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Why Diversity Matters: Understanding and Applying the Diversity Component of the National Science Foundation's Broader Impacts Criterion

Kristen Intemann

Despite the National Science Foundation's recent clarification of the Broader Impacts Criterion used in grant evaluation, it is not clear that this criterion is being understood or applied consistently by grant writers or reviewers. In particular, there is still confusion about how to interpret the requirement for broadening the participation of under-represented groups in science and scepticism about the value of doing so. Much of this stems from uncertainty about why the participation of under-represented groups is desirable or beneficial in the first place. This paper distinguishes three different rationales for the importance of diversity in science and draws out the implications for the kind of diversity that is desirable, as well as how the diversity requirement of the Broader Impacts Criterion should be applied and weighed against other criteria in reviewing particular grants. I argue that there are epistemic, as well as social, benefits to diversity that can help promote scientific progress.

Keywords: Broader Impacts Criterion; Diversity; Under-represented Groups

Introduction

One component of the National Science Foundation (NSF) Broader Impacts Criterion (BIC) for grant proposals is how well the proposed research "broadens the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)" (NSF 2007, 1). Yet there has been much confusion by both grant proposers and reviewers about what, exactly, this component requires of proposals and how it should be weighed against other components of BIC, as well as the Intellectual Merit Criterion (IMC). In response, NSF (2007) has attempted to clarify each component of BIC by

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providing examples of activities that would clearly count. With respect to broadening the participation of under-represented groups, examples of such activities include (NSF 2007):

- Establish research and education collaborations with students and/or faculty who are members of under-represented groups.
- Include students from under-represented groups as participants in the proposed research and education activities.
- Establish research and education collaborations with students and faculty from non-PhD-granting institutions and those serving under-represented groups.
- Make campus visits and presentations at institutions that serve under-represented groups.
- Establish research and education collaborations with faculty and students at community colleges, colleges for women, undergraduate institutions, and the Office of Experimental Program to Stimulate Competitive Research (EPSCoR) institutions.
- Mentor early-career scientists and engineers from under-represented groups who are submitting NSF proposals.

At the same time, NSF assures that the list of examples is “not intended to be exhaustive, nor is any particular example relevant to all proposals” (2007, 1). Thus, unless proposers and reviewers have a clear understanding of the rationale behind the component, it is unlikely that the component will be understood or applied consistently in writing and evaluating grant proposals.

My aim is to distinguish and examine three different possible rationales for why the participation of under-represented groups might be important to advancing NSF’s mission, and to draw out the implications that each has for how the component should be interpreted and applied in relation to particular grant proposals. As I will show, the different ways in which the participation of under-represented groups might be important to science has different normative implications for what kind of diversity is valuable, as well as how much weight the component warrants in particular cases.

The Social Justice Rationale

NSF (2007) has stated that all of the components of BIC are important to advancing the NSF Mission: “To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes” (NSF Act of 1950). If part of the NSF Mission is to advance national prosperity and welfare, then one possible rationale for encouraging the participation of under-represented groups is to ensure that prosperity and welfare are promoted in ways that do not create or reinforce patterns of unjust social inequality. A commitment to social justice requires that the distribution of social goods attached to, and produced by, scientific practice and knowledge be equitable to all citizens, and not merely for the benefit of privileged groups.

There are several ways in which promoting the participation of under-represented groups in science could help further social justice. First, NSF might prioritize research projects that focus on enhancing the well-being of under-represented groups or alleviating social inequalities. For example, research on how to identify, eliminate, or reduce environmental toxins prevalent in poor areas might receive higher funding priority than studying environmental toxins found in areas less likely to affect human beings (or than studies that have nothing to do with human well-being at all). Similarly, NSF might prioritize funding for the development and testing of technological solutions likely to benefit marginalized groups. Several have argued, for example, that NSF should give less priority to genetic enhancement research that is likely to be unaffordable or inaccessible to marginalized groups (for example, Selgelid 2007).

In addition to setting research priorities, promoting social justice may require working to ensure that members of under-represented groups have access to scientific education and training. In so far as science education and training provide access to highly skilled and highly paid jobs, promoting the participation of under-represented groups will help address rather than reinforce existing socio-economic inequalities. Moreover, it can ensure that marginalized communities (such as rural poor communities, Native American reservations, or inner-city urban areas) have members with the expertise and experience to conduct research within those communities. In rural and poor areas, the lack of research institutions and opportunities makes it necessary for individuals to leave their communities in order to achieve science education and training. This is often financially and/or culturally challenging, and can have the affect of draining marginalized communities of their most promising young scholars.

Thus, according to the social justice rationale, the diversity component of BIC should be interpreted in ways that promote the participation and interests of those groups that have been historically marginalized or under-privileged due to unjust social or economic arrangements (such as white women, women and men of colour, those with disabilities, those from rural and/or poor areas, etc.). Research projects should endeavour to address issues of concern to under-represented groups, promote the dissemination of research results to marginalized communities, and support the education, training and mentoring of under-represented groups.

It is important to note that this rationale also has implications for how other components of BIC should be understood and applied. For example, BIC also asks reviewers to consider the potential benefits a proposed research project has to society. If the concern is to promote social justice, then reviewers must consider whether the potential benefits are likely to be distributed in a just manner and not simply whether some benefit exists. Research on genetic human enhancements, for instance, might be thought to have the potential to provide certain benefits to society (such as increased productivity in humans, greater autonomy for patients who wish to choose characteristics of their children, or improved health in patients who can be protected against disease). At the same time, such technology is likely to be unaffordable and inaccessible to marginalized groups. So, while there may be some benefit to society in general, the distribution of benefits within society is likely to widen existing social inequalities. This is not to say that such research should never be done, but that the distribution of benefits and costs within society should be normatively evaluated and weighed in applying BIC in addition to the potential aggregate benefits to society.

According to the social justice rationale, then, promoting the participation of under-represented groups would be a means to fulfilling a more general obligation of all moral agents to promote social justice. There is good reason to think that NSF, as well as scientists more generally, has such a moral obligation. As Heather Douglas (2003) has argued, there is no reason to think that scientists are exempt from general ethical obligations that we believe apply to moral agents generally. Thus, in so far as we think that a general moral obligation to promote social justice exists, we might hold that NSF has an obligation to promote the participation and interests of under-represented groups in ways that will advance, rather than hinder, that aim.

While the social justice rationale provides important reasons to promote the participation of under-represented groups, it does not recognize any particular epistemic benefit to increasing the participation of under-represented groups in science. The social justice rationale captures the importance of under-represented groups in setting research agendas, broadening scientific education and training, and disseminating or applying research results. But, it does not establish any *epistemic* benefits to increasing the participation of under-represented groups in practicing science. So, the question remains: can promoting diversity also contribute to NSF's mission of promoting the "progress of science?" I will now turn to two further possible rationales for the diversity component of BIC, each of which provides epistemic reasons.

The Talented Workforce Rationale

The historical exclusion of certain groups in scientific practice is not only troublesome from a political or social justice perspective. This exclusion has potential epistemic consequences as well. One epistemic consequence is that if there are social, political, or economic barriers that prevent or discourage members of certain groups from practicing science, it is possible that some of the best and brightest scientific minds will be erroneously excluded. That is, one might worry that systems of unjust discrimination may, in effect, improperly limit the pool of talented scientists.

There is empirical evidence to support this worry. Although the representation of women and other represented groups is improving in some areas of science, inequalities persist. For example, the number and percentage of doctoral degrees in science and engineering awarded to minorities (Blacks, Hispanics, American Indians/Alaskan Natives) has increased over the past two decades, but the number of minority faculty in science and engineering departments in the United States is disproportionately small, especially at leading research institutions (Burrelli 2006). Women's participation in some fields has increased, such as in psychology and biological sciences, but remains low in other science and engineering disciplines (NSF 2003, xiii). Female doctorates in science and engineering disciplines are more likely to be unemployed or underemployed, they are less likely to achieve tenure, and they have lower salaries than their male counterparts (NSF 2003, xiii).

Recent studies also show that male scientists tend to overestimate the expertise of male scientists and underestimate the expertise of female scientists in making hiring decisions (Steinpreis, Anders, and Ritzke 1999; Wray 2007), evaluating competence in reviewing grant proposals (Wennerås and Wold 1997; Wray 2007), and in making judgements about whether or not certain testimony is reliable (Rolin 2002). Of course, this sort of problem is self-perpetuating. If gender bias exists in judgements about scientific expertise, the scientists making such decisions will continue to be overwhelmingly male. Thus, if we want to achieve the most talented pool of scientists possible, it may be necessary to take positive steps towards insuring that women, people of colour, and other under-represented groups do not face unjust formal or informal barriers in becoming full members of the scientific community. On this interpretation, encouraging the participation of under-represented groups is a necessary means to achieving a talented scientific workforce that will be best situated to promote scientific progress.

This interpretation is consistent with NSF's aim to "Cultivate a world-class, broadly inclusive science and engineering workforce" and to "prepare a diverse, globally engaged STEM workforce" (NSF 2006, 7). Moreover, the kinds of examples that NSF gives of activities that would meet this requirement of BIC appear to be effective means towards achieving this goal. Mentoring early-career scientists from under-represented groups and encouraging collaboration with faculty and students from such groups would help recruit, train, and retain scientists from populations that may otherwise be discouraged, inappropriately dismissed, or unsupported.

Of course, the diversity component of BIC would not by itself be sufficient in accomplishing this aim. Addressing obstacles to the recruitment and retention of women and minority scientists may require adopting new science education strategies, creating and implementing better mentoring programmes, and addressing challenges related to childcare. However, the diversity component of BIC may be one necessary step towards overcoming barriers to the participation of under-represented groups, particularly those that can occur in grant reviewing.

On this interpretation of BIC, "under-represented groups" would include those populations that face systematic obstacles to entering the scientific workforce, so that their current representation in the sciences is disproportionate to their percentage of the total US population. This may include not only groups that have faced systematic obstacles as the result of a history of discrimination (e.g. on the basis of race, gender, disability, etc.), but also groups that have faced systematic obstacles that are the result of other circumstances. For example, individuals from rural or poor areas, or areas where there are fewer opportunities to receive science education, training, mentoring, or research experience would be included under this rationale, as the aim is to remove such barriers and recruit scientific talent. Similarly, the culture of science graduate programmes and research laboratories is often said to be incompatible with having and raising children (a phenomenon that disproportionately affected women in the past but increasingly affects men). Under this rationale, "parents" might count as an under-represented group if there was significant evidence that they faced systematic barriers entering the scientific workforce.

One implication of this is that which groups count as "under-represented" is contingent on both the obstacles that exist for certain populations as well as their numbers in the scientific workforce (throughout the pipeline of scientific training that begins as an undergraduate and continues through all the ranks of faculty). That is, when obstacles change or cease to exist, or when numbers approximate a group's percentage of the total population, groups may cease to count as "under-represented" and new groups may qualify.

It is also worth noting that, unlike the social justice rationale for diversity, this rationale would not inherently support prioritizing particular research agendas unless there was evidence that supporting particular areas of research helped involve, recruit, or retain members of under-represented groups (which may well be the case). On this rationale, the aim is not to improve social welfare or eliminate all unjust social inequalities. Rather, the main concern is to promote scientific progress by supporting the broadest possible talent pool. Thus, the focus is on what can be done to support the participation of members of historically under-represented groups who may be highly talented and yet face obstacles to developing or utilizing that talent.

Another way to put this point is that, on this interpretation, the diversity component of BIC is clearly distinct from the IMC. Whose participation is involved in a proposed project has nothing to do with the scientific merit of the activity. Rather, it is an added bonus that the activity simultaneously supports or promotes securing the most talented scientific workforce. If this is the case, then it may be reason to think that BIC, or at least the diversity component of BIC, should receive less weight than the IMC. When all other things are equal, it seems that a proposal that significantly involves the participation, education, training, or mentoring of under-represented scientists should be rated higher than one that does not. It may be, however, that the scientific merit of a proposal has to achieve a certain threshold before considerations of diversity are given weight. This is partly a consequence of the fact that the talented workforce rationale assumes that having a diverse scientific workforce is merely a means to scientific progress. If scientific progress was the only aim, this would seem to support giving more weight to the IMC.

While this interpretation of the BIC diversity component seems reasonable, and would help in addressing some of the obstacles faced by members of under-represented groups, there may be more significant epistemic benefits to diversity. I will now turn to a third rationale that argues there are some research contexts where having a diverse research community can make for better, or more objective, science. This rationale will require the participation of under-represented groups in more substantive ways than suggested by the other two rationales, at least in some research contexts.

The Increased Objectivity Rationale

It might at first be difficult to see how the participation of under-represented groups could have epistemic benefits (aside from developing a talented workforce). After all, presumably individual scientists are equally rational beings and employ the same kinds of scientific methods regardless of gender, race, class, or other social position. Thus, it is tempting to think that the social position of individual scientists is irrelevant to the scientific knowledge that will be produced. Even if Albert Einstein had been an African

American female scientist, the reasoning goes, it would have no bearing on the quality of the theories produced. In fact, scientific methods (including observation, replication of results, inductive reasoning, judgements about the logical consistency and simplicity of theories) are thought to be successful precisely because they are methods that are held to be objective. That is, their application is not supposed to depend on the particular social features of the scientists that employ them. Thus, scientific progress is determined by the extent to which individual scientists properly employ scientific methods and not on the social make-up of scientific communities.

Yet this has been shown to be a far too simplistic representation of scientific reasoning and methodology. Several philosophers of science, particularly feminist philosophers of science, have argued that having a diverse community of researchers can help promote the objectivity of scientific communities or minimize the negative influences of bias in scientific reasoning (Anderson 2006; Harding 1991; Kitcher 2001; Longino 1990, 2002; Solomon 2001, 2006; Wylie and Nelson 2007).

This line of argument developed from work on cases in the history of science where we can now see that even conscientious, well-intentioned scientists made problematic assumptions, adopted gender and racial stereotypes, or reasoned in ways that reflected and projected their own experiences, values, and interests (Fausto-Sterling 1985; Gould 1996; Longino 1990; Martin 1996; Solomon 2001). Such cases showed that different life experiences, values, and interests of individual scientists can influence which hypotheses are proposed, which models are offered, as well as which background assumptions and explanations of data seem reasonable. Moreover, they revealed that merely encouraging scientists to be more attentive to scientific norms could not prevent individual biases. It is difficult for an individual scientist to recognize when her own values are influencing her assumptions, because individual scientists cannot always be aware of the multitude of background assumptions being relied upon in any given research context.

Thus, several theorists have concluded that it cannot be individual scientists, but rather scientific communities as a whole that are the locus of objectivity (Harding 1991; Longino 1990, 2002; Nelson 1990). While individual scientists may have inescapable biases, scientific communities can achieve a higher degree of objectivity to the extent that they are structured in ways to help identify individual biases and faulty assumptions. When scientific communities are comprised of researchers with diverse life experiences and values, and there are mechanisms to ensure that all members of the scientific community have opportunities to critically scrutinize research and have those criticisms taken seriously, then any problematic assumptions or biases inappropriately influencing scientific reasoning are more likely to be caught (Longino 1990, 73–74 and 80; 2002, 51). When values are different from one's own, it is easier to see when they are influencing scientific reasoning. Thus, a scientific community comprised of individuals with diverse life experiences, values, and interests, will be more likely to identify the ways that values influence the reasoning of individual scientists.

Using examples from a variety of disciplines, I will now distinguish some of the specific ways in which diversity of researchers can help increase objectivity of research. Examining each of the ways that diversity can contribute to objectivity or correct for individual biases will later provide resources for determining how BIC should be applied according to this rationale. The following list of the epistemic benefits of diversity, however, is not intended to be exhaustive. Furthermore, I will not claim that diversity can provide *each* of these epistemic benefits in *every* research context. My claim is that diversity can provide each of these epistemic benefits in some research contexts.

Generating New Research Questions

Which research questions are posed and how research problems are framed depend on the particular interests, values, and experiences of researchers. Having a diverse community of researchers with different life experiences can thus help increase the pool of research questions proposed. This makes it less likely that certain aspects of scientific phenomena will be systematically ignored.

Consider, for example, research on genetically modified crops. US research on genetically modified crops has been driven by the question "How can we maximize the production of a crop under certain (optimal) material conditions?" (Lacey 1999, 189–196). This ultimately led to the development of genetically modified seeds owned by the Montsanto Corporation that developing countries must buy on a yearly basis. Researchers and grassroots activists from Latin America, however, have recognized the interests of those countries to not be dependent on multinational corporations for their food supply. As a result, they proposed alternative research questions, such as "How can we produce wheat so that all the people in a given region will gain access to a well-balanced diet in a context that enhances local agency and sustains the environment?" (Lacey 1999, 194). This is a very different way to frame the research question than looking at how to maximize wheat production in a controlled laboratory situation, and it may lead to very different technological developments, theories, and experiments. Specifically, it might lead to technological developments that do not reinforce the dependence of resource-poor countries.

Similarly, as women started entering the fields of archaeology, anthropology, and primatology in the 1970s and 1980s, they began to ask questions that had not been previously asked by male researchers in these fields. In particular, they began to ask questions such as "what activities did females engage?" and "how did females contribute to social practices and evolutionary changes?" Asking these new questions revealed novel information and had implications for more general theories about evolution, social development, and animal behaviour (Hrdy 1986; Wiley 2001; Wylie and Nelson 2007).

Having a diverse group of researchers, with different life experiences, values, and interests can generate new research questions that reveal new facts and contribute to our understanding of scientific phenomena. Diverse research communities, then, are more likely to produce scientific knowledge that engages with a broad range of epistemic interests.

Identifying Limitations with Existing Models and Proposing New Models

Diverse research communities will also be more likely to recognize problems with existing models and generate new alternatives. Like research questions, models can reflect value-laden assumptions, categories, stereotypes, and interests. When these assumptions are shared by a homogeneous group of researchers, it is very difficult to recognize their presence. They are more easily identified by individuals with different experiences, values and interests.

For example, feminist economists noticed that neoclassical economic models assumed "heads of households" were the only economic actors, thereby omitting the economic features of domestic labour as well as women's economic contributions (Longino 1996). This led to the development of more complex economic models that recognized multiple economic actors able to describe, measure, explain, and predict new kinds of economic interactions.

Similarly, female biologists noticed that models of reproduction used in the 1980s did not adequately capture biological interactions between the egg and the sperm (Martin 1996). Researchers had relied upon a "lock and key" model, where the passive egg is "unlocked" by the sperm that fertilizes it. While this model fit widespread gender stereotypes, it failed to allow biologists to recognize adhesive molecules on the surface of the egg that bind to the surface of the sperm (Martin 1996, 108). Female biologists, in so far as they were more able to identify and scrutinize the projection of gender stereotypes onto non-gendered phenomena, were more likely to identify problems with the "lock and key" model, and to generate alternatives.

In the same way, researchers with experiences in developing countries have pointed out that most contemporary climate change impact models (used to measure the potential effects of a variety of possible climate change policies) do not measure the "harms" and "benefits" that matter to developing countries in the south, such as impacts to quality of life, cultural traditions, and biodiversity (Schnieder, Kuntz-Duriseti, and Azar 2000). Moreover, most climate impacts models only measure the overall global cost/benefit ratio of various climate change scenarios and do not provide information about the distribution of harms and benefits (Schnieder, Kuntz-Duriseti, and Azar 2000). Thus, such models are not able to provide information about which policies will provide a socially just or equitable distribution of benefits and burdens in dealing with climate change. This has led to the development of new alternative models that can better measure a wider range of potential harms, as well as their distribution (Schnieder, Kuntz-Duriseti, and Azar 2000). In this case, having a diverse community of researchers (including researchers who have knowledge of, or experience living in, developing countries) was important to ensuring that the choice of models (or the assumptions built into those models) were fully scrutinized and that alternatives are considered.

This is not to say that it is impossible for a homogeneous research community to recognize problems with existing models, or identify and scrutinize the presence of unsupported stereotypes or assumptions. The claim, however, is that it will be easier or more likely for diverse research communities to do so, as these are easier to recognize when they are assumptions not held by everyone. This is also not to claim that a female or non-white researcher will automatically recognize problematic assumptions. After all, some members of under-represented groups will also hold those assumptions and stereotypes. The idea, however, is that a community comprised of researchers from different social positions, experiences, values, and interest will at least help increase the opportunity to identify problematic assumptions and propose new models.

Proposing Alternative Hypotheses and Interpretations of Data

Scientific hypotheses are justified to the extent that they account for the data better than other hypotheses. This judgement, however, relies on the creativity and ability of researchers to conceive of alternative hypotheses or explanations of the data. Individual experiences and values can influence which hypotheses a researcher is able to generate (Hempel 1966; Reichenbach 1938). Our personal experiences influences which alternative hypotheses are likely to occur to us. There are several examples from the history of science where alternative hypotheses (that ended up better explaining the data) did not occur to researchers because they simply did not have the sorts of experiences that would have allowed the hypotheses to occur to them.

Consider, for example, research on sex differences in visual–spatial abilities in the 1970s.[1] When females performed less well than their male counterparts, it was inferred that such skills must be biologically determined and that biological differences between males and females accounted for differences in performance. Several other plausible alternative hypotheses that arguably also explain weaker female performance were not considered. These included the possibility that female performance was hindered by experiments that required them to be alone in a dark room with a male researcher, or that required them to be particularly assertive in their responses (Fausto-Sterling 1985, 32). In other words, there were alternative hypotheses that the differences in performance were due to social differences that could also adequately explain the experimental results. White middle-class and upper-class researchers in the 1960s were unlikely to have had the kinds of experiences that would make them aware of what it was like to be nervous of being in a dark room with a strange man or to be discouraged or penalized for being assertive or demanding. As a result, it probably never even occurred to them that the experiment design might hinder the performance of females. In fact, as more female researchers entered the field, the flaws in the experiment were pointed out and the test was subsequently redesigned to address these issues. The resulting experiments showed little to no differences in performance along sex lines (Fausto-Sterling 1985, 33).

Similar problems existed in research on racial differences. One famous study conducted by Walter Mischel at Stanford University had a white experimenter present both black and non-black school children with the choice of either having one small piece of candy immediately or returning the next day and receiving a much larger piece of candy (Mischel 1958).[2] When the black children tended to take the immediate piece of candy and the non-black children overwhelmingly opted to wait until the next day to receive more candy, Mischel concluded: "Negroes are impulsive, indulge themselves, settle for next to nothing if they can get it right away, do not wait for bigger things in the future but, instead, prefer smaller things immediately" (Mischel 1958, 59). It never occurred to Mischel, or anyone in his research group, that there were other plausible hypotheses for the difference in decision-making along racial lines. In particular, black students were more likely to have had experiences that would make them distrustful of white scientists. Thus, it was perhaps far more rational for black students to take "what they could get" immediately, as opposed to risk getting nothing at a later date. Or perhaps some of the differences tracked socio-economic differences between the two groups. In so far as black students were more likely to be poor, it may have been less possible for them to delay gratification. When one is starving, waiting to eat until tomorrow will again not be the most rational decision.

Again, these alternative explanations were probably never considered because it is unlikely that Mischel or his researchers had the kinds of life experiences that would have made them aware that black children have good reason to be suspicious and distrustful of white scientists, or that some of these children may have been in conditions of extreme hunger. A diverse group of researchers, with different life experiences, may be more likely to consider a full range of alternative hypotheses and explanations for data.

Accessing Accurate and Complete Data from Human Subjects

There is growing evidence that, when collecting data from human subjects, subjects may provide different data depending on the race, sex, or other social characteristics of the researcher (Davis and Silver 2003; Johannes, Crawford, and McKinlay 1997). In epidemiological studies, non-white subjects have reported not trusting white researchers (Johannes, Crawford, and McKinlay 1997). Non-white subjects have failed to reveal existing medical conditions or to report subsequent side effects to white researchers in clinical trials. Some subjects are particularly fearful that their answers to surveys will contribute to stereotypes or will be taken as representative of their social group (Davis and Silver 2003). Subjects from marginalized groups are more likely to trust and feel comfortable with researchers of their own race and/or gender. Thus, the social position of the researcher can make a difference (at least in some cases) to how subjects respond and what data are collected. When conducting research that involves a diverse pool of human subjects, having a similarly diverse pool of researchers will increase the accuracy and completeness of data collected.

Opening up New Lines of Evidence

In testing hypotheses, scientists must also make assumptions about what will count as "data" or evidence for or against a hypothesis. As greater numbers of women started entering the field of archaeology in the 1980s, they started challenging assumptions about what was being looked to as "data". In particular, male researchers appeared to have ignored several artefacts that were used in subsistence activities associated with females (Gero 1991; Longino 1990; Wylie and Nelson 2007). These artefacts, such as reeds used for digging (Longino 1990), netting and basketry used for carrying and storage (Bernick 1998), bone awls that were used to make nets

(Dobres 1995; Soffer 2004), as well as stone and bone artefacts used in secondary food processing (Gifford-Gonzales 1993), had not previously been considered "tools". Thus, they were not viewed as evidence for or against hypotheses about the evolution of human tool use. Perhaps these artefacts were overlooked by male researchers because they were influenced by subtle stereotypes that women's labour involves unskilled and natural tasks, or they were less interested in women's tasks, or it simply never occurred to them to wonder what tasks women might have performed that would have involved tools. Regardless, the influx of women into the field of archaeology changed what was taken to be evidence or "data" that needed to be accounted for. Female archaeologists opened up new lines of evidence and contributed to several important advancements in the field.

Similarly, feminist sociologists in the late 1990s found that previous studies on the harmful effects of divorce had focused only on narrow harms to children, such as economic harms or psychological harms of living with one parent (Anderson 2004). Such studies failed to collect a wide range of potentially important data, such as potential benefits of having an independent mother or potential harms of staying in an unhappy or abusive marriage. This led to research on divorce that measured harms from divorce in a much broader way, including comparison measurements for the potential harms of staying in a marriage. Researchers with feminist political commitments challenged old ways of measuring harm and revealed new evidence about the effects of divorce. Thus, having a diverse community of researchers increases the likelihood that a full range of relevant data will be collected and considered.

Revealing "Loaded" Language

There are different ways to describe the same phenomena. Some descriptions can import value-laden assumptions or stereotypes. As discussed earlier, gender stereotypes influenced descriptions of biological processes in human reproduction. The female egg was described as "passive", while sperm are described as "active, aggressive, strong" (despite having an observed weak forward propulsion) and as "penetrating the egg's barrier", despite the existence of an adhesive on the surface of the egg that binds to the surface of the sperm (Martin 1996, 107–108). Primate behaviour has also been described in language that ascribes stereotypical human gender stereotypes, such as female primates as "coy" (Hrdy 1986; Schiebinger 1996). Evelyn Fox Keller (1996) has argued that theoretical and mathematical evolutionary biologists have often used gendered metaphors to employ technical terms such as "competition" in ways that import unsupported gender stereotypes.

The point here is that observations are described in language that can reflect stereotypes and assumptions. Researchers with different values and interests are more likely to "catch" or identify the ways in which stereotypes were being inscribed in descriptions of biological processes. It is easier to recognize how values influence the description of data when the values or stereotypes in question are not one's own. Thus, having a diverse community of researchers makes it less likely that individual biases in description of data will go unnoticed.

Identifying a Fuller Range of Risks

In many research contexts, scientists must engage in risk analysis. As we have seen, some research itself involves cost/benefit analysis. Also, scientists also consider whether the potential benefits of developing some new technology are likely to outweigh the costs. In addition, scientists must make judgements about the risks of relying on some model, theory, or auxiliary hypothesis that might be wrong (Douglas 2000; Hempel 1965). In engaging in risk analysis, scientists must make assumptions about what should count as a potential "harm", as well as potential "benefit".

Judgements about what constitutes a "cost" or "benefit" are informed, however, by one's experiences, values, and interests. Consider for example, research on the environmental effects of high-level radioactive waste (Shrader-Frechette 1997). In assessing the safety of radioactive waste sites, scientists must make judgements about how far into the future risks should be measured, whether it is necessary to include potential harm to non-human animals, whether to make optimistic or "worst-case scenario" assumptions, and which sorts of risk are acceptable. These sorts of judgements, however, may depend on the experiences, values, and interests of individual scientists. Scientists who have lived in areas that have been exposed to environmental hazards, for example, may be more cautious in risking further environmental consequences. Thus, a group of diverse scientists, with different experiences that might bear on how they will evaluate risks, will be more likely to consider all of the potential risks at stake and have a better chance at arriving at a careful balance in risk assessments.

To summarize, I have identified seven different ways that diverse research communities can increase objectivity and correct individual biases. Such communities are more likely to:

1. generate new research questions;
2. identify limitations with existing models and propose new models;
3. propose a fuller range of alternative hypotheses and interpretations of data;
4. access more accurate and complete data from human subjects;
5. open up new lines of evidence;
6. reveal "loaded" language in descriptions of phenomena; and
7. more adequately identify and weigh potential risks.

When research communities are comprised of those with different life experiences and values, and there are opportunities for the research community as a whole to scrutinize the work of individual scientists, it is more likely that any unjustified assumptions, unsupported stereotypes, and unconsidered explanations will be "caught" by someone else within the community. The community as a whole is able to correct for inevitable individual biases and increase objectivity in each of the seven ways discussed above. I will now turn to the implications this rationale has for how the diversity component of BIC should be applied.

Implications of the Increased Objectivity Rationale for BIC

The increased objectivity rationale has implications both for the *kind* of diversity that would be desirable in particular cases, as well as how much *weight* the diversity component of BIC should be given in grant evaluation. First, the kind of diversity that is important to achieving epistemic benefits in particular research contexts may depend on the nature of the research. Projects that deal with human subjects may require a kind of researcher diversity not required by other research projects. If subject responses are influenced by the race and gender of researchers, it will be important to have a pool of researchers whose diversity corresponds to the kind of diversity in the subject pool, to the extent possible. In other research contexts, diversity of life experiences will be more epistemically salient. Research on issues that have global implications such as climate change, nanotechnology, or genetically modified food might benefit from researchers with geographical diversity (such as those who have lived in developing countries, as well as developed countries). Research on race and sex differences might be more objective with researchers from diverse social positions relevant to identifying the presence of stereotypes. Research on water quality on Sioux reservations could achieve epistemic benefits from the participation of Sioux researchers, or those with experiences living on a reservation. Participation of researchers with diverse political values might be important for assessing the risks related to levels of environmental toxins. Thus, the sort of diversity that is important to increasing objectivity in a particular case can depend on the content of the research. Grant reviewers, then, should consider not only the extent to which a proposed project involves the participation of some under-represented group, but rather the appropriate under-represented groups given the nature of the research. Research on Native American populations that involves Native researchers should be rated higher than similar research projects that involve no Native researchers (or involve some unrelated under-represented group).

A further consequence of this is that NSF may need to broaden its notion of under-represented groups in new ways. For example, socio-economic class may also influence the kinds of life experiences, assumptions, and interests that an individual scientist might bring to a research group. In some cases, class experiences might be particularly relevant to framing research questions, or identifying alternative hypotheses, explanations, or models. Yet NSF's diversity component has not identified socio-economic status as a category of under-represented groups in the way it has race and gender. On the increased objectivity rationale, class, citizenship, or other categories likely to track differences in life experiences would be equally important.

Again, the kind of diversity that will help increase objectivity is contingent and something that might change over time. If, for example, systems of oppression were eliminated, such that one's experiences were no longer likely to be shaped by one's race, class, sex, or geographical area, then those features become less salient to the knowledge and assumptions that one might bring to the table in practicing science. Thus, it is not necessarily the case that race and gender diversity will always continue to be relevant to establishing more objective research communities with diverse experiences.

In research contexts where it is reasonable to think that objectivity might be increased by the diversity of researchers, the diversity requirement should be given even more weight than it might otherwise be given according to the other two rationales. This is because, on this third rationale, the diversity of the researchers will have direct bearing on the epistemic quality of the research conducted. In other words, it may turn out that in many cases there is not such a sharp distinction between BIC and the IMC. On this third rationale, diversity is not just important in virtue of its "broader impacts", but also because there are cases where the participation of under-represented groups will be crucial to producing more comprehensive, better justified, and less distorted research. The IMC evaluates proposals according to how well qualified the "proposer (individual or team) [is] to conduct the project" as well as the extent to which the project is "well conceived and organized" (NSF 1999, 1). Yet, as I have argued, the extent to which a project involves the participation of under-represented groups can have direct bearing on these questions of intellectual merit. Thus, in some cases the IMC and BIC will be interrelated; and in these cases, the diversity component should be given even greater weight in deciding whether or not to fund grant proposals.

Of course, as mentioned earlier, there may be research contexts in which having a diverse research community will not provide many, if any, epistemic benefits. Some projects, such as those in theoretical physics, deal with subject matter that may be so far removed from any human experiences, values, and interests that having diverse researchers may not have any substantive objectivity-enhancing effects. In such cases it may not be as important, for the aim of increasing objectivity, to ensure the diversity of research groups. Of course, even in these cases, grant proposers may still be obligated to involve under-represented groups along the lines suggested by the other two rationales. In addition, proposers and reviewers should be careful in assuming that the nature of the research is unrelated to the social experiences of researchers because, as many of the above examples indicate, it can be very difficult for scientists to see how personal experiences are limiting their thinking until perhaps long after the fact. Finally, even if a research project is far removed from anything having to do with human experiences or interests, it may be that the scientific community as a whole has a responsibility to promote the education and training of under-represented scientists so as to help develop a larger pool of diverse scientists that might then be important for other research contexts. Thus, even in cases where having a diverse group of researchers appears less relevant there is some reason to give some weight to the participation of under-represented groups.

Finally, it is important to note that it is not an implication of the third rationale that women or people of colour have a shared or special "way of knowing" that is radically different from white or male scientists. Yet, there have been historical systems of oppression (such as sexism, racism, classism, etc.) that shape life experiences, including one's material conditions, values, opportunities, and interactions. As we have seen, these can lead to individual biases, limitations on the evidence one has access to, or particular research interests. While there is no way to get rid of such individual idiosyncrasies, encouraging the participation of under-represented groups in science will help diversify the body of experiences and interests that the scientific community can draw on in recognizing and evaluating the decisions they must make.

Conclusions

I have distinguished three different possible rationales for the diversity component of BIC. My aim has not been to argue in favour of one of these rationales to the exclusion of the others. Rather, I have attempted to show that there are at least three distinct reasons for thinking that the participation of under-represented groups should be encouraged in writing and evaluating grant proposals. It is important to distinguish these different reasons because each of them has different implications for what sort of diversity is important, how diversity might best be encouraged, and the weight that diversity should be given in relation to other criteria, such as intellectual merit. The second and the third rationales both claim that there are epistemic (in addition to social justice) benefits to diversity, although only the third rationale takes diversity to play a role in the justification of theories, background assumptions, methods, models, as well as descriptions and interpretations of data.

At the same time, the three rationales are somewhat inter-related. For example, the epistemic benefits of diversity generated according to the third rationale may also help promote the aims of social justice. If diverse scientific communities produce new research questions, this may led to the production of research that is more socially responsive to the needs and interests of under-represented groups. If diverse communities better identify and challenge unsupported stereotypes and minimize biases that have systematically disadvantaged under-represented groups, this would also serve interests of social justice. Similarly, promoting a maximally talented workforce under the second rationale would also help establish the more diverse scientific communities required under the third rationale. Thus, while all three rationales are supported by different arguments and have different implications for applying BIC, they are interconnected and mutually supportive.

In conclusion, I have attempted to show that the diversity component of BIC is not just a trivial nod to political correctness. There are substantive epistemic, as well as moral, reasons for thinking that the participation of under-represented groups is important. In some cases, it may even be necessary to promoting scientific progress. While I have not provided a concrete formula for applying BIC in practice, I hope to have provided a framework for thinking about why diversity is important that can guide the application of BIC in particular cases.

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Notes

[1] Anne Fausto-Sterling (1985) provides a detailed analysis of this example.
[2] For more discussion of this example, see Richard Miller (1987, 173–177).

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