitable and honest advocates of emerging scientific knowledge.

The Value of Science Studies in Scientific Interactional Expertise

> Specialized knowledge is indispensable everywhere, of course, but knowledge alone is not synonymous with expertise. The expert is a social kind…a kind of person who not only provides information

> but satisfies the desire for order in the management of uncertainty. Experts therefore have to be accountable as well as knowledgeable. How do they meet this double demand? ~ Sheila Jasanoff (2005: 267)

As we consider the point at which scientific knowledge comes into contact with the public, we are forced to question what kind of information the public is expected to absorb. How does one define what information is necessary for proper public uptake? This question alone is beyond the scope of this paper, but it is raised to illustrate the need for scientists in their role as interactional experts, to consider the way in which to disseminate scientific information. A common system of understanding is what I am promoting, after all. To bring clarity to this we need to define 'understanding'. Among the various definitions given, the term "understanding" is defined as "accept[ing] as a fact or truth or regard as plausible *without* utter certainty."[31] Absolute knowledge of scientific information in this debate from all groups is inconceivable and unnecessary. What is an equitable expectation? To illustrate this I want to return to the correspondence I carried out with a prominent scientist and activist in the hES cell debate. Again, in response to the question regarding public misunderstandings in the controversy he wrote, "In my experience, both groups [politicians and the lay public] lack a basic understanding of the biology of early human development and cell specification." Is a decision to support or oppose hES cell research contingent on understanding cell specification or the intricacies of early human development? In this obtuse way I would say, no. But, framed differently one must say, yes. Considering the teleology[32] of early human embryonic development or the ontological choreography of human embryos in infertility clinics (Cussins, 1996) provide contextualized scientific knowledge situated in important metaphysical paradigms. This is the crux of science's engagement with society. There is meaning in the substance of science which speaks to the human conscience and which helps the lay citizen formulate conceptions of right and wrong from within the fray of scientific knowledge creation. But what is it specifically that enables science to be conveyed properly to the laity? Is there a strategy by which scientists can be equipped to be interactional experts?

Before addressing these important questions, I want to introduce Collins and Evans' idea of "referred expertise" (2002). They define this group as "expertise in one field [that] can be

applied in another." It is at this juncture that I feel compelled to introduce the science studies community which has long sought to understand the process of knowledge creation and it's pertinence within the social domain, for which this paper is a case in point. What I want to make an argument for is the importance of referred expertise on the part of the science studies community as knowledge experts which may be of significant importance to scientists in understanding their role as interactional experts. Although there has been some emergence of this phenomenon, the intercalation of science and technology studies with basic science research has rarely occurred and with limited effectiveness. Although this concept may seem self-evident, its practice is intriguingly difficult. What I believe is of critical importance is the education of the scientist as interactional expert by means of the science studies expert. In this way, other cases in which major scientific innovations have required some capacity for interactional expertise with the lay public, such as the genetically modified food controversy (Winickoff, 2005: 115), have called for panels of experts to seek out relevant sources of knowledge in which social dynamics have been studied in the context of scientific innovation. These studies have predominantly been published in the science and technology studies literature. Although basic science research journals often publish articles involving the social or political issues of a controversy, the in-depth analyses have predominantly been constrained to their own journals and texts. This inherent separation of the primary literature makes it difficult for engagement between these related fields. I want to highlight the relatedness of these disciplines and the need for interaction particularly within the context of socially and politically contentious science.

Supporting this premis in his work on PET scanning, Joseph Dumit wrote that his study was an effort "to understand how the meaning of facts change – how we are never simply handed the facts but are continually faced with facts-in-the-world and continually judging the status and relative worth of them for ourselves" (2004: 159). Illustrated here is the challenge set before the scientific community in terms of the importance of context; that is, the "facts-in-the-world" regarding scientific knowledge. I want to argue that it is the prerogative of scientific investigators within the field of stem cell research to become educated by studies derived from the social studies community in regard to this controversy. In doing so, they equip themselves to act effectively as contributive *and* interactional experts within advisory panels and public forums when speaking on behalf of this issue. From this educative approach, scientists will be informed

of salient methodologies for engaging the public to equip them with our long sought after common system of understanding.

The Power of Pedagogy

Only subsequent to gaining interactional expertise are scientists enabled to be effective in educating the public. Let it be put forward here, however, that not all scientists engaged within core knowledge creation around a controversial issue are compelled to engage the public. However, those that extend beyond the bounds of their work bench into the public forum in an effort to engage this dimension of the controversy are obliged to approach with care. The formation of a common system of knowledge is dependent on this awkward interaction. However, scientists as honest intermediaries equipped with the skills of interactional expertise can at the very least contribute to the often contentious and dynamic playing-out of science in society. Given the means to forming a common system of knowledge, here we see its formulation as a substrate for public decision making. Returning to my interview with Dr. O'Shea, it was repeatedly emphasized that common understanding was a necessary starting point for effective social analysis and deliberation within the controversy over hES cell research.

> Personally I feel like people should make their own choices. People who are against it have a right to be against it. They just need to know where stem cells come from. And once you know and know what the possibilities are and you choose for some reason not to do it, I don't really have a problem with that. *But I think it's only fair that people start at the same educational levels* (2007).

To illustrate this need for education and a common knowledge system, I want to turn to a 2004 survey by Peter D. Hart Research Associates and the Civil Society Institute who took a public survey seeking to determine relative support of hES cell research (Peter D. Hart Research Associates, 2004).[33] The following two findings in particular regarding the role of educating the respondent illuminates the critical role of a common system of understanding.

The more people have heard about the issue, the more they support stem cell research. Voters who say that they know a lot about the issue support stem cell research by 68 percent to 26 percent, whereas voters who say that they know little about the issue support it by a much smaller 36 percent to 30 percent.

Support grows with more information. Support for embryonic stem cell research increases 13 percentage points to 66 percent when people are informed that couples are donating unwanted embryos that otherwise would be discarded. After hearing a more detailed description of embryonic stem cell research and the diseases it can help cure, support grows even more. Overall, three in four (76 percent) voters support stem cell research after hearing the following description: "Embryonic stem cells are special cells that can develop into every type of cell in the human body. The stem cells are extracted from frozen embryos in fertility clinics, donated by couples who no longer want or need the embryo. This process destroys the embryo. These stem cells can then reproduce on their own, creating what is called a 'line' of stem cells that many researchers can work with. Scientists believe that there is a good chance that stem cells can be developed into cures or treatments for diseases such as cancer, Parkinson's, Alzheimer's, juvenile diabetes, and spinal cord injuries."

Given the observation that support for hES cell research correlated with an increase in knowledge of the science is beside the point. What is important to emphasize in this discussion is the way in which legitimate public opinion requires a foundation of properly understood scientific information. The critical role of the scientist as honest intermediary and interactional expert provides an effective mechanism by which public education can be achieved. From this paradigm, it is clear that productive deliberation within the controversy over hES cell research demands an educated public. Importantly, this educated public correspondingly requires interactional expertise on the part of the scientist to communicate with equanimity emerging scientific data salient to social, political, and scientific arbitration in this debate over hES cell research.

Conclusion

> …differing perceptions of what "the controversy" is and what sort of evidence might "settle" it are *themselves* often stakes in a controversy. This is all the more likely to be true…when "stakeholders in the debate belong to…different communities with different appreciations of the evidence at stake" or to "competing social groups" with opposing political and ethical agendas.
> ~ Steve Epstein (1996: 166)

This paper is an effort toward navigating the idiosyncratic nuances of this indelible debate over hES cell research. Three generalized groups, the social, the political, and the scientific, are delineated as separate domains of interpretation from which to view the current situation in this controversy. Each of these perspectives, although beneficial to the whole, independently contains fatal weaknesses epistemologically and ontologically which preclude their capacity for establishing a common system of knowledge. As Epstein and others have noted, the differences in translated knowledge between these groups is one of the undeniable sources of confusion and division within this debate. To exemplify this confusion and complexity, we can ask the question: how does society or science or politics define hES cells? There are variations on the theme: it is nascent human life, a therapeutic tool, a derivation of the early stage human embryo, a moral conundrum, a scientific fact, the topic of a policy initiative, a technological innovation, a totipotent cell, a tool for drug discovery….These conceptualizations are synecdochal representations of a more complex reality that concatenate a long history of struggle. This paper has made a modest effort to describe aspects of this complexity that relate specifically to how differences in understanding circumscribe this seemingly unresolvable conflict. In taking a step outside of this boundary and looking in at the whole, I have made an argument for the stabilization of scientific knowledge as the obligatory passage point required for movement in the direction of common understanding. By this I mean that there is a necessary bottleneck through which this controversy must pass on the way toward a framework of common knowledge. This bottleneck is the stabilization of the generalized scientific concepts, in all there diversity, related to this controversy. "Solutions to problems of knowledge," write Shapin and

Schaffer, "are solutions to the problem of social order" (1985: 332). By social mandate we are compelled to see that issues of morality, ethics, and policy can take form in accordance with properly construed and understood formulations of scientific information.

Setting an example for us regarding the democratic nature of science, Galileo argued that anyone could see through his telescope the facts about the heavens. To reach a unifying knowledge in the controversy over hES cell research, I am making an injunction to the scientific community to take responsibility for their essential role as honest intermediaries in this controversy. In its entirety, this paper argues that there is one essential imperative if we are expected to properly navigate between the Scylla of social disjunction and the Charybdis of technical inaction: the praxis of scientific epistemology is the motive force that will *initiate* productive movement in the direction of a collective understanding.

NOTES

[1] Refer to the following texts for a broad history of this debate at the political level: 1) Congress passed a law initiating a moratorium on research using "a living human fetus, before or after the induced abortion of such a fetus, unless such research is done for the purpose of assuring the survival of such fetus." National Research Act, Pub. L. No. 930348, § 213, 88 Stat. 342 (Passed by the 93rd Congress as H.R. 7724, July 12, 1974) In the text of this law, the term "fetus" refers to the product of conception from the time of implantation onward, which includes what we now consider as embryos *in utero.* 2) President Clinton attempted to allow research on embryos produced by IVF without approving the production of embryos for the purpose of research. National Institutes of Health Revitalization Act of 1993, Pub. L. No. 103-43, § 121©, 107 Stat. 122 (1993), repealing 45 C.F.R. § 46.204(d). This legislation was denied by congress. 3) The Dickey Amendment which significantly influenced Bush's current policy does not allow for federal funding for the derivation of hES cells. It can be found in §128 of Balanced Budget Downpayment Act, I, Pub. L. No. 104-99, 110 Stat. 26 (1996). It has been carried over into various Public Laws every year since its original enactment.

[2] The ability for a cell to differentiate into all cell types of the mature body as well as all the supportive tissues *in utero* is defined as totipotential. ES cells exclusively retain this characteristics as opposed to other pluripotent stem cells which have the capacity of differentiating into several different cell types, but with reduced plasticity compared to the ES cell.

[3] "Remarks by the President on Stem Cell Research," as made available by the White House Press Office, August 9, 2001. A more thorough analysis of this policy is outlined in a publication by the President's Council on Bioethics entitled, "Monitoring Stem Cell Research."

[4] Legislation such as President Bush's 2001 policy or the 2006 legislation HR 810 which sought to expand the number of hES cell lines available to scientists or HR 3144 which sought to expand federal funding for alternative sources of pluripotent stem cells are all deeply divisive matters that seem to complicate the debate.

[5] Similar thoughts have been articulated by Sheila Jasanoff, "What happens in science and technology today is interwoven with issues of meaning, values, and power in ways that demand sustained critical inquiry" (Jasanoff, 2004: 15).

[6] Refer to "Review of recent polls of US opinion on human embryonic stem cell research" published by the Center for Genetics and Society, November 8, 2006. For other poll information see, Vogel G. Deriving 'Controversy-Free' ES Cells is Controversial. Science. 2005 Oct 21; 310(5747); 416-17.

[7] Emphasis added.

[8] Similar sentiments have been articulated by Sheila Jasanoff, "All social groups and movements…regardless of their standpoint on particular issues, seem to embrace science in order to realize their microutopian visions of perfection and progress" (Jasanoff, 2005: 227).

[9] Snowflake children is a term used by organizations that promote the adoption of embryos left over from in vitro fertilization to describe children that result, where the children's parents were not the original cell donors. These embryos are transferred to infertile couples via embryo adoption. Ninety-nine children have been born from this program.

[10] To give a brief outline of current examples of adult stem cell therapies in the clinic see: 1) Nyolczas N, Gyongyosi M, Beran G, Dettke M, Graf S, Sochor H, Christ G, Edes I, Balogh L, Krause KT, Jaquet K, Kuck KH, Benedek I, Hintea T, Kiss R, Preda I, Kotevski V, Pejkov H, Dudek D, Heba G, Sylven C, Charwat S, Jacob R, Maurer G, Lang I, Glogar D. Design and rationale for the Myocardial Stem Cell Administration After Acute Myocardial Infarction (MYSTAR) Study: A multicenter, prospective, randomized, single-blind trial comparing early and late intracoronary or combined (percutaneous intramyocardial and intracoronary) administration of nonselected autologous bone marrow cells to patients after acute myocardial infarction. *American Heart Journal*. 2007;153:212; 2) Kawamura A, Horie T, Tsuda I, Abe Y, Yamada M, Egawa H, Iida J, Sakata H, Onodera K, Tamaki T, Furui H, Kukita K, Meguro J, Yonekawa M, Tanaka S. Clinical study of therapeutic angiogenesis by autologous peripheral blood stem cell (PBSC) transplantation in 92 patients with critically ischemic limbs. *J Artif Organs*. 2006;9:226-233; 3) Smrke D, Gubina B, Domanovic D, Rozman P. Allogeneic Platelet Gel with Autologous Cancellous Bone Graft for the Treatment of a Large Bone Defect. *Eur Surg Res*. 2007;39:170-174; and 4) Fahnehjelm KT, Tornquist AL, Malm G, Winiarski J. Ocular findings in four children with mucopolysaccharidosis I-Hurler (MPS I-H) treated early with haematopoietic stem cell transplantation. *Acta Ophthalmologica Scandinavica*. 2006;84:781-785.

[11] Several publications can be referred to for more information: see *Stem Cells and Public Policy*, authored by staff of the Center for Genetics and Society and published in June 2006 by The Century Foundation. Web site: http://www.genetics-and-society.org/; see the National Institutes of Health, *Report of the Human Embryo Research Panel*, Bethesda, MD: NIH, 1994; see the July 2002 report by the President's Council on Bioethics, *Human Cloning and Human Dignity: An Ethical Inquiry;* see, Murray TH. Ethical (and political) issues in research with human stem cells. Novartis Found Symp. 2005;265:188-96; discussion 196-211.

[12] The President's Council on Bioethics. Monitoring Stem Cell Research: Appendix F, "The Meaning of Federal Funding" by Peter Berkowitz, J.D., Ph.D**.**

[13] Berkowitz specifically cites numerous judicial cases over abortion that invoked moral arguments in addition to general claims of "value" which the government uses to establish policy. These include ideas of marriage, family, education, respect for individual rights etc. which indicate the ways in which government uses value judgments (commonly reflecting moral philosophy) which shape legislative formulations.

[14] "Remarks by the President on Stem Cell Research," as made available by the White House Press Office, August 9, 2001.

[15] In a remark by President Bush in 2002 he stated the matter further, saying, "no human life should be exploited or extinguished for the benefit of another" ("Remarks by the President on Human Cloning Legislation," as made available by the White House Press Office, April 10, 2002). Emphasis added.

[16] Refers to a transcript of the September 3, 2003 meeting of the President's Council on Bioethics (found at www.bioethics.gov) and more comprehensively in "Monitoring Stem Cell Research".

[17] Blastomeres are the cells of the early embryo that divide up until the eight cell stage (2 days after conception).

[18] The Library of Congress THOMAS: EMBRYONIC STEM CELL RESEARCH -- (House of Representatives - March 13, 2007) pg. H2483.

[19] The Library of Congress THOMAS: Alternative Pluripotent Stem Cell Therapies Enhancement Act of 2007 (Introduced in House).

[20] See http://www.whitehouse.gov/dpc/stemcell/2007/index.html for the full text of this report online.

[21] "Madam Speaker, there is a doctor at Wake Forest University and just recently he did some research and reported in a very respected medical journal of being able to obtain cells from amniotic fluid as early as 10 to 12 weeks of a pregnancy.

Now, that is not a true embryonic cell, but it is getting pretty darn close to it. It is getting darn close to it. I would be very interested in hearing what Dr. *Bartlett* says about if you compare the potential of those cells in amniotic fluid that you can obtain when a woman, let's say for genetic diagnosis she is 10 to 12 weeks pregnant, she is over the age of 35, she has concerned about the increased risk of Down Syndrome, and she wants some assurance that that baby, her baby, doesn't have Down Syndrome. So that is why the amniotic fluid is obtained, to get some of those cells to know the exact genetic makeup of that child.

But there are lots of extra cells that could be then used with the patient's consent without harming anything, certainly without destruction of any living embryo." The Library of Congress THOMAS: EMBRYONIC STEM CELL RESEARCH -- (House of Representatives - March 13, 2007) pg. H2480.

[22] Quoted in Yuval Levin. The Moral Challenge of Modern Science. The New Atlantis. 2006. p. 32.

[23] The identity of this scientist is withheld as a matter of respect.

[24] The full survey can be seen at: www.vcu.edu/lifesci/images2/survey2001.pdf. The VCU Life Sciences Survey was conducted from August 23- September 2, 2001 with 1122 adults nationwide. The margin of error for the poll is +/- 3 percent.

[25] The abode of the blessed after death in classical mythology

[26] Similarly, Sergio Sismondo has written that scientific artifacts and knowledge claims "are typically the result of many different innovations, some of which might normally be considered technical, some economic, some social, and some political. The "niche" of a technological artifact or a scientific fact is a multi-dimensional development" (2004: 70).

[27] Merriam-Webster Dictionary

[28] This instantiation has also been re-iterated by Collins and Evans: "this is the kind of society we like – one where we do consider that scientists with experience of an esoteric specialism are the best people to make judgments about what should count as truth within the specialism" (Collins and Evans, 2002: 243)

[29] "*Contributory Expertise*: This means enough expertise to contribute to the science of the field being analysed. *Interactional Expertise*: This means enough expertise to interact interestingly with participants and carry out a sociological analysis" (Collins and Evans, 2002).

[30]This perspective is also re-articulated by Daniel Sarewitz: "Science becomes a tool for correcting and improving the incremental democratic policy process by providing insight, rather than dictating policy by providing predictions." (Sarewitz, 2000: 98)

[31] Merriam-Webster Dictionary. Emphasis added.

[32] Specifically defined as "the fact or character attributed to nature or natural processes of being directed toward an end or *shaped by a purpose*." Merriam-Webster Dictionary. Emphasis added.

[33] Methodology: From March 24 to 29, 2004, Peter D. Hart Research Associates conducted a telephone survey on behalf of the Civil Society Institute. This survey was conducted among registered voters in 18 states and was designed to explore public opinion on federal funding for stem cell research. The states included were Ohio, Michigan, Pennsylvania, Maine, New Hampshire, Wisconsin, Minnesota, Iowa, Washington, Oregon, New Mexico, Nevada, Arizona, Florida, Louisiana, Arkansas, Missouri and West Virginia. With 802 interviews, the margin of error for this survey is plus or minus 3.5 percent, with larger margins of error for subgroups. The complete report on this survey can be found at: www.resultsforamerica.org.

Bibliography

Bangsboll S, Pinborg A, Yding Andersen C, Nyboe Andersen A 2004. Patients' attitudes towards donation of surplus cryopreserved embryos for treatment or research. *Hum Reprod* 2004;19:2415-2419.

Battey, James 2007. Scientist and former chair of the NIH stem cell task force. National Institutes of Health. Bathesda, MD. March 30, 2007. Personal Interview.

Bishop, Tricia 2007. *Word Choices: In the high-stakes world of stem cell research, success or failure can hinge on turn of a phrase.* Baltimore Sun. March 11, 2007.

Bloor, David 1991. Knowledge and Social Imagery, 2nd ed. (Chicago: University of Chicago Press)

Budziszewski J 1999. The Revenge of Conscience: Politics and the Fall of Man. Spence Publishing Company.

Bush, G.W. 2001, "Stem Cell Science and the Preservation of life," *The New York Times,* August 12, 2001.

Bush, Vannevar 1945. *Science: The Endless Frontier. A Report to the President*. U.S. Government Printing Office.

Chong S, Normile D 2006. STEM CELLS: How Young Korean Researchers Helped Unearth a Scandal .. *Science*. 2006;311:22-25.

Collins, Harry and Robert Evans 2002. "The Third Wave of Science Studies," Social Studies of Science 32.

Cussins, Charis 1996. "Ontological Choreography: Agency through Objectification in Infertility Clinics," Social Studies of Science 26.

Daston, Lorraine and Peter Galison 1992, "The Image of Objectivity," Representations 40

De Coppi P, Bartsch G, Siddiqui MM, Xu T, Santos CC, Perin L, Mostoslavsky G, Serre AC, Snyder EY, Yoo JJ, Furth ME, Soker S, Atala A 2007. Isolation of amniotic stem cell lines with potential for therapy. *Nat Biotech*. 2007;25:100-106.

Descartes, Rene. Donald A. Cress (Translator) 1637/1998. Discourse on the Method for Conducting One's Reason Well and for Seeking Truth in the Sciences. Hacket Publishing Company.

Dumit, Joseph 2004. Picturing Personhood: Brain Scans and Biomedical Identity (Princeton: Princeton University Press).

Epstein, Steven 1996. Impure Science: AIDS, activism, and the politics of knowledge. University of California Press.

Feiler, Bruce 2001. “Who Gets to Be “Solomonic”?” Slate Magazine (www.slate.com), August 27, 2001.

George, Robert P. and Berg, T 2007. “Six Stem Cell Facts”. The Wall Street Journal. March 14, 2007. pg. A15.

Harding, Sandra 2000. “Should Philosophies of Science Encode Democratic Ideals?”, in D. L. Kleinman, ed., *Science, Technology, and Democracy* (Albany: SUNY Press).

Holden C 2007a. STEM CELL DEBATE: Scientists Protest 'Misrepresentation' as Senate Vote Looms. *Science*. 2007;315:315a-3316.

Holden C 2007b. STEM CELLS: Data on Adult Stem Cells Questioned. *Science*. 2007;315:1207a.

Holden C 2007c. STEM CELLS: Versatile Stem Cells Without the Ethical Baggage? *Science*. 2007;315:170.

Hwang WS, Ryu YJ, Park JH, Park ES, Lee EG, Koo JM, Jeon HY, Lee BC, Kang SK, Kim SJ, Ahn C, Hwang JH, Park KY, Cibelli JB, Moon SY 2004. Evidence of a Pluripotent Human Embryonic Stem Cell Line Derived from a Cloned Blastocyst. *Science*. 2004;303:1669-1674.

Hwang WS, Roh SI, Lee BC, Kang SK, Kwon DK, Kim S, Kim SJ, Park SW, Kwon HS, Lee CK, Lee JB, Kim JM, Ahn C, Paek SH, Chang SS, Koo JJ, Yoon HS, Hwang JH, Hwang YY, Park YS, Oh SK, Kim HS, Park JH, Moon SY, Schatten G 2005. Patient-Specific Embryonic Stem Cells Derived from Human SCNT Blastocysts. *Science*. 2005;308:1777-1783.

Jasanoff, Sheila 2004. “Ordering Knowledge, Ordering Society,” in States of Knowledge: The Co- Production of Science and Social Order (London: Routledge).

Jasanoff, Sheila 2005. *Designs on Nature: Science and Democracy in Europe and the United States* (Princeton: Princeton University Press).

Jiang Y, Jahagirdar BN, Reinhardt RL, Schwartz RE, Keene CD, Ortiz-Gonzalez XR, Reyes M, Lenvik T, Lund T, Blackstad M, Du J, Aldrich S, Lisberg A, Low WC, Largaespada DA, Verfaillie CM 2002. Pluripotency of mesenchymal stem cells derived from adult marrow. *Nature*. 2002;418:41-49.

Jiang Y, Vaessen B, Lenvik T, Blackstad M, Reyes M, Verfaillie CM 2002. Multipotent progenitor cells can be isolated from postnatal murine bone marrow, muscle, and brain. *Experimental Hematology*. 2002;30:896-904

Kalichman, Michael and Lawrence M. Hinman 2006. Words that Divide: Stem Cell Field is a Semantical Minefield. The San-Diego Union Tribune. May 24, 2006.

Kass, Leon 1993. "The problem of technology." *Technology in the Western Political Tradition*. Eds. Jerry Weinberger and Arthur M. Melzerb. Ithaca, NY: Cornell University Press.

Kleinman, Daniel 1995. Politics on the Endless Frontier: Postwar Research Policy in the United States. Duke University Press.

Kleinman, Daniel 2000. "Democratizations of Science and Technology", in D. L. Kleinman, ed., *Science, Technology, and Democracy* (Albany: SUNY Press).

Klimanskaya I, Chung Y, Becker S, Lu SJ, Lanza R 2006. Human embryonic stem cell lines derived from single blastomeres. Nature. 2006 Nov 23;444(7118):481-5.

Kuhn, Thomas 1962/1996. The Structure of Scientific Revolutions, 3rd ed. (Chicago: University of Chicago Press).

Latour, Bruno 1987. *Science in Action: How to Follow Scientists and Engineers through Society*. Cambridge, Mass.: Harvard University Press.

Latour, Bruno 1991. "Technology is Society made Durable," in John Law, ed., *A Sociology o Monsters? Essays on Power, Technology, and Domination* (London: Routledge).

Leigh Star, Susan, and James Griesemer 1989, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939," Social Studies of Science 19.

Levin, Yuval 2006. The Moral Challenge of Modern Science. The New Atlantis.

Mackenzie, Donald 1989. "From Kwajalein to Armageddon? Testing and the Social Construction of Missile Accuracy," in David Gooding, Trevor Pinch, and Simon Schaffer, The Uses of Experiment: Studies in the Natural Sciences (Cambridge: Cambridge University Press).

Mol, Annemarie 2003. The Body Multiple: Ontology in Medical Practice (Durham: Duke University Press).

Nelkin, Dorothy 1995. "Science Controversies: The Dynamics of Public Disputes in the United States." *Handbook of Science & Technology Studies*. Sheila Jasanoff,

Gerald E. Markle, James C. Peterson, and Trevor Pinch, editors. Thousand Oaks, CA: Sage Publications.

Normile D, Vogel G, Holden C 2005. STEM CELLS: Cloning Researcher Says Work Is Flawed but Claims Results Stand. *Science*. 2005;310:1886-1887.

O'Shea, Sue 2007. University of Michigan, Ann Arbor, MI. February 26, 2007. Personal Interview.

Peter D. Hart Research Associates 2004. "Survey: expanded stem cell research backed by strong majority of voters in 18 states." (Newton Centre, MA: Civil Society Institute).

Pielke, Roger A 2006. "When Scientists Politicize Science." *Regulation*.

Pielke R, Prins G, Rayner S, Sarewitz D 2007. Climate change 2007: Lifting the taboo on adaptation. *Nature*. 2007;445:597-598.

Pinch, Trevor and Wiebe Bijker 1987. "The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," in Wiebe Bijker, Thomas Hughes, and Trevor Pinch, eds., The Social Construction of Technological Systems (Cambridge MA: MIT Press).

Presidents Council on Bioethics 2005. "Alternative Sources of Human Pluripotent Stem Cells – A White Paper." Washington D.C.

Sarewitz, Daniel 2000. "Human Well-being and Federal Science—What's the Connection", in D. L. Kleinman, ed., *Science, Technology, and Democracy* (Albany: SUNY Press).

Sarewitz, D., Foladori, G., Invernizzi, I., & Garfinkel, M. 2004. "Science Policy in Its Social Context." *Philosophy Today*, Supplement.

Selznick, P. 1992. *The Moral Commonwealth: Social theory and the promise of community.* Berkley, CA: University of California Press.

Shapin, Steven and Simon Schaffer 1985. Leviathan and the Air-Pump (Chicago: University of Chicago Press).

Sismondo, Sergio 2004. An Introduction to Science and Technology Studies. (Oxford: Blackwell).

Suchman, Lucy 2007. Human-Machine Reconfigurations: Plans and Situated Actions, 2nd Ed. (Cambridge: Cambridge University Press).

Takeshita N, Kubo H 2004. Regulating preimplantation genetic diagnosis--how to control PGD. J Assist Reprod Genet. 2004 Jan;21(1):19-25.

Wohn DY, Normile D 2006. KOREAN CLONING SCANDAL: Prosecutors Allege Elaborate Deception and Missing Funds. *Science*. 2006;312:980-981.

Winickoff, David, Sheila Jasanoff, Lawrence Busch, Robin Grove-White, and Bryan Wynne 2005. Adjudicating the GM Food Wars: Science, Risk, and Democracy in World Trade Law. The Yale Journal of International Law. Vol. 30.

Winner, Langdon 1986. "Do Artifacts have Politics?" (1980). The Whale and the Reactor: A Search for Limits in an Age of High Technology (Chicago: University of Chicago Press).

Wright, Lisa 2007. The office of Rep. Roscoe Bartlett. Washington DC. March 30, 2007. Personal Interview.

Wynne, Brian 1996. "Misunderstood Misunderstandings: Social Identities and the Public Uptake of Science," in Alan Irwin and Brian Wynne, eds., Misunderstanding Science? The Public Reconstruction of Science and Technology (Cambridge: Cambridge University Press).