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Critchley, C. R. (2008). Public opinion and trust in scientists: the role of the research context, and the perceived motivation of stem cell researchers

Originally published in *Public Understanding of Science, 17* (3), 309-327

Available from:
http://dx.doi.org/10.1177/0963662506070162

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Public opinion and trust in scientists: the role of the research context, and the perceived motivation of stem cell researchers

Christine R. Critchley

This research examined why the public may be less supportive of stem cell research when conducted in a private compared to public research context. A representative sample (n = 403) of Australians who were exposed to information relating to privately funded scientists were significantly less likely to approve of stem cell research than those who were presented with a scenario of scientists working within a publicly funded University (n = 401) and a control condition (n = 404). Mediation analyses revealed that the decrease in approval was primarily associated with the tendency of privately funded scientists to be trusted less than their publicly funded counterparts. Public trust in University scientists was also found to be higher than that of private scientists because publicly funded scientists were perceived to be motivated more by benevolence, and more likely to produce benefits that will be accessible to the public. While private scientists were perceived to be more self interested than public scientists, perceived self interest did not explain the decrease in trust. There were also no significant differences across research contexts for the perceived competence of scientists or the likelihood that stem cell research would result in cures for diseases. The implications of these results are discussed in relation to the possible decrease in public trust that may occur alongside the increasing privatization of academic enquiry, and particularly controversial scientific research.

Keywords: Stem cell research, trust, Lay theories of human motivation

1. Introduction

Ever since James A. Thomson isolated the master cells responsible for human physiological development (Thomson et al., 1998), the stem cell debate has been a top priority for most Western governments. The debate juxtaposes the promise of revolutionary advances in the treatment of pernicious diseases and vast economic opportunities, against the ethical and moral consequences of destroying human embryos for research purposes (de Wert and Mummery, 2003; Nisbet, 2004). Ethicists, feminists, philosophers and religious groups are, however,

skeptical of the claims made by scientists. Questions are often asked as to whether or not ground-breaking cures for diseases will be found, and if so, can they be found using stem cells derived from adult rather than embryonic tissue. Opponents also fear that allowing scientists to destroy embryos is potentially opening the doors to a brave new world scenario, where human beings are at best exploited or dehumanized, and at worst killed for the benefit of others.

Many have viewed the stem cell debate as simply an extension of the age-old science versus religion argument. Using fetal tissue for scientific purposes is yet another example of advancement in science that threatens to erode the power of religion through explaining the unknown, attempting to play god, and unsettling comfortable notions of the nature of humanity (e.g., Eramian, 2002). The predominant assumption underlying the message from the popular media, governments and within the scientific community is that opposition to stem cell research is primarily a function of religious and/or conservative moral beliefs. Recent empirical research has found however, that religious beliefs may not be as important in the formation of public support for stem cell research as the media debate would suggest. Although peer reviewed research examining the underlying reasons for public approval of stem cell research is scant, there is some evidence that opposition is dependent upon the context of the research, and the level of trust in scientists, as well as religious beliefs (Critchley and Turney, 2004; Evans et al., 2002). This research attempts to further explore whether or not approval of stem cell research is contingent upon where the research is being conducted, who is conducting the research and why.

Perceived motivation for stem cell research and the impact on public opinion

Pro-life, and indeed environmental and feminist groups, are both skeptical of the claims being made by stem cell scientists, and question the underlying motivation for the research. Private research companies are often accused of hiding their true motivation for wanting to harvest human embryonic tissue. Finding cures for diseases is not thought to be the ultimate goal. Instead, using discarded embryos is seen as the first step in opening the doors to the commercialization of cloned human beings that will enable biotechnology companies to engage in the "unlimited ransacking of embryonic humans for whatever purpose scientists see fit … and to enhance the R & D capacity of multinational drug and cosmetic companies" (van Gend, quoted in CNS News, 2002: 1–2).

Concern about the effect of the profit motive on the integrity and quality of scientific research has long been discussed amongst policy makers, philosophers, political scientists, sociologists and scientists (Chalmers and Nicol, 2004; Cherry, 2003; Dasgupta and David, 1994; Goozner, 2004; Krimsky, 2003). Advocates of privatization argue that injecting private money into scientific research will increase productivity, expedite the generation of knowledge, and hasten the availability of any beneficial products that may arise. Opponents point out however, that the profit motive increases the potential for conflicts of interest that compromise academic integrity, standards and quality; lead to the withholding or suppression of knowledge and results; restrict the free exchange of ideas; and reduce access to the benefits of the research.

Just as the public are often assumed to be ignorant of the complexities of scientific research, they are also often assumed to be unaware of the commercialization process (Millstone and van Zwanenberg, 2000; van Gend, 2002). Many would disagree, arguing that the public are quite capable of understanding that commercial considerations could result in different outcomes than activities driven by an interest in the public good (e.g., Chalmers and Nicol, 2004; Hayward, 2002). Instead, it is argued that an awareness of any profit motive underlying scientific research will eventually lead to significant erosion in trust, and a devaluing of science by the community.

In relation to biotechnology, Chalmers and Nicol (2004) argue that public trust in science, scientists and particularly their regulators is crucial for the viability of the industry.

"Unless there is public trust in the scientists undertaking this research and the regulatory agencies charged with overseeing their work, the promise of the biotechnology revolution may never be realised" (Chalmers and Nicol, 2004: 117). In order to enhance public trust, they argue that increased public involvement in the regulation of science is required to ensure that the goals of research emphasize the public good rather than commercial considerations. Ensuring that the products of scientific research are safe and beneficial to the community is not enough to maintain or restore trust. There also needs to be, through public regulation, a preservation of the traditional scientific values of universalism, collegiality, disinterestedness and organized skepticism (Merton, 1973).

Though empirical data specifically examining the relationship between the commercialization of research and trust in science are sparse, there is some evidence to support the hypothesis that public trust is linked to the context in which scientists work (Centre for Science in the Public Interest, 2004; Critchley and Turney, 2004; Farquharson and Critchley, 2004; Hargreaves et al., 2002; Wellcome Trust, 1999, 2000). In a representative British sample of 1037 participants, Hargreaves et al. (2002) found that in response to the question, "How far do you agree that you trust scientific evidence from Universities," 60 percent agreed, whereas only 14 percent agreed when Universities was substituted with "private business." Also over three-quarters of the respondents in this research believed that it is important to have some scientists who are not linked to business.

Similar results have been found in both US and Australian surveys. For example, the Centre for Science in the Public Interest (2004) found that over 59 percent of 1000 US respondents reported confidence in the safety of a drug when it was attributed to a government funded University professor. Forty-one percent were confident if the University professor's research was funded by a drug company, and only 24 percent were confident if the professor was described as owning stocks in the company. Using a representative sample of 1013 Australians, Critchley and Turney (2004) found that 66 percent of the respondents were comfortable with stem cell research being conducted in publicly funded Universities compared to only 36 percent being comfortable with it in private organizations. Finally, using the qualitative responses of 79 British adults, the Wellcome Trust (1999) found that scientists were perceived to be driven by academic interests, but they were also perceived to be motivated by self interest (e.g., strived for personal glory, media attention and awards). Moreover, participants in this research also described scientists as "inevitably compromised by outside influences" (Wellcome Trust, 1999: 33), and saw commercial pressures as the most likely outside influence that could corrupt their research.

Taken together, these results suggest that the public is less trusting of, and less comfortable with scientists working in a private context than their publicly funded counterparts. What these results do not show however, is why scientists working in a market orientated context are less trusted, and whether this change in trust decreases public approval for their work. The current research attempts to do just that, by pinpointing what conditions are altered by the scientist's context, and whether variations in them decrease trust, and in turn approval of the research .

Trust and lay theories of human motivation

The definition of trust has been, and still is undergoing healthy debate. Despite voluminous attempts to define trust and mistrust across a number of diverse disciplines, there still appears to be little consensus on what exactly trust is (Bigely and Pearce, 1998; Braithwaite and Levi, 1998). A common theme underlying the diversity though, is that trust is an expectation that a trustee is both able and motivated to behave in a way that is valued by a trustor (e.g., Deutsch, 1960; Hardin, 2002; Levi, 1998; Lewicki and Bunker, 1995; Luhmann, 1979; Putman, 2000;

Rotter, 1967; Shapiro, 1987; Sztompka, 1999). Some trust theorists argue that trust is only possible between known specific individuals who can comprehend the actual risks and benefits associated with the trustee (e.g., Hardin, 2002). Others however, point out that there are globalized forms of trust in generalized others that do not depend upon having the specific knowledge to assess the possible risks or outcomes (e.g., Levi, 1998; Sztompka, 1999).

In the absence of detailed knowledge, trust can still occur, but does so as a heuristic assisting individuals to reduce the complexity of the social world. Science is one area where many individuals lack "the interest, abilities, knowledge, or other resources to personally make decisions and take actions" (Siegrist et al., 2000: 354). Thus, when asked whether one supports a complex activity such as stem cell research, it may be that trust in those who have the responsibility for conducting and regulating the research will be important in determining the response. Levi (1998) agrees, arguing that generalized trust in institutions can occur if the people behind the organizations are perceived to be "competent and credible, and likely to act in the interests of those being asked to trust institutions" (p. 80). This type of trust is dependent upon the perceived goodwill or motivation of other people or organizations, not necessarily exclusively on a detailed knowledge of the outcomes that may or may not be delivered.

Siegrist and his colleagues have consistently found evidence that an uninformed public do in fact generalize their trust towards scientific institutions (e.g., Siegrist, 2000; Siegrist and Cvetkovich, 2000; Siegrist et al., 2000). Their research suggests that support for new technologies is strongly associated with "the willingness to rely on those who have the responsibility for making decisions and taking actions related to the management of technology, the environment, medicine, or other realms of public health and safety" (Siegrist et al., 2000: 354). Furthermore Siegrist's research has consistently found that if an individual trusts the organizations associated with a particular technology, they will be more likely to believe that the perceived outcomes of the technology will be beneficial rather than detrimental, and in turn, report increasing support (e.g., Siegrist, 2000; Siegrist et al., 2000).

Chalmers and Nicol (2004) also argue that it will be trust, particularly in the regulatory agencies in which scientists are embedded, that will lead to public support for complex and controversial science. While public concern over the risks versus the benefits of science is important in generating trust or mistrust, they emphasize that the level of trust in scientists and their employers is also determined by the perceived motivation for the scientific activity. Commercialized environments that have little public regulation will compromise traditionally benevolent motives for scientific research, and replace them with more self-interested profit motives. Thus, scientists working within a private context will be perceived to be less motivated by the public good, will be trusted less, and in turn, support for their work will decrease.

Those writing within the public understanding of science literature agree, arguing that attitudes towards science are partially reliant on public awareness relating to the process of scientific inquiry, and particularly "an awareness of the practical political interdependencies between government, industry and scientific institutions" (Sturgis and Allum, 2004: 58). Specifically, positive attitudes and higher levels of trust are thought to be associated with a belief that science operates independently from political and industrial influences as well as the knowledge that science produces valuable outcomes (Bauer, 2000).

Underlying notions of trust is the assumption that human beings are lay theorists (e.g., Deutsch, 1960; Lindskold and Bennett, 1973; Rempel et al., 1985). That is, trust is reliant upon an individual's lay theory of what motivates and causes another's behavior. A belief that another's behavior is primarily determined by benevolence may lead to increased levels of trust because benevolent individuals are thought to be more likely to act in the trustor's interests rather than just their own. Beliefs about whether or not human beings are self interested or benevolent are thought to be dependent upon cultural norms (Miller, 1999; Miller and

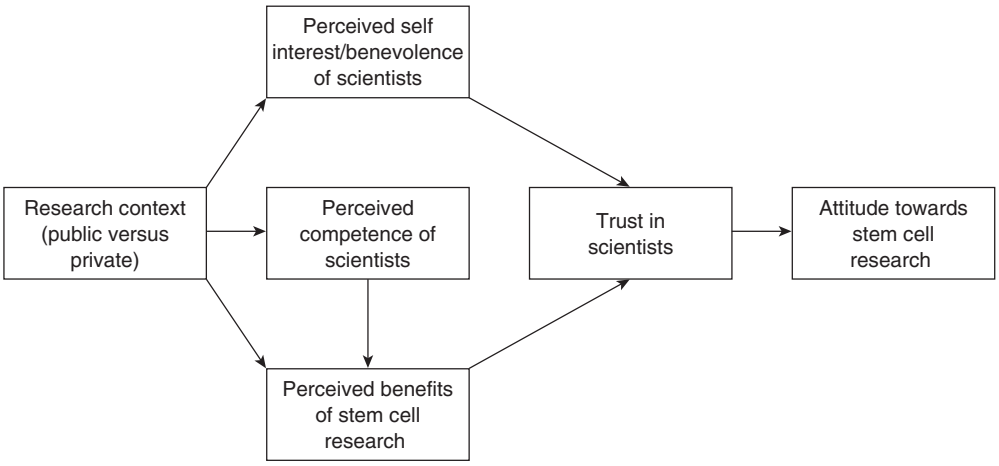

Figure 1. Proposed model for explaining the relationship between the research context and support for stem cell research.

Ratner, 1998; Ratner and Miller, 2001) and the salient constraints associated with particular contexts (e.g., Heath, 1999; DeVoe and Iyengar, 2004).

Heath (1999) as well as DeVoe and Iyengar (2004) have shown that in an organizational context, the salience of an agency relationship between an employee and employer has been linked with an observer's belief that employees are more motivated by external rewards (e.g., salary, benefits, security) than factors intrinsic to the work itself (e.g., developing skills and abilities, enjoyment of the job). Also a number of studies have demonstrated that the presence of an external system of rules where individuals are sanctioned or rewarded for cooperative behavior has been linked with variations in perceptions of benevolence and trust (e.g., Mulder et al., 2006; Yamagishi, 1986). Here is it argued that the mere presence of a sanctioning system conveys the message that people are motivated by self interest and are unlikely to act benevolently or in a trustworthy manner without external constraints. Thus, when external constraints are salient, as in an agency relationship or an individualistic culture, prominence is given to the importance of external and hence self interest motivations rather than intrinsic or benevolent motivations in others. Stem cell scientists working in a private context where financial rewards are salient should therefore be perceived to be more motivated by self interest and less by benevolent concerns than those working in a context where the public good is emphasized.

Summary

This research attempts to empirically examine for the first time, why the research context may influence support for stem cell research. As displayed in Figure 1, it was expected that a decrease in support for stem cell research would occur in a private compared to public context, and that this change would be explained by the level of trust in scientists, the perceived motivation and competence of scientists and the perceived benefits of stem cell research. As suggested by lay theories of human motivation, it was expected that scientists working within a market orientated context would be perceived to be more motivated by self interest, less by benevolence, and in turn would be trusted less compared to their publicly funded counterparts. Moreover, it was hypothesized that the perceived motivation of scientists would mediate the

context–trust relationship independently from expectations relating to the benefits of stem cell research. Trust in scientists may be the result of the public's desire for the methods and procedures of scientific activities to be conducted ethically and transparently, in addition to a belief that stem cell research will result in beneficial outcomes.

The perceived competence of private scientists was expected to be lower than that of public scientists owing to the lack of organized skepticism and transparency that is claimed to be associated with privately funded research (e.g., Krimsky, 2003). In line with the trust literature, any reduction in the perceived competence of scientists should be associated with a significant decline in trust owing to the perception that quality research outcomes will be less likely. Thus, the relationship between the research context and perceived benefits was expected to be partly mediated by the perceived competence of scientists. A direct effect from the context to perceived outcomes was also expected, given the possibility that private stem cell research companies may be perceived to restrict access to any benefits, thus reducing the perceived likelihood that benefits may arise regardless of the competence and interests of the scientists producing them.

2. Method

Participants and procedure

A representative sample of 1208 Australians over the age of 18 years participated in the research. All were interviewed via a computer assisted telephone interviewing (CATI) facility in May 2004. A total of 10,215 calls were made, with a response rate of 19 percent, a cooperation rate of 20 percent, and a refusal rate[1] of 75 percent (see AAPOR, 2004, for the definitions and calculations of these rates). Participants' telephone numbers were selected randomly from all listed Australian phone numbers. A quota system within the OZQUEST software program was used to ensure that the proportion of completed interviews represented the actual population from each State and Territory of Australia. This meant that numbers were selected at random, and dialed, until the number of completed interviews was representative of each state. Gender was also contained within the quota to ensure that equal numbers of males and females were also selected.

The interviews, described further below, were identical except for the descriptions that were provided relating to the context of the scientists' research. Three different contexts were used: public, private and a control condition with no context description. The quota was designed to also ensure that equal numbers of participants and the proportion of males and females were equal within each context. This was achieved, with a total of 608 males (50.3 percent) and 600 females (49.7 percent) being interviewed, and roughly 50 percent of males and females interviewed in each of the three contexts.

Apart from the low representation of indigenous, European and Asian Australians, the sample was fairly representative of the Australian population.[2] A total of 81.34 percent were Australian born (compared to 78 percent nationally), and the majority were born in the 1950s (21.85 percent), 1960s (20.45 percent) and 1940s (18.54 percent). The median age of the Australian population in 2005 was 36.6 years, including all persons under 15 years of age, while the median age in this sample was those born in the 1950s, not including those under 18 years (range was: born in 1900s to the 1980s). The sample was slightly over-represented with University educated respondents and under-represented by those with a trade. Approximately half of the sample had no non-school qualifications (49.70 percent compared to 53 percent nationally), 13.58 percent had completed a trade or certificate (compared to 25 percent

nationally),[3] and 35.76 percent had completed a university degree or diploma (compared to 22 percent nationally). There were no significant differences in any of these demographic variables across the public, private and control contexts (i.e., at $p > .05$), including religious affiliation, church attendance, beliefs relating to whether an embryo is a human being, and beliefs relating to who should fund scientific research in Australia.

Materials

Trust and attitudes Before trust and attitudes were assessed, a description of stem cell research was read out to all participants. Three different descriptions were used for each of the three context groups, varying only in terms of where the scientists were conducting the research. Given that respondents were aware that a University was conducting the research, a control condition was included to assess possible enhancement of positive responses to the public or University condition. The public context read:

> I am now going to ask you some questions about Australian scientists. We are interested in what you think about Australian scientists who are currently using human embryos for scientific purposes. The human embryos are 3–6 days old and are left over from in vitro fertilization procedures. Scientists claim that stem cells from the human embryos can eventually grow into human tissue. They claim that this process could eventually lead to cures for untreatable conditions such as cancer, diabetes, multiple sclerosis, spinal cord injury, and Parkinson's disease. The embryo always dies as a result of the procedure. *Stem cell scientists are receiving their research funds from the people of Australia through grants provided by the Australian government. The research is being conducted in publicly owned Australian Universities, and the scientists working on the stem cell research receive the same salary and other benefits as all other academics in the University.*

The control and private conditions were identical up to the italicized text. The control condition stopped at the end of this sentence, while the private condition read:

> Stem cell scientists are receiving their research funds from privately owned Australian companies, through money received from the company's profits. The research is being conducted in privately owned Australian companies, and the scientists working on the stem cell research often own shares in the company as well as receiving their salary and other benefits. This means that they can potentially earn more money than other scientists if the results of their research make profits for the company.

The public condition was used to represent a prototypical example of a research context that is arguably familiar to the Australian, British, and European public, and contrast it with a private context. In Australia, a common research scenario is one where scientists are employed in a publicly funded University, obtain their research funds from national competitive government grant schemes, and receive similar salaries and entitlements to other academics employed within the same University.

After participants were read the descriptions they were asked, "On a scale from 0–10, what is your level of trust in these scientists? 10 means totally trust and 0 means don't trust at all." Thus high scores represented higher levels of trust. To assess their attitude towards stem cell research participants were then asked, "Overall, what is your level of approval of Australian scientists using human embryos for scientific purposes?" The responses ranged from 1 to 5, where 1 = "strong approval," 2 = "approval," 3 = "mixed feelings," 4 = "disapproval" and 5 = "strong disapproval." Scores were recoded so that high scores represented high

approval and "don't know" responses were treated as missing (there were nine "don't know" responses for attitude and 34 for trust).

Perceived benefits of stem cell research Three questions were used to assess a respondent's belief that stem cell research would result in beneficial outcomes. After listening to the scenario and after responding to the trust and attitude questions, participants were asked: "On a scale from 0–10, where 0 = no chance at all to 10 = extremely likely, how likely do you think the following things will happen as a direct result of allowing stem cell research to continue in Australia?" The outcomes were presented in randomized order across respondents, and were: untreatable illnesses will be cured within my lifetime; untreatable illnesses will be cured eventually, but not in my lifetime; and ordinary Australians will have access to the benefits of stem cell research regardless of cost. A total of six outcomes were presented, but only the three that were directly related to widely considered beneficial outcomes were used in the current research.

As for attitude and trust, "don't know" responses were treated as missing. A total of 36 respondents answered "don't know" for cures in my lifetime, 35 for cures not in my lifetime, and 53 for access to benefits. Given that the three outcome variables were significantly inter-correlated, missing values were replaced by regressing them onto the two non-missing outcome scores using regression imputation via EQS for Windows (Bentler, 1995). The two items measuring a belief that cures would be found were associated with each other ($r = .37$, $p < .001$), with a belief that the public was more likely to obtain access to the benefits of stem cell research (in my life: $r = .36$, $p < .001$; not in my life: $r = .37$, $p < .001$), and with higher levels of trust in scientists (in my life: $r = .26$, $p < .001$; not in my life: $r = .27$, $p < .001$). The higher the likelihood that the public would access benefits was also associated with higher levels of trust ($r = .37$, $p < .001$).

To check that respondents did in fact value the three outcomes, they were asked, prior to hearing the scenario, how important they thought each outcome was. Specifically they were asked, "I would now like you to think about what you think is important about science. On a scale of 1–10, where 0 = not at all important to 10 = extremely important, how important is it to you that the Australian Government spends more of tax payers' money on the following things?" The order of the outcomes was again presented randomly across respondents, and they were: science finds a cure for untreatable illnesses in my own lifetime; science finds a cure for untreatable illnesses, but not in my own lifetime; and ordinary Australian people have access to good quality medical care regardless of cost.

The majority of respondents thought that all three outcomes were important. Over 90 percent answered at 6 or above on the 11-point scale for all three scales. The mean score for cures in my lifetime was 9.37 (Median = 10, Mode = 11, SD = 2.16, Don't know = 1.26 percent), cures but not in my lifetime, 9.16 (Median = 10, Mode = 11, SD = 2.26, Don't know = 2.20 percent) and access was 10.10 (Median = 11, Mode = 11, SD = 1.69, Don't know = .75 percent). A multivariate analysis of variance (MANOVA) found no significant difference in the mean importance placed upon these outcomes across context, $F\ (3,1162) = 1.92$, $p > .05$, $\eta^2 = .01$.

Perceived motivation and competence of scientists A total of 18 questions were used to measure the perceived motivation and competence of stem cell scientists. After they heard the description and were asked the trust, attitude and outcome questions, participants were asked to indicate how many Australian scientists they thought demonstrated 18 attributes (read out in a randomized order across interviewees). The responses ranged from 1 = "none" to 5 = "most or all." The 18 attributes were identical across all three conditions, apart from a leading stem designed to make salient the context of the scientists' work. In the public and private conditions, the questions read, "How many scientists working in public Universities [*private companies*] are …" and in the control condition there was no context stated.

Table 1. Standardized regression weights and proportional item weights for perceived motivation and compliance questions

Item	λ	W
Self interest		
Motivated by money	.61	.12
Motivated to win prizes and awards	.73	.19
Study things primarily because it will benefit their careers	.49	.08
Enjoy being treated as important people	.53	.09
Like having media attention	.74	.19
Want to be famous and well known	.83	.33
Benevolence		
Want to make life better for ordinary people	.80	.22
Want to improve Australian society	.78	.19
Want to contribute towards the understanding of our world	.68	.13
Use ethical research methods	.74	.16
Are honest about the results of their research	.71	.14
Consider the well-being of those who participate in their research	.74	.16
Competence		
Are truly interested in finding out about the things they study	.77	.17
Are naturally curious about their work	.74	.14
Have a true passion for their area of work	.81	.20
Are very intelligent people	.79	.18
Have a natural talent for their particular area	.75	.15
Are highly trained in what they do	.77	.17

Note: W = proportional item weight.

A total of six attributes each were designed to assess self interest and benevolence motives, and the perceived competence of scientists. Competence was defined as how intelligent, talented and trained scientists were believed to be, as well as how interested, curious and passionate they are for their work. In line with the work of DeVoe and Iyengar (2004) and Heath (1999), self interest was defined as motives that were considered to be extrinsic to the scientists' work, such as being motivated by money, winning prizes or awards, liking media attention and seeking fame. Perceived benevolence was operationalized by motivations that represented engaging in the research to assist others, to contribute to knowledge and the perceived integrity of the scientists (see Table 1 for the actual attributes).

Using LISREL 8.54 (Jöreskog and Sörbom, 2003), a single composite score for competence, self interest and benevolence was computed from the factor score regression weights (FRWs) for each question. Factor score regression weights were calculated from three, one-factor confirmatory congeneric measurement models (Fleishman and Benson, 1987; Jöreskog, 1971; Werts et al., 1978) using a scaled covariation matrix of the polychoric correlations, with the method of weighted least squares (WLS; Jöreskog and Sörbom, 2003). To ensure the consistency of the structure of the models across the three contexts, a multi-group analysis was computed, restraining all parameter estimates to be equal across groups. The resulting fit indices and parameter estimates (see Table 1) suggested that all three constrained models were a good fit with the data across the three contexts.[4]

The confirmatory models were all computed using complete cases only (public: $n = 318$, private: $n = 306$, and control: $n = 321$). Before composite scores for each factor were calculated, missing values on individual questions were replaced using regression imputation via EQS for Windows (Bentler, 1995). Missing values on a particular question were predicted

Table 2. Means and standard deviations for attitudes, trust, outcome beliefs, perceived motivation and competence

	Mean (SD)			
	Public	Private	Control	Total
Attitude	3.90* (1.15)	3.37 (1.17)	3.88 (1.12)	3.72 (1.17)
Trust	7.15* (2.17)	5.91 (2.42)	6.94 (1.99)	6.67 (2.26)
Access	6.96* (2.73)	6.22 (2.73)	6.75 (2.57)	6.64 (2.69)
Cures in my lifetime	6.74 (2.65)	6.52 (2.55)	6.85 (2.45)	6.70 (2.56)
Cures but not in my lifetime	8.71 (2.33)	8.64 (2.13)	8.75 (2.17)	8.70 (2.21)
Competence	4.55 (.57)	4.46 (.62)	4.48 (.58)	4.50 (.59)
Self interest	2.97†* (.81)	3.27† (.85)	3.10 (.81)	3.11 (.83)
Benevolence	4.37* (.67)	4.21 (.71)	4.30 (.65)	4.29 (.68)

Notes: Range for attitude: 1 = strong disapproval to 5 = strong approval. Range for trust: 0 = don't trust at all to 10 = totally trust. Range for outcomes: 0 = no chance at all to 10 = 100% likely. Range for perceived motivation and competence: 1 = none to 5 = most or all.

*Mean score for public is significantly different from private at $p < .001$.

† Public significantly different from control.

using the individual's score on the five remaining items for a particular factor. Cases that had more than two missing values for the six questions were excluded from the analyses. A total of 82 cases were deleted. For the remaining cases, each question was multiplied by its FRW, and then proportionally summed to obtain an overall indicator of perceived competence, self interest and benevolence.

Respondents who believed that many scientists were benevolent were also significantly more likely to trust scientists ($r = .41$, $p < .001$), perceive them to be more competent ($r = .66$, $p < .001$), slightly less self interested ($r = -.13$, $p < .001$), and more likely to find cures for diseases (in my life: $r = .16$, $p < .001$; not in my life: $r = .21$, $p < .001$) that would be accessible to ordinary people ($r = .28$, $p < .001$). As expected, competent scientists were also trusted more ($r = .30$, $p < .001$), and seen to be more likely to find cures for diseases (in my life: $r = .13$, $p < .001$; not in my life: $r = .19$, $p < .001$) that were more accessible ($r = .21$, $p < .001$). Higher self interest scores were also slightly associated with lower trust ($r = -.17$, $p < .001$), lower perceived competence ($r = -.10$, $p < .001$) and a belief that cures would not result in the long term ($r = -.10$, $p < .001$). Perceived self interest was not significantly (at $p < .05$) associated with short-term outcome beliefs (i.e., in my lifetime) or beliefs relating to the accessibility of stem cell research outcomes.

3. Results

Summary of differences across context

A series of univariate analyses of variance (ANOVA) using simple contrasts revealed that the context significantly influenced respondents' perceptions of stem cell scientists. As shown in Table 2, respondents were more likely to approve of stem cell research if it was conducted within a public University than if it was conducted in a private company. Scientists working within a public University were also more likely to be trusted, and perceived to be motivated more by benevolent, and less by self interest factors than their privately funded counterparts. The context did not however, influence the perception that scientists were competent. Scientists working in a University were perceived to be just as competent as those working within private companies. With one exception, perceptions of stem cell scientists working in Universities were relatively similar to those where no context was specified. However, in the

public context, scientists were perceived to be less self interested than scientists working in an unknown context.

As shown in Table 2, respondents were significantly more likely to believe that the benefits of stem cell research would be more available to ordinary Australians if the work was conducted in a University compared to a private company. Interestingly, the context of the research did not significantly influence the belief that stem cell research would actually result in cures for diseases, either within the respondents' lifetime or after. As shown by the relatively high means, respondents generally believed that stem cell research would lead to cures for diseases, but that this would be more likely to occur after their own lifetime.

Testing for mediation

To determine the variables responsible for the change in trust and attitude, LISREL 8.54 (Jöreskog and Sörbom, 2003) was used to test a multiple mediation path model based upon the theoretical model presented in Figure 1. According to Baron and Kenny (1986), a significant relationship between the independent variable (i.e., context) and the mediators (i.e., perceived motivation, perceived benefits etc.) must be found in order to obtain evidence of mediation. Given that the context did not significantly impact upon the two items assessing the belief that cures would be found or the perceived competence of scientists, these three variables were not included in the model. Also given the lack of significant differences between the public and control conditions, and the focus on comparisons between the public and private context, all control respondents were omitted from the analysis.

The initial model to be tested consisted of the independent variable private context (coded 0) versus public (coded 1) predicting three mediators, perceived benevolence, perceived self interest and access to the benefits of stem cell research. The three mediators were predictors of trust, which was in turn a predictor of attitude. Perceived benevolence and self interest were allowed to covary given the expectation that self interested scientists should be perceived to be less benevolent and vice versa. Polychoric correlations were used to account for the ordinal properties of the items (though the two perceived motivation variables were treated as continuous) and WLS was used to estimate the parameter estimates and goodness of fit indices. There were two multivariate outliers for the six variables that were deleted from the analysis (leaving 740 cases to be analyzed: public $n = 376$, private $n = 364$).

The results suggested that the fit of the initial model with the data was relatively poor, $\chi^2\ (7) = 75.62$, $p < .001$, CFI = .91, IFI = .91, SRMR = .12. Modification indices showed that the model's fit would be most improved with the addition of a path from the context to trust ($\Delta\chi^2 = 45.40$), and from perceived benevolence to the outcome variable ($\Delta\chi^2 = 22.40$). Given that change in trust across contexts could be accounted for by factors not assessed in the model, the former path was added. The second path was also considered to be theoretically reasonable, as the extent to which one believes the products of stem cell science will be accessible, could be associated with the goodwill or benevolence of the scientists. Thus, this path was also added to the model, but was represented by a correlation as theoretically this relationship could occur in either direction.

The amended model, shown in Figure 2, was an excellent fit with the data, $\chi^2\ (5) = 5.29$, $p > .05$, CFI = 1.00, IFI = 1.00, SRMR = .01. Figure 2 contains the standardized direct effects for the model, and Table 3 shows the unstandardized indirect and total effects. As shown in Figure 2, the research context was significantly associated with all three context–trust mediators. Public scientists were perceived to be more benevolent and less self interested than their private counterparts were. Also access to the benefits of stem cell research was believed to be more likely when the research is conducted in a public compared to private context. The

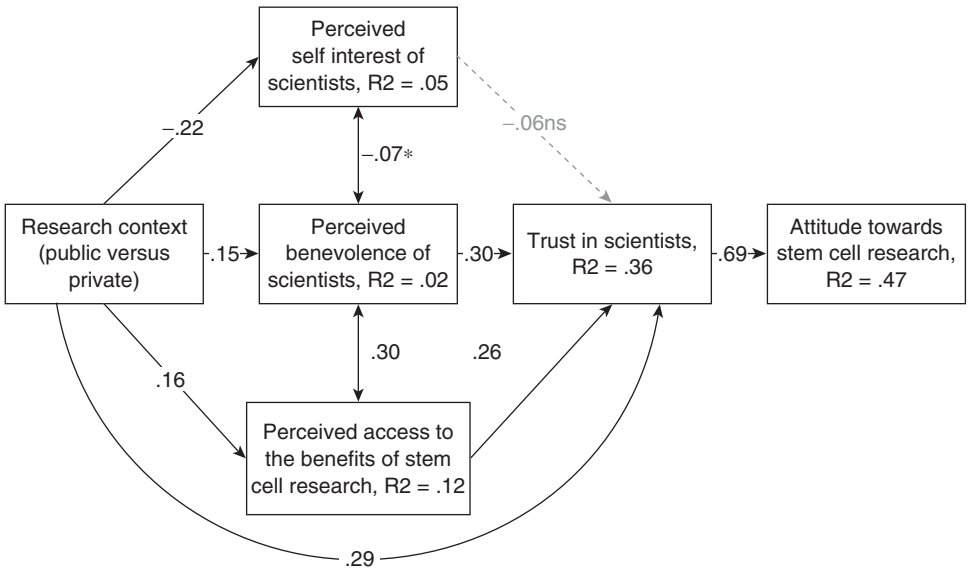

Figure 2. The best fitting model for explaining the relationship between the research context and support for stem cell research.
Note: All paths were significant at $p < .001$. * = $p < .05$.

correlations between the mediators revealed that the perception that scientists are benevolent was significantly associated with a belief that the products of stem cell research would be more available. There was also a slight tendency for self interested scientists to be perceived as less benevolent.

While perceived benevolence and beliefs about access were significantly associated with trust in scientists, self interest was not. A decrease in trust was therefore not associated with a belief that scientists are conducting stem cell research for self interested reasons. Rather, trust in scientists was reliant upon a belief that scientists are conducting their work for the benefit of others and that eventually the benefits of stem cell research would be made available to the public. The non-significant self interest–trust relationship, combined with the relatively weak correlation between self interest and benevolence, suggests that these two constructs are somewhat independent. That is, trusted scientists could be perceived to be both self interested and benevolent.

An increase in trust was also directly associated with the research context. Scientists working within a public context were trusted more than those in a private context, regardless of the perceived motivation of the scientists and whether or not the public would obtain access to the benefits of the research. However, as the significant indirect effect of context on trust in Table 3 shows, the change in trust that was due to the context was partly due to the mediators. The total effect of the context on trust was .38 and the total indirect effect via the three mediators was .10. Thus, 26.32 percent (i.e., .10/.38) of the total effect that the research context had on trust was due to the effect that it had on the three mediators. In other words, as hypothesized, public scientists were trusted more than private scientists partly because they were perceived to be more benevolent and more likely to deliver any benefits from the research to the public.

Of the total indirect effect of the context on trust, .05 ($.15 \times .30$) was due to benevolence, .04 ($.16 \times .26$) was due to access beliefs, and 0.01 ($-.22 \times -.06$) was due to self interest. Therefore perceived benevolence and access beliefs both independently mediated the relationship between

Table 3. Unstandardized Total and Indirect Effects for the Multiple Mediation Model

	Dependent variables				
Independent variables	Attitude	Trust	Self interest	Benevolence	Access
	Total Effects				
Context	.26** (.03)	.38** (.04)	–.22** (.03)	.15** (.03)	.16** (.03)
Trust	.70** (.03)	—	—	—	—
Self interest	–.04 (.02)	–.06 (.03)	—	—	—
Benevolence	.20** (.06)	.29** (.08)	—	—	—
Access	.18** (.03)	.26** (.05)	—	—	—
	Indirect Effects				
Context	.26** (.03)	.10** (.02)	—	—	—
Trust	—	—	—	—	—
Self interest	–.04 (.02)	—	—	—	—
Benevolence	.20** (.06)	—	—	—	—
Access	.18** (.03)	—	—	—	—

Note: Figures in parentheses are the standard errors of the unstandardized regression weight. All unstandardized regression weights were equal to the standardized weights, except for the total effect of Trust on Attitude where the standardized coefficient was .69, and the standardized total effect of benevolence on trust which was .30.

the research context and trust. Public scientists were trusted more because they were considered more likely to produce accessible public benefits *and* to be more benevolent. Thus, these results provide evidence for partial mediation, and for the idea that both benevolence and access to benefits are uniquely important reasons for why trust decreases in a private compared to public context. However, the relatively large direct effect of the context on trust suggests that there are also other reasons for why trust changes across research contexts.

As Figure 2 shows, a more positive attitude towards stem cell research was strongly associated with increased trust in the scientists conducting the work. The total effect of the context on attitudes was also significant (see Table 3), indicating that respondents were less supportive of private compared to public stem cell research. The effect of the context on attitude was entirely indirect via the context's effect on perceived benevolence, access beliefs, and especially trust. Most of the mediation effect was due to trust alone, with the specific indirect effect of the context on attitudes via trust being .20 (.29 × .69) and accounting for 76.92 percent (.20/.26) of the total mediation effect. The remaining indirect effect of the context on attitude was uniquely via perceived benevolence (.15 × .30 × .69 = .03) and access beliefs (.16 × .26 × .69 = .03).

4. Discussion

Taken together, the results from this research clearly support the concern voiced by Chalmers and Nicol (2004) and others (e.g., Krimsky, 2003; Van Der Weyden, 2001) that the public will be less supportive of controversial scientific research if it is conducted within a private company rather than a publicly funded University. Respondents were significantly more likely to approve of stem cell research conducted by University scientists than they were by privately funded scientists. The results therefore coincide with previous research suggesting that the public is less supportive of scientific research when the profit motive is involved

(e.g., Center for Science in the Public Interest, 2004; Critchley and Turney, 2004), and with general public opinion surveys demonstrating that Australians are skeptical of privatization in general (see Hayward, 2002 for a review).

This research attempted to extend on previous work by examining the reasons behind the lack of support for privately funded research. As expected, the effect of the research context on attitudes was mediated by trust in scientists. Approval of stem cell research was higher when conducted in a public compared to a private context, because scientists working within a University were more likely to be trusted. As well as coinciding with previous findings that consistently link trust in science with attitudes towards stem cell (Critchley and Turney, 2004; Evans et al., 2002) and other controversial science (e.g., Siegrist, 2000; Siegrist and Cvetkovich, 2000), the results support empirically for the first time, that the privatization of scientific research will reduce trust in scientists, and in turn decrease support for their work.

The current research also attempted to explain why the level of trust in scientists should be lower for those working in a private compared to a public context. Making salient the norm of self interest in the private context was expected to reduce levels of trust because those working within commercialized organizations would be perceived to be motivated more by self interest and less by benevolence than those working in an environment that traditionally represents the public interest (DeVoe and Iyengar, 2004; Heath, 1999; Miller, 1999). It was also expected that private compared to public scientists would be trusted less because they would be perceived to be less competent and less likely to produce cures for diseases (Krimsky, 2003). Although the zero order correlations showed that benevolent scientists were perceived to be more competent, more likely to cure diseases, and were associated with greater expectations that benefits from their research would be accessible to the public, the results suggested that it was only the perceived benevolence of scientists and access beliefs that explained why trust decreased. Scientists working in a public University compared to a private company were trusted more, partly because they were perceived to be motivated by benevolence, and partly because public access to the benefits of University research was considered to be more likely. There was therefore some evidence to suggest that trust in scientists may be uniquely associated with lay theories of motivation, and moreover, that perceptions of what motivates scientists are linked with the profit motive (Miller, 1999). Trust in scientists, and changes in this trust, are therefore associated with more than just a belief that their work will result in beneficial outcomes. As hypothesized, this research has shown that perceptions of why scientists are conducting stem cell research, and of whom it will benefit are also important factors.

Although private scientists were perceived to be significantly more self interested than public scientists, self interest did not significantly mediate the context–trust relationship. Contrary to expectations, the effects of self interest and benevolence on trust were found in this research to be relatively independent. This suggests that the public may accept a scientist's desire for external rewards, fame, glory and media attention, as long as they are also thought to be working for the benefit of others, and are ethical, open and honest. Hence, the results reported here do not support the notion that perceived self interest and benevolence are opposite ends of the one dimension; an idea that is often assumed within the trust literature (e.g., see Braithwaite and Levi, 1998 for a review).

Further evidence that perceived motivation is an important unique contributor to trust, was that benevolence was associated with trust in scientists despite how competent they were perceived to be, despite the perceived benefits of their research and despite beliefs relating to how available the products of stem cell research would be. While perceived competence and a belief that stem cell research would result in cures were significantly associated with higher levels of trust as expected (e.g., Mayer et al., 1995; Siegrist, 2000; Sitkin and Roth, 1993), scientists working in a private context were perceived to be just as competent and just as

likely to produce cures for diseases as those working within public Universities. Thus, contrary to expectations, the demonstrated difference in trust across contexts was not associated with a corresponding difference in perceived competence or a belief that the research would actually cure diseases either in the short or long term.

This research therefore did not directly support the idea that trust in science will decrease alongside increasing commercialization because of a decrease in the quality of the scientific method and outcomes (Krimsky, 2003). However, this result may be specific to stem cell research where the high sophistication of their work may result in perceptions of highly competent and able scientists regardless of their employment context. Indeed, in this research stem cell scientists were perceived to be highly competent and to be able to cure diseases in all three conditions. Future research should therefore examine the mediating effects of competence and outcome beliefs on the context–trust relationship using different types of scientists that may vary more widely in terms of how competent the public perceives them to be, and how likely their work is believed to result in beneficial outcomes.

Over half of the variance in the decreased level of trust reported in private company scientists was not associated with the mediating variables assessed in this research. The strong direct effect of the context on trust meant that other factors not assessed in this research, or indeed measurement error, may have accounted for some of this change. The finding that respondents trusted private scientists less because they believed the products of their research would be less available for the public *and* that this effect was independent from the indirect effect of perceived benevolence, may suggest that aspects closely tied to the company's self interest as well as the scientists' own motivation may account for the reduced levels of trust in the private context. One such factor may be the degree to which scientists are willing to sacrifice their independence or relinquish the control and direction of their research and its outcomes to the commercial or economic goals of others (e.g., managers, company directors, funding sources). Private company scientists may be perceived to value independence less than University scientists, which in turn may lead to a decrease in the extent to which they are trusted.

As critics of privately funded science point out, skepticism towards private science should increase as a result of the perceived lack of independence of the research from company objectives. With lack of independence comes the increased likelihood that conflicts of interest will occur, information will be withheld from public scrutiny and research will be directed towards projects likely to reap profitable outcomes rather than contribute towards the public good (Goozner, 2004; Krimsky, 2003). Research by the Wellcome Trust (1999), suggests that the public are aware of these issues, and particularly that scientists' work can be compromised by commercial pressures. This perception may lead to a belief that private scientists are more likely to succumb to pressure aimed at reducing transparency and increasing profit at the expense of serving public needs, *even if* they are seen to be personally motivated by benevolent concerns. Trust in benevolent scientists could be reduced if they are perceived to be under pressure to comply with the non-benevolent goals of others. Including a measure of the extent to which scientists' work is perceived to be independent of their employer could therefore improve the prediction of variations in trust in future research.

The decrease in trust in the private context could therefore have been due to the perception that the scientists working within private companies are under pressure to comply with a company norm of self interest, rather than the scientists themselves being personally motivated to increase their pay packet and boost their egos. If so, then this would suggest that trust in the regulatory environment, and the scientists' reaction to it, have an influence on public trust in the scientists themselves. Future research would therefore benefit by examining the distinction, and interrelationship, between trust in scientists and trust in their organizations. This could be done by including measures of the perceived motivation and trust in those who

regulate and control scientific research (i.e. the institutions and companies), in addition to measures relating to the actual scientists themselves.

Less extreme public and private scenarios may also be used that include different sources, amounts and types of funding, as well as separating funding issues from independence issues. For example, scientists who conduct their research within a public University and are funded by a private company, scientists who are employed by a private University and are partially funded by public money and so on. As well as contributing to the theoretical literature on the nature of trust itself, and particularly the transference of trust between individuals, groups and institutions (e.g., Doney et al., 1998; Zucker, 1986), this knowledge would be crucial in understanding how to circumvent the decrease in trust that may occur alongside the increased trend of public and private research partnerships.

Methodological factors may have also accounted for the unexplained variance in trust found across the public and private research contexts. The trust and attitude questions were read out immediately after the description of the vignettes, then the perceived outcome questions and finally, the perceived motivation questions. Owing to a recency type effect (e.g., Haugtvedt & Wegener, 1994) the increased salience of the information relating to the scientist's context may have augmented the difference in mean trust and attitude scores relative to the mean differences in perceived motivation scores. Some of the variation in trust, and in fact the attitude scores across contexts may have been due to the salience of the context in the participants' minds at the time of answering the question. By the time the perceived motivation questions were asked, the potency of words such as, "company profits" and "earning more money" may have waned, reducing the impact of the context on later responses.

In conclusion, this research has found further support for the argument that the approval of controversial scientific research is indeed tied to the context in which the scientists conduct their work. Moreover, it has provided the first empirical evidence to show that the public will be more accepting of publicly funded stem cell research because University scientists are trusted more, and that this trust is partly dependent upon a perception that they are more concerned with the public good than private scientists are. Given that this result was found to occur regardless of church attendance and beliefs of whether an embryo is a human being, governments and policy makers should therefore consider the impact of the regulation of science on public trust in stem cell research, as well as their current concerns with the moral and ethical consequences of using human embryonic tissue for research purposes. Attempts to increase the public support of controversial science should therefore target public trust in scientists as well as the trust in the institutions directing and/or funding the research. Moreover, in line with the concerns raised by Chalmers and Nicol (2004), this research suggests that if trust in science is to be maintained and/or restored, efforts need to be made to distance economic incentives both from the regulation of science *as well as* from the scientists themselves. Public trust in science and particularly controversial science requires,

> confidence in the regulators and in the scientists being regulated. Even where seemingly appropriate forms of regulation are in place, this may not be enough to retain public trust. If researchers and regulators are seen by the public as being primarily concerned with the economic considerations, then public trust may be lost irrespective of the adequacy of the regulatory regime. (Chalmers and Nicol, 2004: 127)

Acknowledgements

The author would like to thank the staff at the Swinburne University CATI facility for their efforts in conducting this survey, and all those respondents who kindly gave their time

to be interviewed. Thanks are also due to Janet Wheeler, Allison Clarke and Sally Buckley for assisting with scripting and data collection, and to Swinburne University for funding the research. Finally Professor Michael Gilding should be acknowledged for his encouragement and support, as well as Karen Farquharson, Elizabeth Hardie and Lyn Turney for their helpful suggestions with the manuscript.

Notes

1 The number of refusals that were eligible could not be determined. If it could be assumed that 66% were eligible then the response rate would have increased to 25%. The percent eligible was calculated using the AAPOR Outcome Rate Calculator, Version 2.1 (AAPOR, 2005).
2 For comparison figures using the Australian Bureau of Statistics (ABS) 2001 Census, see: http://www.abs.gov.au/. Note that ABS percentages are reported using one or no decimal points.
3 This ABS category includes those with other vocational qualifications that may not specifically be a trade.
4 All three x^2 to degrees of freedom ratios were below 3 (Wheaton et al., 1977); all Comparative Fit Index (CFI; Bentler, 1990) and Incremental Fit Index (IFI; Bollen, 1989) values were at or over .95; and all Standardized Root Mean Residual (SRMR; Sörbom and Jöreskog, 1982) were at or below .06. As shown in Table 1, all standardized regression weights (SRW) were significant at $p < .001$, and all were relatively large. Also all three composite scale reliability coefficients (rc; Jöreskog and Sörbom, 1989) were at or above .86, indicating good internal consistency.

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