Gender and Scientists' Views about the Value-Free Ideal

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A small but growing body of philosophically informed survey work calls into question whether the value-free ideal is a dominant viewpoint among scientists. However, the survey instruments used in these studies have important limitations. Previous work has also made little headway in developing hypotheses that might predict or explain differing views about the value-free ideal among scientists. In this article, we review previous survey work on this topic, explain limitations of the survey instruments used, describe an improved survey, report results from an initial administration of it that strengthen and refine previous results, and develop two hypotheses that may account for gender effects found in the data. These hypotheses suggest that gender socialization and a greater tendency for female scientists to be aware of sexism in their fields makes them more likely to reject certain aspects of the value-free ideal.

1. Introduction

According to value-free ideal, the integrity of science depends on separating it from social or political values at certain key junctures, especially in the analysis of data and evidence. This ideal is often thought to have

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achieved its height of popularity in the decades following World War II, and to remain a highly influential, if not dominant, perspective today (Proctor 1991; Douglas 2009, chap. 3; Harding 2015). However, claims about the influence of the value-free ideal raise empirical questions about the views of scientists. To what extent do they endorse the ideal, and what factors—disciplinary affiliation or gender, for instance—are associated with their views on this topic? Such questions are of interest for several reasons. A sense of scientists' attitudes regarding the value-free ideal would be helpful for philosophers who wish to communicate with scientists on this or related issues. Furthermore, if they exist, interconnections between demographic variables and scientists' views about the appropriate role of values in their work would be significant. For example, such links might suggest that changes in the demographics of a field could lead to changes in its philosophical outlook on the value-free ideal. They could also suggest that a prevailing stance on value-freedom in a field might have consequences for who is more or less likely to perceive it as attractive and welcoming. Research of the sort we describe here, then, is relevant to understanding one aspect of how science and society are co-constituted, and is potentially relevant to efforts to increase the demographic diversity of science. Gender is a particularly promising category to consider from these perspectives. A body of philosophical and social science research exists for constructing plausible hypotheses about how gender might be related to scientists' views regarding the value-free ideal. And the gender distribution among scientists, while still skewed toward men, includes a sufficient proportion of women to make statistical comparisons of male and female viewpoints feasible.

The views of scientists regarding the value-free ideal have been examined in some recent empirically oriented philosophical work (Robinson et al. 2016; Steel et al. 2017), as well as in a number of surveys on advocacy administered to ecologists (Lach et al. 2003; Steel et al. 2004; Gray and Campbell 2009; Reiners et al. 2013a; Singh et al. 2014; Crawford et al. 2016). While gender is considered as a predictor variable in some of these studies, previous work has notable limitations. First, survey instruments employed often do not permit respondents to express views about the value-free ideal that are prominent in the philosophical literature. Some instruments presume that value-freedom and objectivity are inherently linked, some ask only whether value-free science is possible and not whether it is desirable, and measures are rarely taken to guard against ambiguity between epistemic and non-epistemic readings of the word "value." These features create difficulties for interpreting the results. A second limitation for present purposes is that previous empirical work has not articulated hypotheses about the relationship between gender and scientists' views regarding the value-free ideal. Gender effects when found appear almost as curiosities, neither supported by theoretical expectations nor suggesting further research questions.

In this paper, we describe a survey instrument to overcome these limitations and data generated using it. The instrument is designed to emphasize that social or ethical (rather than epistemic) values are in question. To better capture the range of positions that might be taken with respect to the value-free ideal, our instrument contains four sets of items that measure the extent that respondents endorse four philosophical positions that depart from that ideal. We name these after philosophers known for advocating them in current literature.

The Longino (1990, 2002) Proposition: *Diversity of social values tends to enhance scientific objectivity.*

The Harding (1986, 2015) Proposition: *Scientific objectivity is strengthened by promoting social justice and framing research in light of the experiences of socially marginalized groups.*

The Douglas (2009) Proposition: *Scientists should consider the ethical and social costs of errors when deciding the sufficiency of evidence* (see also Rudner 1953).

The Kourany (2010) Proposition: *Promoting social justice and human welfare should be core aims of science.*

The first three propositions insist, in different ways and for different reasons, that an influence of values in the assessment of scientific evidence can be desirable and compatible with doing rigorous, objective science. The first three propositions, then, conflict with a core tenet of the value-free ideal sometimes referred to as "impartiality," according to which values should be eliminated as far as possible from the analysis of data and evidence in science (Lacy 1999, pp. 69–70). In contrast, the Kourany proposition conflicts with a distinct aspect of the value-free ideal sometimes referred to as "neutrality," according to which science should not advocate any particular conception of a just or morally best world (Weber 1949; Root 1993; Lacy 1999, pp. 74–87).[1] By including instruments for the four above propositions, with which respondents may agree or disagree, our survey does not presume that value-freedom is inherently desirable or linked to objectivity.

1. While current debate on the value-free ideal in philosophy of science has tended to focus on impartiality, some have recently argued, in effect, that science should be value-neutral and that neutrality entails impartiality (Betz 2013). According to this view, science should avoid imposing its values upon society, yet that would be a consequence of scientists' values influencing the interpretation of data or assessment of evidence.

This article is organized as follows. In section 2, we review previous survey work on scientists' views about the value-free ideal, and on associations between these views and gender. This prior work suggests that the value-free ideal may not be a predominant view among current scientists. Some studies also find some associations with gender, although these tend to be somewhat inconsistent across studies and are not linked to hypotheses. In section 3, we report data from a survey we conducted of science faculty at a major research university. The results of this study strengthen previous findings suggesting that the value-free ideal is not a majority opinion among scientists. The results also suggest some interesting gender dynamics in views of scientists. Next, in section 4, we develop two hypotheses which may explain the gender effects found in our data, that we call the gender socialization hypothesis and the standpoint epistemology hypothesis. Finally, section 5 discusses limitations and potential implications of these findings.

2. Previous Survey Work on the Value-Free Ideal

In this section we review previous survey work on scientists' views about the ideal of value-free science, with specific attention to potential gender differences. For present purposes, we limit our review to articles that report data from a survey on topics related to the value-free ideal wherein the sample of the survey included scientists. Our review does not include articles written by scientists arguing for a particular stance related to this topic, nor do we include articles that report surveys whose sample is limited to non-scientists (cf. Steel et al. 2001; Elliott et al. 2017). However, we do include surveys that sample scientists as well as others, such as members of the "attentive public" or undergraduate students. We searched for articles by entering combinations of "science," "values," and "survey," in Google Scholar, the Social Sciences Citation Index, and the Philosophers Index. When a relevant article was found, we also searched articles that cited it. We divide the articles we review into two groups, surveys of ecologists and Toolbox Dialogue Initiative studies, which we discuss in sections 2.1 and 2.2, respectively. Section 2.3 summarizes some of the common findings of these studies, and discusses their limitations.

2.1. Surveys of Ecologists

We begin by examining a group of surveys of ecologists on their views about the appropriate relationship between scientists and policy makers. Survey work on this topic was motivated by a movement within ecology dating to the 1990s to promote advocacy on environmental issues by ecologists (see Reiners et al. 2013a). That in turn stimulated a lively philosophical debate among ecologists about whether policy advocacy is compatible with doing proper science (cf. Nelson and Vucetich 2009), and led to surveys of ecologists that often explicitly discuss the value-free ideal in connection with policy advocacy by scientists. We found six articles of this sort that satisfied our inclusion criteria (Lach et al. 2003; Steel et al. 2004; Gray and Campbell 2009; Reiners et al. 2013a; Singh et al. 2014; Crawford et al. 2016). The Appendix displays the verbatim question stems, items, and response categories for each of these instruments in the order we discuss them below.

We begin with two closely related articles. Lach and colleagues (2003) and Steel and colleagues (2004) report results of a survey administered to Pacific Northwest ecologists at universities and federal agencies, managers of state and federal natural resource programs, members of environmental interest groups, and members of the "attentive public." Both of these studies report results from the same sample, although the second reports some results not mentioned in the first. Using their "Attitudes about Proper Roles of Scientists" instrument displayed in the first row of the Appendix, the authors examine these individuals' views about the proper roles of scientists in natural resource management decisions (i.e., reporting results, interpreting results, integrating science into decisions, advocating for specific decisions, and making decisions) and investigate any differences in views across these four samples (Steel et al. 2004, pp. 7–8; Lach et al. 2003, pp. 174–5). Among scientists, interpreting and integrating roles were the most favored across all four samples, while reporting, advocacy and deciding roles were disfavored (Steel et al. 2004, p. 7; Lach et al. 2003, pp. 174). Regarding advocacy, only 16% of scientists in the sample agreed that "[s]cientists should actively advocate for specific natural resource management policies they prefer" (Steel et al. 2004, p. 7).

In addition, Steel and colleagues (2004) report results from an index for positivism and several demographic variables including gender. To measure adherence to positivism, they create an "Attitudes toward Positivism" instrument assessing agreement or disagreement with the five statements displayed in the second row of the Appendix. Positivism as characterized by this index combines an image of science as generating cumulative, objective knowledge about the world along with some elements of the value-free ideal.[2] An interesting result from this instrument is that 75% of scientists agreed that "[s]cience provides objective knowledge about the world," while only 25% of scientists agreed that "[i]t is possible to eliminate values and value judgments from the interpretation of scientific

2. Historically, this appears to be a somewhat problematic characterization of positivism, as the actual logical positivists were not advocates of the value-free ideal (Howard 2003; Reisch 2005; Kourany 2010).

data" (Steel et al. 2004, p. 7). A possible interpretation of these results is that many scientists in their sample did not regard value-freedom as necessary for objectivity. The only statistically significant difference concerning gender reported is that women are less supportive of the reporting role than men (Steel et al. 2004, p. 10).

Next, we consider two articles reporting surveys closely resembling that of Steel and colleagues, but with different samples. In the first, Gray and Campbell "assessed attitudes toward science and policy advocacy in the case of marine protected areas (MPAs) on the basis of a survey of delegates at the First International Marine Protected Areas Congress" (Gray and Campbell 2009, p. 460). As noted in the Appendix, Gray and Campbell use Lach et al.'s (2003) "Attitudes about Proper Roles of Scientists" instrument and Steel et al.'s (2004) "Attitudes toward Positivism" instrument. Like Steel and colleagues, Gray and Campbell consider how such views vary across several different groups, including academic scientists, natural resource managers, and members of nongovernmental organizations (NGOs), although Gray and Campbell report no breakdown of results by gender (Gray and Campbell 2009, p. 463). In their sample, they find the integrative role of science to be most popular, having near universal support; the interpretive role came in second, while reporting and decision-making roles were unpopular (Gray and Campbell 2009, p. 464). Approximately 79% of scientists in their sample agreed that science provides objective knowledge, while only 33% agreed that science can be value-free (Gray and Campbell 2009, p. 464). However, in contrast to Steel and colleagues (2004), 49% of scientists in Gray and Campbell's sample agreed that scientists should advocate for policies they prefer (Gray and Campbell 2009, p. 464).

In the next article, Singh and colleagues (2014) report the results of a survey of attendees at nine ecology conferences. The authors examine the extent to which ecologists engage in advocacy and what makes them more or less likely to do so. They adopt a version of Lach et al.'s (2003) "Attitudes about Proper Roles of Scientists" instrument, asking not only whether respondents think scientists should perform these roles but also whether they actually do (Singh et al. 2014, pp. 161–2). Singh and colleagues also use Steel et al.'s (2004) "Attitudes toward Positivism" instrument, although they do not report response data for it (Singh et al. 2014, p. 162). Similar to Gray and Campbell (2009), Singh and colleagues find that scientists favor interpreting, integrating, and advocating over other roles (Singh et al. 2014, p. 164). They also find a mismatch between activities and normative judgments, wherein ecologists favor interpretive, integrative, and advocacy roles, but in practice mainly report and sometimes interpret (Singh et al. 2014, p. 165). They do not report any results by gender.

We now turn to two studies that rely on distinct survey instruments developed by Reiners and colleagues (2013a). One, the 7-item "Engagement in Advocacy Activities" instrument, asks respondents how often or how much they participate in advocacy activities, such as writing letters for or donating money to an environmental cause (Reiners et al. 2013a, p. 1230). Another, the 4-item "Effects of Advocacy on Scientific Activity" instrument, asks respondents whether or not they thought an ecologist who "is openly supportive of environmentalism and expresses beliefs that risks to the environment are real and serious" can be objective and contribute to science (Reiners et al. 2013a, p. 1232). A third, the 6-item "Attitudes toward Value-Free Objectivity in Research" instrument, measures respondents' views that basic and applied ecological research is, can be, and should be "purely objective and value-free" (Reiners et al. 2013a, p. 1235). Their survey also included basic demographic questions, such as age and gender (Reiners et al. 2013a, p. 1228).

The analyses of their data from 1215 members of the Ecological Society of America produced six major findings. First, most ecologists reported little engagement in advocacy issues. Second, there was no clear consensus among ecologists about which activities constitute advocacy. Third, ecologists tended to view values "consistent with environmental advocacy" more in line with ecology than those consistent with "environmental skepticism." Fourth, women were more likely than men to have a favorable view of advocacy and to view it as compatible with scientific objectivity. Fifth, older ecologists engaged in advocacy more frequently and also placed a higher value on objectivity than did younger ecologists. Sixth, ecologists employed in government preferred greater separation between science and values than did other ecologists (Reiners et al. 2013a, pp. 1226–27).

The last survey of ecologists we review here examined views about advocacy among undergraduate students, graduate students, academic ecologists, and ecologists working for government agencies or NGOs (Crawford et al. 2016). The authors aimed to assess: (a) views about what activities count as advocacy, (b) norms about the advocacy-related behavior of scientists, and (c) whether these views vary across the different groups included in the study. The authors' 9-item "Perceived Advocacy" instrument is similar to Reiners et al.'s (2013a) "Engagement in Advocacy Activities" instrument. Briefly, Crawford et al. (2016) found that undergraduate students and members of NGOs tended to regard almost all activities—from speaking at an academic conference to defending value-laden policy approaches—as advocacy. Graduate students, faculty, and ecologists working in government agencies, on the other hand, had similar and more discriminating views about what advocacy is. Crawford et al. conclude: "Overall, groups agreed that scientists should engage in advocacy and work closely with policy makers, disagreed with avoidance of all forms of advocacy, but neither agreed [n]or disagreed that scientists were obligated to engage in advocacy" (Crawford et al. 2016, p. 364). They did not report any results by gender.

2.2. Toolbox Dialogue Initiative Studies

The second group of studies includes two articles led by philosophers who analyze data generated from the Toolbox Dialogue Initiative, which is "an NSF-funded initiative that uses a workshop-based dialogue method to understand and facilitate collaborative, interdisciplinary science" (cf. O'Rourke & Crowley 2013; Gonnerman et al. 2015; Steel et al. 2017, p. 22). Prior to workshop discussions, which are documented with verbatim transcripts, participants complete brief surveys on topics in several areas of philosophy of science. Thus, Toolbox workshops produce qualitative and quantitative data. Most relevant to our interests here is their 5-item "STEM Values Module," which is displayed in the Appendix. This module assesses respondents' views about the relationship between value-neutrality and objectivity.

Robinson and colleagues examined whether responses to these statements vary across eight academic branches: life sciences, physical sciences and mathematics, social and behavioral sciences, engineering, medicine and health sciences, arts and humanities, education, and business (Robinson et al. 2016, p. 6). They mostly found no such association, save for one exception (Robinson et al. 2016, p. 10). Social and behavioral scientists were more likely than those in life sciences to disagree with the statement, "Value-neutral scientific research is possible" (Robinson et al. 2016, p. 10). The authors reported no results by gender.

The final article we review Steel and colleagues (2017) examined responses to an adaptation of the Toolbox Values Module, as described in the Appendix. Steel et al.'s (2017) primary interest was to assess whether scientists in their sample were inclined to agree with the ideal of value-free science. They assume that support for the value-free ideal is signified by agreement with the first three statements and disagreement with the last two. Given this, they found no evidence that the scientists in their sample, on average, endorsed the value-free ideal. For four of the five statements, the difference between the mean response and the midpoint of the Likert scale was statistically significant but in the direction of favoring a greater role for values (Steel et al. 2017, p. 26). The lone exception was for the third statement, for which the difference between the mean response and the midpoint was not statistically significant. A gender effect was examined for all statements with the exception of the final one concerning advocacy.[3] Women were more likely than were men to agree with the second and fourth statements: "Incorporating one's personal perspective in framing a research question is never valid" and "Determining what constitutes acceptable validation of research data is a values issues" (Steel et al. 2017, pp. 26–7).

2.3. Take Away Points

In this section we consider what the work reviewed above suggests regarding scientists' views about the value-free ideal and the methodological implications of these results.[4] Perhaps the most interesting finding is that many scientists surveyed appear to delink objectivity from value freedom. Studies that use the "Attitudes about Positivism" index find strong majorities of scientists agreeing that science provides objective knowledge, but find significantly less than half agreeing that it is possible to eliminate value judgments from data interpretation (Gray and Campbell 2009, p. 464; Steel et al. 2004, p. 7). Similarly, in Steel and colleagues respondents were more likely to disagree than agree with the statement, "Objectivity implies an absence of values by the researcher" (Steel et al. 2017, p. 26). Methodologically, these findings suggest that survey instruments regarding science and values should avoid prompts that imply that value-freedom and objectivity are inherently linked. Substantively, such results suggest that a significant proportion of scientists may not accept a common rationale for impartiality, according to which value-free assessment of data and evidence is necessary to secure scientific objectivity (Lacy 1999; Proctor 1991, p. 6).

A second theme is that survey work reviewed here suggests ambivalence about advocacy on the part of scientists. With the exception of one survey (Lach et al. 2003; Steel et al. 2004), scientists were evenly split or slightly in favor of advocacy in the studies reviewed here. For example, in data reported in Steel et al. (2017) respondents were more likely to agree than disagree with the statement, "Biomedical researchers should engage in advocacy related to their research." And Reiners and colleagues (2013a) found that female and older respondents were more likely to favor advocacy and less likely to see it as contrary to objectivity than were their respective counterparts. These results suggest that, in at least some fields, significant proportions of scientists regard advocacy in a positive light. Advocacy, moreover, is related to the Kourany position that the promotion of social

3. The sample for this statement contained too few males to make this statistically feasible (Steel et al. 2017, p. 27).

4. Thus, in this section we do not discuss aspects of the reviewed work with marginal relevance to the value-free ideal, such as statements in the "Attitudes towards Positivism" index concerning the progressiveness of science.

justice and human welfare should be an aim of science and the rejection of neutrality that this entails. While scientists might become advocates for a particular issue entirely of their own initiative, such behaviors are more likely if supported by norms within a scientific field that emphasize the promotion of an extra-scientific conception of the good. Indeed, the surveys of ecologists regarding advocacy reviewed above were motivated by the emergence of such norms in ecology (Reiners et al. 2013a).

Further, some scattered gender effects emerge. As noted, Reiners and colleagues found that female ecologists tended to express more positive views towards policy advocacy than their male counterparts (Reiners et al. 2013a). For their part, Steel and colleagues found that female scientists were more likely than their male colleagues to agree with the statement, "Determining what constitutes acceptable validation of research data is a value issue" (Steel et al. 2017, p. 27). These two findings suggest that gender effects might be found for the Kourany and Douglas propositions in our own sample, a point we return to below in section 3.2.

The studies reviewed here also possess a number of limitations from the perspective of gender and scientists' views about the value-free ideal. The most obvious of these is that they often do not report an analysis of the data by gender, and no attempts are made to develop hypotheses that might explain those gender effects that were found. A subtler limitation is that the instruments are problematic for eliciting views about the value-free ideal. We consider three such limitations: (a) assuming that objectivity is tied to value freedom; (b) not distinguishing the possibility of value-freedom from its desirability; and (c) not distinguishing between epistemic and non-epistemic uses of the term "values." To illustrate the first problem, recall that Reiners et al.'s (2013a) "Attitudes toward Value-Free Objectivity in Research" instrument asks respondents whether science is/can be/should be "purely objective and value free," implying that these two concepts are inherently conjoined. However, there are prominent philosophical accounts of objectivity according to which objectivity does not entail value freedom (Longino 1990; Douglas 2009; Harding 2015). In another article, Reiners and colleagues note such philosophical complexities, but suggest, "it is reasonable to assume that respondents shared a commonsense notion of objectivity as unbiased, disinterested experience that precisely corresponds to a mind-independent world" (Reiners et al. 2013b, p. 3). If "disinterested" is taken to imply an absence of values, then conjoining "purely objective and value free" might be supported by the assumption that the survey respondents hewed to the commonsense notion of objectivity just quoted. But the studies reviewed here call this assumption into question, as they suggest that scientists frequently delink value-freedom from objectivity. Furthermore, both of the hypotheses about how gender may be related to attitudes regarding the value-free ideal that we articulate in section 4 also suggest such a perspective.

Not all of the survey instruments link objectivity with the value-free ideal. For instance, Steel and colleagues' (2004) "Attitudes toward Positivism" instrument contains separate statements relating to objectivity and value-freedom, thereby making it less subject to the problem discussed in the previous paragraph. Likewise, Robinson et al.'s (2016) "STEM Values Module" asks respondents to express their agreement or disagreement with the statement, "Objectivity implies an absence of values by the researcher." However, Steel and colleagues' (2004) "Attitudes toward Positivism" instrument does not distinguish between "can be" and "should be" with respect to value-freedom, asking only about the first of these. Similarly, Robinson and colleagues' (2016) "STEM Values Module" asks respondents to consider whether, "Value-neutral scientific research is possible," but not whether it is desirable. Asking only about the possibility of value-freedom or neutrality creates difficulties for interpreting responses vis-à-vis the value-free ideal. For instance, someone might think that while values cannot be fully eliminated from the analysis of scientific data, scientists should endeavor to minimize the impact of values as much as possible. Or one might think that science can be largely separated from human values, but judge this undesirable on the grounds that science should improve the lot of humanity and not merely satisfy scientists' intellectual curiosity.

The third concern is that the words "value" and "values" in this context are ambiguous between an epistemic and non-epistemic reading (Douglas 2009; Steel 2010). Examples of epistemic values might include objectivity and truthfulness, while public health and environmental sustainability would naturally be regarded as non-epistemic values. This distinction is important because the value-free ideal is normally understood as excluding only non-epistemic values from certain key aspects of science. Thus, a respondent might disagree with the statement that objectivity implies an absence of values because she thinks that objectivity depends on epistemic values. Moreover, this might create bias in the direction of overstating the extent of disagreement with the value-free ideal. Reiners and colleagues note ambiguity between epistemic and non-epistemic readings of "values," but suggest that their respondents would understand "values" to refer to non-epistemic values alone, although they provide no evidence to support this assumption (Reiners et al. 2013a, p. 1240). Steel et al. examined transcript data to assess whether workshop participants tended to use "values" to refer only to non-epistemic values or to include epistemic values as well; they found that a reading of "values" that includes epistemic values "occurred frequently enough [in approximately 20% of cases] to suggest that further surveys on this topic should be designed so as to reduce this ambiguity" (Steel et al. 2017, p. 29).

3. A New Survey

In this section, we present a set of survey instruments we developed to overcome the limitations discussed in the previous section, and we discuss data generated by a pilot study of these instruments. We first describe the instruments in section 3.1 then discuss the pilot study results in section 3.2. Given the previous studies, we expected that the value-free ideal would not be a majority viewpoint in our sample, and our data bears out this expectation—thereby strengthening earlier results. In addition, the survey recorded information on a number of factors that might be related to views concerning value-freedom, such as disciplinary affiliation, age, ethnicity, and gender.

3.1. The Survey Instruments

The instrument consists of 33 questions, six of which asked respondents about their disciplinary background and affiliation, and three asked about gender, age (by five-year intervals), and ethnicity. The other items on the survey were statements relating to various aspects of the value-free ideal. Respondents were invited to express their agreement or disagreement with these statements on a 7-point Likert scale (1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = moderately agree, 7 = strongly agree). In this subsection, we focus on these Likert-scaled components of the survey.

This central portion of the survey instrument was divided into four sections, where each section was intended to reflect a philosophical position that departs from the ideal of value-free science. The first section focuses on Longino's contextual empiricism, according to which scientific objectivity emerges from an open discourse in which participants hold a diversity of social values (Longino 1990; 2002). The second section takes up Harding's notion of strong objectivity, according to which science is more likely to be objective if it aims to promote egalitarian political goals, such as gender and racial equality, and emphasizes the perspectives of marginalized groups (Harding 1986; 2015). The third section is based on the argument from inductive risk (Rudner 1953; Douglas 2009), which attempts to show that scientists should consider social and moral costs of error when considering what is sufficient evidence for claims they make. Finally, the fourth section presents statements related to the idea that science, as an institution, has a responsibility to promote social justice (Kourany 2010). Please see Table 1 for a list of these four central instruments of the survey.

Table 1. Instruments Used in Current Study

Relevant Proposition	Measurement Instruments
The Longino Proposition *Diversity of social values tends to enhance scientific objectivity.*	The following questions ask you to consider your thoughts about scientific objectivity and how it relates to societal values. Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 1. It is possible for scientists to be guided by their societal values and still be objective when they: a. choose their general research topics b. select or frame their specific research questions c. design their study d. gather their data e. analyze their data f. report their results Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 2. Individual scientists are able to prevent their societal values from influencing their research decisions. 3. In some cases, scientific objectivity is ENHANCED when scientists' are guided by their societal values. 4. Objectivity requires input from a diverse variety of SCIENTIFIC perspectives. 5. Objectivity requires input from a diverse variety of SOCIETAL perspectives. 6. Input from diverse perspectives can make a scientific field objective, even if the decisions of individual scientists are influenced by their societal values.
The Harding Proposition *Scientific objectivity is strengthened by promoting social justice and framing research in light of the experiences of socially marginalized groups.*	The following questions ask you to consider your thoughts about the relationship between scientific objectivity and efforts to promote social justice (e.g., gender, racial equality).

Table 1. *(Continued)*

Relevant Proposition	Measurement Instruments
	Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 7. Scientific objectivity IS COMPROMISED when scientists' efforts to promote social justice guide how they: a. choose their general research topics b. select or frame their specific research questions c. design their study d. gather their data e. analyze their data f. report their results
	Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 8. Science is more likely to be objective if scientists aim to promote egalitarian values and oppose sexism, racism, and other forms of discrimination. 9. Science should aim to advance knowledge, while being neutral about political ideals. 10. Scientists should prioritize framing research questions in ways that reflect the experiences of economically and politically marginalized groups. 11. Science will ultimately discover the same basic facts and laws of nature no matter the cultural or social backgrounds of scientists. 12. Science that attempts to promote social equality will likely be of lower quality than more politically neutral research.
The Douglas Proposition *Scientists should consider the ethical and social costs of errors when deciding the sufficiency of evidence.*	The following questions ask you to consider your thoughts about the extent to which scientists should consider value judgments related to social, health, economic, or ecological harms that might occur if their claims turn out to be mistaken (e.g., mistakenly concluding that a new pharmaceutical does not have harmful side effects).

Table 1. *(Continued)*

Relevant Proposition	Measurement Instruments
	Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 13. Scientists should consider societal values in their decisions about what is sufficient evidence (such as sample size, p-values) when they: a. select or frame their specific research questions b. design their study c. gather their data d. analyze their data e. report their results Please indicate whether you disagree or agree with each of the following statements. [7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree] 14. If asserting a result when it is false would have very harmful consequences, then the claim should not be asserted unless the evidence for it is exceptionally strong. 15. Scientists have a moral responsibility to consider harms that might follow if their findings are wrong. 16. Scientists who consider the social costs of error when deciding whether or not to assert their results would NOT be objective. 17. Considering the social costs of error is the job of those who apply science to solve practical problems and NOT the job of scientists. 18. If scientists considered the social costs of error when deciding whether to assert their results, then the public would view science as politically biased.
The Kourany Proposition *Promoting social justice should be a core aim of science.*	The following questions ask you to consider your thoughts about whether science has a responsibility to advance public welfare, understood broadly to include such things as public health, environmental sustainability, as well as social justice and equality.

Table 1. *(Continued)*

Relevant Proposition	Measurement Instruments
	Please indicate whether you disagree or agree with each of the following statements. {7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree}
	19. When individual scientists have expertise related to certain public issues, they have a responsibility to do the following:
	a. publicly communicate the state of the science on the issue
	b. counter the public statements of influential people and organizations that misinterpret, ignore, or deny the state of the science on the issue
	c. support public decisions in line with the state of the science
	d. oppose public decisions at odds with the state of the science
	Please indicate whether you disagree or agree with each of the following statements. {7 response categories: strongly disagree, moderately disagree, slightly disagree, neither disagree nor agree, slightly agree, moderately agree, strongly agree}
	20. Science should NOT aim to promote equality or justice, because these concepts raise moral and political issues about which reasonable people disagree.
	21. The aim of science should be to advance knowledge, and attempting to promote social justice would be likely to conflict with this aim.
	22. Examples of sexist and racist science suggest that supposedly value-neutral science can in fact be harmful to economically and politically vulnerable groups.
	23. Scientists should NOT act as advocates in any circumstance, because doing so would lead to bias and compromise objectivity.
	24. The institution of science has a responsibility to advance human welfare, which includes promoting social justice.

Consider how the instrument avoids the three difficulties discussed in section 2. First, none of the statements in the instrument presuppose or suggest that objectivity and value-freedom are intrinsically conjoined. In item 1, for instance, respondents are asked whether guidance by social values is compatible with objectivity in six aspects of scientific work. A survey participant who believes that objectivity requires freedom from societal values in any of these contexts is therefore free to express this view, and similarly for one who holds the opposite opinion.

Second, the survey instrument asks both about the possibility and desirability of value freedom. The "can" issue is raised in item 2, that states, "Individual scientists are able to prevent their societal values from influencing their research decisions." Whether science should be value-free is raised in different ways in the instrument. These statements include numbers 8 ("Science is more likely to be objective if scientists aim to promote egalitarian values and oppose sexism, racism, and other forms of discrimination"), 15 ("Scientists have a moral responsibility to consider harms that might follow if their findings are wrong"), and 24 ("The institution of science has a responsibility to advance human welfare, which includes promoting social justice"). Oppositely phrased statements on these issues are also included, such as number 17 ("Considering the social costs of error is the job of those who apply science to solve practical problems and NOT the job of scientists") and number 21 ("The aim of science should be to advance knowledge, and attempting to promote social justice would be likely to conflict with this aim"). Each of these statements asserts some negative or positive aspect of the value-free ideal, thereby enabling respondents to express their views about its desirability, as distinct from its possibility.

Finally, the instrument was designed to indicate that "values" was intended in a non-epistemic sense. Several steps were taken to accomplish this. The term "values" was associated with qualifiers such as "societal" or "political" that would suggest a non-epistemic interpretation, and in some cases non-epistemic values, such as social justice, were named. In addition, a brief statement was inserted to introduce each of the four question groups that reinforced the non-epistemic interpretation of "values." For example, in the case of inductive risk, this statement read, "The questions on this page ask you to consider your thoughts about the extent to which scientists should consider value judgments related to social, health, economic, or ecological harms that might occur if their claims turn out to be mistaken (e.g., mistakenly concluding that a new pharmaceutical does not have harmful side effects)."

In addition, by providing a more comprehensive coverage of philosophical aspects of the value-free ideal, the instrument was designed to provide a more refined picture of the ways in which respondents agreed or disagreed with the value-free ideal. The four groups of prompts were linked to four philosophical positions that depart from the value-free ideal, as explained above.[5] Suppose respondents were on average inclined to agree that scientists have a responsibility to consider social costs that might result if claims they make turn out to be false, but are inclined to disagree with the idea that promoting social equality would make science more objective. Then data generated by our instrument could reveal this.

The initial run of the instrument suggested several further improvements. The instrument could be shortened, which might increase the response rate and the rate of completed surveys among those who start the survey. For example, the initial six questions about academic background could be reduced to one and moved to the end of the survey with the three demographic questions. Some specific suggestions about statements that might be removed based upon the data analysis are discussed in the next subsection. In addition, clarity of the wording of some statements could be improved. Some respondents found statement 20 confusing: "If asserting a result when it is false would have very harmful consequences, then it should not be done unless the evidence for it is exceptionally strong." A better rendition would be, "If a mistaken claim would have very harmful consequences, then scientists should require exceptionally strong evidence before making an assertion."

5. Robinson et al. also link four of their five prompts to the same philosophical positions, but these linkages are somewhat tenuous (Robinson et al. 2016, p. 4). For example, they associate, "Objectivity implies an absence of values by the researcher," with Longino's (1990; 2002) contextual empiricism. While an implication of Longino's approach, the denial of this statement does not express the key idea of contextual empiricism that objectivity is a social property resulting from open discussion involving diverse values. They also associate, "Incorporating one's personal perspective in framing a research question is never valid," with Harding's (1986; 2015) strong objectivity. But "personal perspectives" does not capture Harding's emphasis on promoting social equality and foregrounding views of marginalized groups as a remedy for epistemic distortions generated by oppressive social hierarchies. The statement, "Allowing values to influence scientific research is advocacy," is connected to Kourany's (2010) position that science has an obligation to promote social equity and human welfare. However, this statement only asks whether value-laden science is tantamount to advocacy, not whether advocacy is good or whether science should have moral as well as epistemic aims. The association between, "Determining what constitutes acceptable validation of research data is a value issue," and the argument from inductive risk (Rudner 1953; Douglas 2009) is on more solid ground. But the argument from inductive risk is usually framed in relation to accepting hypotheses, not data. That it might be applied to the latter case was an innovation of Douglas (2000) that was not considered by Rudner (1953).

3.2. Survey Results

The survey instrument was administered online to science faculty at the University of British Columbia in Vancouver, Canada in 2016. We interpreted "science" broadly to include social and natural sciences as well as health research. A total of 244 participants responded to the survey (N=244, response rate 7%). Among these, 43% are in medical and health sciences, 14% in life sciences, 14% in engineering, 7% in physical science and mathematics, 7% in social and behavioral science, and the remaining 12% are faculty members are in education, business, and architecture (3% did not answer this question). The age distribution was widely spread: 13% are 30–39 years old, 28% 40–49, 14% 50–59, 26% 60–69, and 14% of them are over 70 years old (4% are under 30 or did not respond to this question). In addition, 58% of the respondents are male, 35% female and 7% identified themselves as neither or did not answer this question. With regard to ethnicity, 79% of the respondents identified themselves as white, while 18% identified as having a different ethnicity other than white, and 3% did not respond to this question.

In the survey, some statements are positively phrased in relation to a value-free conception of science (so agreement would express agreement with some aspect of the ideal), while others were negatively phrased. We reverse coded responses to the negatively phrased statements (i.e., 1 becomes 7, 2 becomes 6, and 3 becomes 5). Consequently, a Likert response of less than 4 indicates disagreement with the value-free perspective, while a response of greater than 4 indicates agreement with it. Not all respondents submitted answers to all survey items. Of the 11,439 Likert responses possible for our sample size (279 participants × 41 items per survey), 1603 were left blank, which is just over 14%. We filled in missing Likert responses with 4.01's. As 4 is the midpoint of the Likert scale indicating "neither agree nor disagree," assigning 4 to non-responses appears to be reasonable, while the additional .01 enables later differentiation of non-responses from those who entered 4.

We used Cronbach's alpha to assess how strongly associated responses were within each group of statements. The statements were divided according to the four-part division explained above, but with the lettered items treated as separate statement groups. Thus, items 1a through 1f were one group, as were items 2 through 6, items 7a through 7f, items 8 through 12, and so on. A value of Cronbach's alpha equal or greater than .70 is usually considered acceptable. With one exception, the Cronbach's alpha score for the statement groups was above this threshold, the exception being for the second group of statements, corresponding to items 2 through 6. When items 2 and 4 were excluded, Cronbach's alpha rose above the threshold. This result is not surprising for item 4 ("Objectivity requires input from a diverse variety of SCIENTIFIC perspectives"), which was included only as a contrast with statement 5 ("Objectivity requires input from a diverse variety of SOCIETAL perspectives"). The situation for item 2 ("Individual scientists are able to prevent their societal values from influencing their research decisions") is more interesting. This statement was included because it is a premise of contextual empiricism, according to which objectivity is not achieved by individuals but only as the result of a process of community criticism. However, the Cronbach's alpha analysis suggests that this was not a connection strongly made among the survey respondents.

To simplify analysis and to take advantage of consistent responses to thematically related groups of prompts as suggested by Cronbach's alpha, we constructed two composite variables from each thematic group, which we are labeled Longino1, Longino2, Harding1, Harding2, Douglas1, Douglas2, Kourany1, and Kourany2. The first composite variable in each pair records the individual's average response to the lettered prompts. For example, Longino1 is the average of items 1a through 1f. The second composite variable in each pair is the average of the unlettered prompts in that group. For instance, Harding2 is the average of items 8 through 12. The only exceptions to this pattern are items 2 and 4, which were omitted from Longino2 as a result of the Cronbach alpha analysis. In this case, the composite variable is just the average of the non-omitted variables.

In order to assess the extent to which scientists in our sample were inclined to agree or disagree with the value free ideal, we examined the means of all of the composite variables, comparing these against the scale's midpoint of 4 using a series of one-sample *t*-tests. We also used Holm's method (Holm 1979) to correct for familywise error rate. The results of the one-sample *t*-tests are summarized in Table 2.

The analysis of the means confirms some key findings of previous empirical work on scientists' views about values in science reviewed in section 2. One consistent finding noted there was a tendency of scientists to delink objectivity from value-freedom. This result is replicated in our data, as illustrated by the responses to the Longino1 composite variable, which asked respondents whether scientists could be objective even if their decisions in various aspects of research were guided by societal values. The mean for Longino1 is 2.86, below the midpoint of 4.0 by a statistically significant margin, thereby indicating disagreement with the value-free position on this issue. In addition, the results for the Kourany1 and Kourany2 variables are consistent with the findings of the more recent studies reviewed in section 2 that scientists frequently regard advocacy in a positive light. Finally, the direction of the means overall—statistically

Table 2. Summary of means, standard deviation, and results from one-sample *t*-tests for each of the prompts. Composite variables marked with an asterisk (*) are significant, correcting for familywise error rate using Holm's method.

Composite	*t*	df	*P*	*M*	*SD*
Longino1*	−12.38	278	<.001	2.86	1.53
Longino2*	−5.13	278	<.001	3.57	1.40
Harding1	0.32	278	.751	4.03	1.62
Harding2	1.32	278	.188	4.08	1.09
Douglas1	−1.18	278	.240	3.86	1.93
Douglas2*	−12.10	278	<.001	3.18	1.14
Kourany1*	−21.37	278	<.001	2.39	1.26
Kourany2*	−10.07	278	<.001	3.24	1.26

significantly less than the midpoint for five of the composite variables and statistically indistinguishable from the midpoint for the other three—reinforces the general sense from earlier work that the value-free ideal is not a dominant perspective among scientists.

In addition, we compared mean responses to the eight composite variables broken down by gender, again controlling the familywise error rate using Holm's method. The overall pattern displayed by this analysis is that the means for female responses are statistically indistinguishable from or less than those of their male counterparts. The two composite variables for which statistically significant effects were found are Harding2 and Kourany2. Female scientists (n = 86, M = 3.77, SD = 1.08) were more inclined to agree with anti-value-free view(s) probed by the second Harding propositions than were male scientists (n = 142, M = 4.26, SD = 1.20), with $t(226)$ = 3.14, p = .002, d = .42. This is an association that could not have been detected in earlier work, as previous instruments did not include useful items relating to standpoint epistemology. Female scientists (n = 86, M = 2.77, SD = 1.37) were also more inclined to agree with anti-value-free view(s) probed by the second Kourany propositions than were male scientists (n = 142, M = 3.23, SD = 1.18), with $t(226)$ = 2.74, p = .007, d = .36. A statistically significant result, the Kourany proposition is consistent with the prior finding by Reiners and colleagues (2013a) concerning a gender effect on the topic of advocacy, noted in section 2.3. We did not, however, replicate Steel and colleagues (2017) by finding a

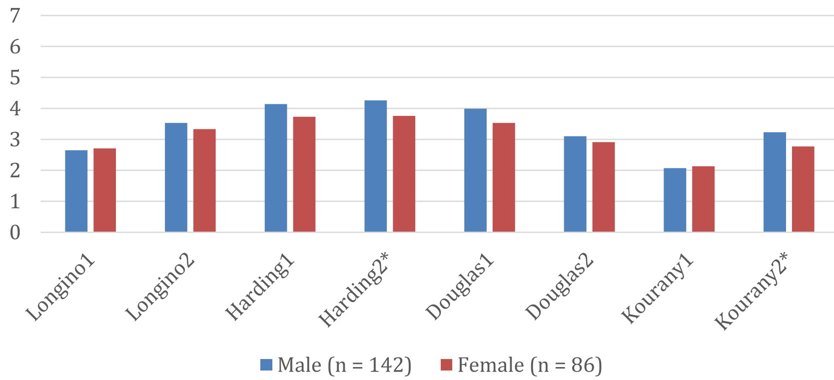

Figure 1. Mean responses for composite variables separated by gender. Asterisks (*) indicate statistically significant (p. < 0.05) differences, correcting for the familywise error rate using Holm's method.

statistically significant effect for either of the Douglas composite variables, although Douglas2 came close.[6] The results of the gender analysis are displayed by the graph in Figure 1.

In addition, we analyzed the data to learn whether the two statistically significant gender effects presented in Figure 1 are explained by other demographic or disciplinary categories we measured. To address this question, responses to the composite scores for Harding2 and Kourany2 were regressed on five demographic variables. Three were dummy variables: *gender* ("male" = 0, "female" = 1); *race* ("nonwhite" = 0, "white" = 1), and *field* ("respondents' current academic position is in a field other than education, medicine, or the social and behavioral sciences" = 0, "respondents' current academic position is in education, medicine, or the social and behavioral sciences" = 1). *Age* captures participants' age in one of six categories ("20–29" = 1 and "70 or higher" = 6). Finally, *position* reflects participants' current academic position (1 = "graduate student or post-doctoral student", 2 = "adjunct professor or assistant professor (non-tenure stream), 3 = "assistant professor (tenure stream)", 4 = associate professor (without tenure) or associate professor (with tenure), 5 = full professor (without tenure) or full professor (with tenure)", and 6 = "professor emeritus". The latter two variables were treated as continuous variables. For both composite variables, a significant regression equation was found: Harding2 ($F(5, 198) = 3.82$, $p = .002$, Adjusted $R^2 = .07$) and Kourany2 ($F(5, 198) = 4.33$, $p = .001$,

6. The numbers for Douglas2 are as follows: female scientists ($n = 86$, $M = 3.53$, $SD = 2.08$) versus male scientists ($n = 142$, $M = 3.99$, $SD = 2.04$): $t(226) = 1.66$, $p = .098$, $d = .22$.

Adjusted R^2 = .08). Table 3 presents the results for each of the five predictors included in the two OLS models.

In both of these models, statistically significant effects for Gender and Field were found, and for those two predictors only, although Age comes close for Kourany2. These results suggest that the gender effect found for the Harding2 and Kourany2 composite variables in our sample is not explained by any of our other predictor variables. Furthermore, the effect of Field is in a plausible direction, as it indicates that respondents in education, medicine, or the social and behavioral sciences—essentially, non-natural scientists—were more likely to disagree with the value-free position than other respondents (i.e., natural scientists). Let us consider, then, hypotheses that might explain these results.

4. Socialization and Standpoint

In this section we articulate two hypotheses that may be helpful for interpreting the gender effects described in the previous section. We call these the gender socialization hypothesis and the standpoint epistemology hypothesis.

Let us begin with the first of these. Gender socialization refers to processes through which people learn norms, expectations, and stereotypes related to gender prevalent in their society and internalize them as part

Table 3. Regression analysis for the Harding2 and Kourany2 composite variables.

	B	*SE B*	Β	*T*	*P*
Harding2					
Gender	−0.50	0.18	−.20	−2.73	.007
Race	0.09	0.23	.03	0.39	.700
Field	−0.46	0.17	−.19	−2.71	.007
Age	0.04	0.07	.04	0.47	.642
Position	−0.05	0.07	−.07	−0.77	.444
Kourany2					
Gender	−0.52	0.19	−.20	−2.68	.008
Race	−0.03	0.25	−.01	−0.11	.913
Field	−0.51	0.18	−.20	−2.84	.005
Age	0.15	0.08	.16	1.93	.056
Position	−0.12	0.07	−.15	−1.69	.094

of their own identity (Rittenour et al. 2014; Kuhnert et al. 2017). This perspective suggests that women and men will tend to be motivated to engage in prosocial behavior—that is, voluntary behavior aimed at helping other people (Eisenberg and Mussen 1989)—in ways that accord with stereotypical gender roles. One development of this idea focuses on a distinction between agentic and communal prosocial behaviors (Eagly 2009; Diekman and Clark 2015). Agentic prosocial behaviors involve taking the initiative, often at personal risk, with the opportunity to earn status (e.g., as being heroic). Examples include saving a child from a burning building or killing a lion that preys on livestock and people in a remote village. In contrast, communal prosocial behaviors are typified by standing relationships with those helped, special concern for socially disadvantaged people, and long-term commitments. Examples here include providing extended care for an ill relative, or a schoolteacher devoted to educating children in an impoverished community. Agentic prosocial behaviors are stereotypically masculine, while communal prosocial behaviors are stereotypically feminine. The key idea, then, is that women are more likely to engage in prosocial behaviors that fit the stereotype associated with their gender, and likewise for men. Note that this is intended as a statistical hypothesis about average differences between groups, not as a deterministic prediction of individual actions. In addition, the hypothesis predicts similar proclivities to prosocial behavior across genders when no context is provided for the action or when the context involves both agentic and communal elements.[7]

Consider how the above connects to the relationship between gender and scientists' views on the value-free ideal. A scientist whose identity is strongly linked to communal prosocial aims may be more likely to choose research projects that provide opportunities to express that identity, for example, by selecting a field or research project that aims to promote human welfare or reduce social inequities (Diekman et al. 2010). And such scientists may be more likely to see communal prosocial aims as inherent to their own work and scientific investigation in their fields more generally. The gender socialization hypothesis, then, can be stated as follows: "Female scientists are more likely than their male peers to agree that science should have communal prosocial aims, such as promoting welfare and equity."

Consider this hypothesis in connection with items 20 through 24 of the survey instrument from which the Kourany2 composite variable is

7. That men and women exhibit similar levels of prosociality in neutral contexts appears to be supported by research involving economic games (cf. Croson and Gneezy 2009). Espinosa and Kovárik (2015) argue that the association between female gender and prosociality reappears when games are framed in a manner that suggests a communal context (e.g., the other player is a friend).

derived. These items invite respondents to express their views on whether science, as an institution, has a responsibility to promote human welfare and social justice. These statements are framed in a manner that highlights communal rather than agentic prosociality. Due to its reliance on public funding, academic science is often thought to have a standing relationship with home provinces, states, or countries that create responsibilities to do social good. The emphasis on social justice and welfare naturally suggests concern for socially disadvantaged people. Finally, framing the issue in terms of a responsibility of science as an institution suggests a long-term commitment, rather than a one-off action initiated by a heroic individual. Thus, if the gender socialization hypothesis is correct, then one would expect that women would be less likely than men to agree with statements such as 20 ("Science should NOT aim to promote equality or justice, because these concepts raise moral and political issues about which reasonable people disagree") and more likely to agree with statements such as 24 ("The institution of science has a responsibility to advance human welfare, which includes promoting social justice"). In short, the hypothesis predicts that the mean of the Kourany2 composite variable will be lower among women than men, which is the case in our data.

There was, however, no association between gender and responses to the Kourany1 composite variable in our data set. Given the gender socialization hypothesis, this difference can be explained by a substantive difference between Kourany1 and Kourany2. The statements included in Kourany1 concern the responsibility of an individual scientist to engage in important public issues related to his or her expertise. Unlike statements about the social responsibilities of science as an institution, this framing suggests an agentic context in which the individual scientist takes the initiative to enter public debate. Nevertheless, the background relationship between publicly funded researchers and the society who supports them is still present. Since, both agentic and communal elements are salient in the items included in Kourany1, the gender socialization hypothesis predicts no clear difference in responses by gender.

Turn, then, to the standpoint epistemology hypothesis. According to Wylie, standpoint epistemology is "characterized by the thesis that those who are marginalized or oppressed under conditions of systemic inequity may, in fact, be better knowers, in a number of respects, than those who are socially or economically privileged" (Wylie 2012, p. 47). This proposition is sometimes referred to as the thesis of epistemic advantage, which along with the situated-knowledge thesis is taken to comprise standpoint epistemology (Rolin 2006; Intemann 2010, p. 783). According to the situated-knowledge thesis, "social position shapes and limits what we can know because it influences the kind of experiences one has" (Intemann 2010, p. 784). Those who defend standpoint epistemology take pains to distinguish it from gender essentialism. Thus, the epistemic advantage in question is neither universally held by those who are marginalized or oppressed nor always absent among others (Rolin 2006; Intemann 2010; Wylie 2012). Moreover, the knowledge in question is said to take the form of a standpoint, which is distinct from an individual perspective or belief. Instead, standpoints arise "through a critical, conscious reflection on the ways in which power structures and resulting social locations influence knowledge production" (Intemann 2010, p. 785). This critical reflection is, furthermore, a collective effort so that standpoints are achievements of a community (Intemann 2010, p. 786).

Regarding standpoint epistemology's implications for the value-free ideal, Intemann states:

> standpoint feminism … takes certain ethical and political values to be central to inquiry and rejects the view of science and objectivity as "value-free." It is this normative commitment that also grounds standpoint theorists' claims that research involving or affecting marginalized groups should begin with the lives and experiences of those marginalized groups… The aim here is to examine power relations, institutions, policies, and technologies that perpetuate oppression from the perspective of the oppressed, so that they may be changed, undermined, or abolished. (Intemann 2010, p. 786)

Thus, standpoint epistemology diverges from the value-free ideal by asserting that combatting oppression should be an aim of science, and that the quality of science can be enhanced through careful attention to the value-laden standpoints of marginalized or oppressed people.

For the present purposes, we are interested in standpoint epistemology as an empirical hypothesis that can generate predictions concerning the relationship between gender and views about the value-free ideal among scientists. A first step in this direction is to understand the thesis of epistemic advantage as a statistical hypothesis, according to which being socially marginalized or oppressed makes one more likely to be a better knower in some respects. As the latter emphasis indicates, the epistemic advantage is not thought to be comprehensive (Intemann 2010, p. 783; Wylie 2012, p. 47). It is only said to pertain to some areas or aspects of knowledge, presumably those related to the marginalization or oppression in question. For example, as a result of being subject to gender discrimination, women might be more likely than men to be knowledgeable of it and the social mechanisms whereby it operates. Understood statistically, then, standpoint epistemology predicts that, if representative samples of men and women responded to a valid instrument for measuring knowledge of gender discrimination, the mean score among the women would be higher than that for the men. Note that the statistical interpretation is consistent with the claim that standpoint epistemology does not entail essentialism.

The statistical interpretation is also consistent with the claim that standpoints are collective achievements; it only assumes that an epistemic achievement of a collective tends to improve the knowledge of its members. One might wonder whether membership in a group that is subject to discrimination can lead to enhanced knowledge of social processes related to that discrimination, without the mediating step of a collectively achieved standpoint that is understood as a collective epistemic achievement.[8] While we see no reason to exclude this possibility *a priori*, it is plausible that people are more likely to recognize particular instances of mistreatment as manifestations of a general pattern given discussions with others who have had similar experiences.

A statistical interpretation of standpoint epistemology, then, entails that, due to experiencing oppression related to gender, women are more likely than men to possess knowledge related to this oppression. Moreover, if standpoint epistemology is correct, such knowledge may include the epistemic advantage and situated-knowledge theses articulated by standpoint epistemology itself. For example, female scientists would not only be more likely than their male colleagues to be aware of androcentric biases present in their fields, they may also be more likely to notice that men are more frequently oblivious to such biases than women. Such observations would naturally suggest that what one is likely to know can depend on one's social situation, and that people who are on the receiving end of discrimination, or oppression more generally, are more likely to have an accurate understanding of it. For the present purposes, then, the standpoint epistemology hypothesis can be stated as follows: "Female scientists are more likely than their male peers to agree with the epistemic advantage and situated-knowledge theses."

Consider this hypothesis in connection with items 8 to 12 of the survey instrument. If the hypothesis is correct, one would expect women to be more likely than men to agree with statements such as 8 ("Science is more likely to be objective if scientists aim to promote egalitarian values and oppose sexism, racism, and other forms of discrimination") and more likely to disagree with 11 ("Science will ultimately discover the same basic facts and laws of nature no matter the cultural or social backgrounds of scientists"). In short, the standpoint epistemology hypothesis predicts that the mean for the Harding2 composite variable will be lower for women than for men, which coincides with our data.

8. We thank an anonymous referee for raising this issue.

However, a challenge for the standpoint epistemology hypothesis is that there was not a statistically significant gender effect for the Harding1 composite variable.[9] Unlike the case of Kourany1 and Kourany2, Harding1 and Harding2 appear thematically similar. The association between gender and Harding1 is in the predicted direction (i.e., women are more inclined to disagree with the value-free perspective than men), the means for males and females are similar to those for Harding2, but the difference in means for Harding1 falls just short of statistical significance.[10] So, one possibility is that the data were insufficiently powered to detect the effect that was present as predicted by the hypothesis. Additional possibilities are that there is some hidden difference between Harding1 and Harding2, or that the standpoint epistemology hypothesis is simply false.

We do not suggest that the two hypotheses articulated here are the only possible interpretations of the data. Besides the possibility of additional mechanisms linking gender to views about the value-free ideal, it is impossible to know at this stage how robust and replicable the results reported in section 3.2 will prove to be. However, we regard the gender socialization and standpoint epistemology hypotheses as promising starting points for research on the relationship between gender, values, and science.

5. Concluding Discussion

The chief contributions of this paper have been the following:

- We review previous survey work on scientists' views about the ideal of value-free science, and identify three key limitations in the survey instruments employed.
- We present a new survey instrument designed to overcome these limitations, and report data generated using it.
- Our data strengthen earlier results casting doubt on the assumption that the value-free ideal is a dominant position among scientists and refine earlier work by suggesting that scientists are more inclined to disagree with the value-free ideal in some ways than others.
- Our data also suggest two possible gender effects, and we articulate hypotheses that might explain them.

9. An anonymous referee suggests that the standpoint epistemology hypothesis would also predict that women would be more likely to agree with statements included in the Longino2 composite variable. We disagree with this suggestion, as Longino2 concerns the benefits to objectivity of a diversity of social perspectives, which could include perspectives related to maintaining an inequitable status quo (e.g., androcentrism).

10. The numbers for Harding1 are: female scientists (n = 86, M = 3.73, SD = 1.79) versus male scientists (n = 142, M = 4.14, SD = 1.69): $t(226) = 1.72$, p = .087, d = .23.

These conclusions should be considered with some limitations in mind. It is uncertain how representative our survey sample, or the samples of the surveys we review, actually are. In addition, designing valid survey instruments on issues related to values and science is an inherently complex task, as the discussion in section 2.3 shows. While we regard our present work as a step forward, we also recognize that further refinements may be forthcoming. Finally, the two hypotheses concerning gender effects were developed to explain the survey results rather than proposed in advance, so further studies specifically designed to test them would be desirable.

We close by considering what significance our study or further research in a similar vein might have. We offer three responses to this question. First, claims about views of scientists—for instance, that the value-free ideal is the dominant perspective (Harding 2015, pp. 1–2)—sometimes serve as background assumptions or premises for philosophical discussions of science and values. So, it is useful to assess whether such claims are true. Second, philosophical claims may have empirical aspects on which surveys or other social science methods may shed light. For example, standpoint epistemology suggests that social position influences what a person is likely to know. One way to explore standpoint epistemology, therefore, is to carefully work out some of these implications and put them to empirical tests. Moreover, we do not think standpoint epistemology is unique in this regard. Finally, the gender effects found in our data and the hypotheses we have developed to account for them are significant in several respects. They suggest the intriguing possibility that changing gender demographics in a scientific field might impact how its members tend to view the relationship between science and values. Such a possibility is of theoretical interest for philosophical and social understandings of science. The hypotheses we develop are also of practical interest insofar as suggesting that prevailing views regarding value-freedom or neutrality within a field may have an effect on how attractive it is to aspiring female scientists. Research on the relationship between gender and scientists' views about the value-free ideal, therefore, promises to offer a significant perspective on science.

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Appendix: Survey Instruments from Reviewed Studies

Study	Samples	Key Measurement Instruments
Lach et al. 2003	Four samples in the Pacific Northwest: university & federal agency scientists (N=155); managers of state & federal natural resource programs (N=167); members of public interest groups (N=119); & members of the "attentive public" (N=198)	"Attitudes about Proper Roles of Scientists" Instrument We would like to know what you think should be the proper role of scientists in natural resource management decisions. Please indicate your level of agreement or disagreement with the following statement. [5 response categories: "strongly disagree" to "strongly agree"] • Scientists should only *report* results and leave others to make management decisions. • Scientists should report results and then *interpret* for others involved in management decisions. • Scientists should work closely with managers and others to *integrate* scientific results into management decisions. • Scientists should actively *advocate* for specific natural resource management decisions. • Scientists should *make decisions* about natural resource management.
Steel et al. 2004	Lach et al. (2003) samples	Lach et al.'s (2003) "Attitudes about Proper Roles of Scientists" Instrument "Attitudes toward Positivism" Instrument In recent years there has been increasing debate about what makes for reliable scientific findings that can be used with confidence to make important decisions. Please take a moment to let us know how you characterize

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
		science and the scientific process by indicating your level of agreement or disagreement with the following statements. [5 response categories: "strongly disagree" to "strongly agree"] • Use of the scientific method is the only certain way to determine what is true and false about the world. • The advance of knowledge is a linear process driven by key experiments. • Science provides objective knowledge about the world. • It is possible to eliminate values and value judgments from the interpretation of scientific data. • Facts describe true states of affairs about the world.
Gray & Campbell 2009	1st International Marine Protected Areas Congress attendees from academic institutions (N=57); government agencies (N=73); nongovernment organizations (N=50); & other (N=19)	Lach et al.'s (2003) "Attitudes about Proper Roles of Scientists" Instrument Steel et al.'s (2004) "Attitudes toward Positivism" Instrument
Singh et al. 2014	Participants at 9 conservation- & ecology-related conferences that focused on ecology, environment, & land or natural resource management (N=508)	slight adaptation of Lach et al.'s (2003) "Attitudes about Proper Roles of Scientists" Instrument (slight wording changes & an example of each role) Steel et al.'s (2004) "Attitudes toward Positivism" Instrument
Reiners et al. 2013a	Non-student US members of the Ecological Society of America (N=1215)	"Engagement in Advocacy Activities" Instrument How often do you provide financial support for an environmental cause as a private citizen? [6 response

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
		categories: "never" to "more than 12 times a year"]
		Approximately how much money do you donate to environmental causes each year? [6 response categories: "$0" to "more than $5000"]
		How important is it to you to engage in some personal environmental action each day (such as bicycling to work, recycling paper, or buying green products? [6 response categories: "not at all important" to "extremely important"]
		Approximately how often do you write letters to an editor, politician, or agency concerning an environmental cause, as a self-identified professional ecologist? [6 response categories: "never" to "more than 12 times a year"]
		How often do you speak publicly concerning an environmental cause, as a private citizen without referring to your ecological expertise? [6 response categories: "never" to "more than 12 times a year"]
		How often have you provided organizational leadership for or against an environmental cause such as prohibiting beach development? [4 response categories: "never" to "4 or more times"]
		Approximately what percentage of your scientific research is funded by an advocacy source such as The Nature Conservancy or the Electric Power Research Institute? [integer between 0 and 100]

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
		"Effects of Advocacy on Scientific Activity" Instrument An ecologist who is also an 'environmental activist' (i.e., is openly supportive of environmentalism and expresses beliefs that risks to the environment are real and serious) is just as likely to: [7 response categories: "strongly disagree" to "strongly agree"] • be objective. • contribute to understanding nature. • contribute to the betterment of society. • have a long and fulfilling scientific career. "Attitudes toward Value-Free Objectivity in Research" Instrument Please indicate your level of disagreement or agreement with the following statements. [7 response categories: "strongly disagree" to "strongly agree"] • The pursuit of [basic/applied] research by ecologists is purely objective and value-free. • The pursuit of [basic/applied] research by ecologists can be purely objective and value-free. • The pursuit of [basic/applied] research by ecologists should be purely objective and value-free.
Crawford et al. 2016	Ecology & biology undergraduate students (N=37), graduate students (N=77), & faculty (N=38) at the University	"Perceived Advocacy" Instrument Please indicate your belief about whether each activity is a form of

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
	of Georgia; science & policy professionals at state and federal government agencies (N=48); & science & policy professionals at conservation or environmental nongovernmental organizations (N=49)	advocacy. [7 response categories: "strongly disagree" to "strongly agree"] • Publishing in a peer-reviewed journal • Presenting scientific findings at professional conferences • Accepting funding from an interest group • Performing advisory roles within a scientific society • Appearing before a court or legislative body as a topical expert • Presenting scientific findings at public events • Publishing in media that targets specific interest groups • Performing advisory roles within an interest group • Writing to Congress regarding environmental policy "Acceptable Conduct of Scientists" Instrument Please indicate the degree that scientists should exhibit each of the following practices. [7 response categories: "strongly disagree" to "strongly agree"] • Avoid all forms of advocacy • Feel obligated to engage in advocacy • Receive training to be more effective advocates • Engage in advocacy to improve environmental policy

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
		• Advocate if they distinguish between facts and values • Work closely with managers and policy makers "Norms about the Acceptability of Scientists to Engage in Activism" Instrument Please indicate how unacceptable or acceptable you believe the following behaviors of scientists are. [7 response categories: "highly unacceptable" to "highly acceptable"] • Providing research-based information to policy makers • Donating money to environmental causes • Offering policy recommendations in peer-reviewed publications • Advocating for a policy in an editorial for public media • Receiving and using funds from an advocacy group • Providing leadership for advocacy groups
Robinson et al. 2016	Participants in 43 workshops conducted by the Toolbox Project between March 2009 and October 2013 (N=355)	"STEM Values" module Please indicate your level of disagreement or agreement with the following statements. [5 response categories: "strongly disagree" to "strongly agree"] • Objectivity implies an absence of values by the researcher. • Incorporating one's personal perspective in framing a research question is never valid.

Appendix. *(Continued)*

Study	Samples	Key Measurement Instruments
		• Value-neutral scientific research is possible. • Determining what constitutes acceptable validation of research data is a value issue. • Allowing values to influence scientific research is advocacy.
Steel et al. 2017	For first four statements: 289 interdisciplinary scientists participating in 43 Toolbox workshops	Slight adaptation of Robinson et al.'s (2016) "STEM Values" module (the following is used in place of the fifth statement: "Biomedical researchers should engage in advocacy related to their research.")
	For fifth statement: 66 interdisciplinary health scientists participating in 7 Toolbox workshops	The respondents for the new fifth statement were different from those who answered the first four statements (Steel et al. 2017, 25)