

## Original Research Reports

# Not All Education is Equally Liberal: The Effects of Science Education on Political Attitudes

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### Abstract

Education stands as a potent predictor of political attitudes; however, the underlying mechanisms and moderators of this relationship are not well-understood. We hypothesize that the liberalizing effect of education is moderated by discipline, and that the scientific ethos that serves to guide empirical inquiries facilitates the development of more liberal political attitudes via concerns about fairness and equality. As predicted, being educated in a science-related discipline, as opposed to a non-science discipline, was associated with greater political liberalism; importantly, this effect could not be accounted for by self-selection (Study 1). Furthermore, concerns about fairness and equality, as captured by an individual's social dominance orientation, mediated the relationship between studying science and political liberalism (Study 2). Study 3 replicated these findings and attest to their generalizability. Study 4 directly assessed the underlying mechanism, endorsement of the scientific ethos, and replicated the mediational model; those who endorsed the scientific ethos more strongly reported more liberal political attitudes, and this was mediated by their lower social dominance orientation.

**Keywords:** education, social dominance, political orientation, attitudes, scientific ethos

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Education has long been considered an important factor in shaping attitudes and behavior. A growing body of research suggests that individuals' educational experiences influence their inferences about both the physical (Peng & Knowles, 2003) and social world (Hastie, 2007; Pascarella & Terenzini, 1991; Stubager, 2008). Not surprisingly, a number of recent studies have demonstrated that education emerges as a critical factor that differentiates political liberals from political conservatives (e.g., Schoon, Cheng, Gale, Batty, & Deary, 2010). Nevertheless, the question remains as to the underlying mechanisms that account for the education-political liberalism link and its boundary conditions. What psychological processes explain the relationship between education level and political attitudes? Furthermore, to what extent does the content of one's education moderate the relationship between education and politics?

A variety of studies have been conducted on the impact of college education on the values, beliefs, and behaviors across a variety of domains, including sexuality (e.g., at Aristotle University in Thessaloniki, Greece—Papaharitou et al., 2008), politics (e.g., at ten Southern California universities in the USA—McClintock & Turner, 1962; at the University of Missouri in St. Louis, Missouri, USA—Thumin, 1972; for a more recent review, see Hastie, 2007), environmentalism (e.g., at Bloomberg University in Pennsylvania, USA—Lang, 2011), and social attitudes (e.g., at a private prestigious university in the Eastern USA—Lottes & Kuriloff, 1994). The general consensus has been that a university education has a liberalizing effect, such that college seniors report more liberal attitudes than freshman (e.g., at Bennington College in Vermont—Newcomb, 1943/1957; for review, see Feldman & Newcomb, 1969a, 1969b). Cognitive theorists have attempted to explain this effect by positing that education promotes the ability to link new ideas, which in turn allows for a more liberal orientation (Gaasholt & Togeby, 1995).

Beyond the general liberalizing effect of higher education, existing research has also begun to examine how the specific content of one's education predicts attitudes and behavioral outcomes. Studies that have focused on attitudinal correlates of educational discipline have largely focused on political attitudes, and found that relative to those whose fields focus on corporations and profit, those whose fields focus on individuals and social groups tend to be more politically liberal (e.g., among members of professional groups, like APA psychologists—Spaulding & Turner, 1968; among participants of the Family Survey Dutch Population—Van de Werfhorst & de Graaf, 2004).

Additional studies have extended these findings to behavioral outcomes. Relative to other majors, economics students emphasize self-interest in ultimatum games and allocate smaller amounts of money to the responder than did arts and science students (e.g., at the College of the Holy Cross in Massachusetts, USA—Carter & Irons, 1991), display less cooperation in the prisoner's dilemma game (for review, see Frank, Gilovich, & Regan, 2000), donate less frequently to charitable causes (e.g., at the University of Washington, USA—Bauman & Rose, 2011), behave in less environmentally-friendly ways (e.g., at Bloomberg University in Indiana, USA—Lang, 2011), and show less favorable attitudes towards the disenfranchised (e.g., at an Ontario University, Canada—Guimond, Begin, & Palmer, 1989; Guimond & Palmer, 1996). Recent empirical research has attempted to account for these findings by demonstrating that students whose studies focus on the financial sector possess more positive and less immoral associations with greed (for review, see Wang, Malhotra, & Murnighan, 2011).

Along a slightly different vein, studies have also found that the content of one's college education influences more general tendencies towards openness to experience, with those in science fields displaying more openness than those majoring in other fields (e.g., at Saint Louis University in Missouri, USA—Chibnall, Blaskiewicz, & Detrick, 2009). These attitudes have been corroborated with additional studies that have found that both arts and science students tend to be more tolerant and accepting of taboo sexual behaviors, including extramarital relationships, homosexuality, and controversial sexual practices (e.g., at Aristotle University in Greece—Papaharitou et al., 2008). More generally, however, choice of major also influences the norms individuals rely on when making moral judgments (e.g., at a large regional public university in the Southeastern USA—Livingstone, Derryberry, King, & Vendetti, 2006) and attributions of causality (e.g., at an Ontario University, Canada—Guimond et al., 1989).

While there is considerable consensus regarding the reliable relationship between education and attitudes about the social world, an ongoing debate exists regarding the process that accounts for such a relationship. Two primary hypotheses have been put forth. On the one hand, the self-selection hypothesis posits that individuals select disciplines that closely match their preexisting worldviews and ideologies (Astin, 1979; Feldman & Newcomb, 1969a, 1969b). Existing findings concerning personality differences between individuals who choose different

academic disciplines support this hypothesis (e.g., at a medium-sized public university in the Eastern USA—Pringle, DuBose, & Yankey, 2010), as does a growing body of research that suggests a broader link between cognitive ability and social attitudes (e.g., Hodson & Busseri, 2012; McClosky, 1958).

On the other hand, the socialization hypothesis posits that educational disciplines vary in their underlying ideological assumptions, and that participation in higher education alters the individuals' attitudes to match those in their chosen discipline. Paz-y-Miño and Espinosa (2009) examined the difference in views on evolution between biology and non-biology majors at Roger Williams University in Rhode Island, USA. As would be expected, biology majors scored higher on beliefs in evolution than non-biology majors. However, they also found an increase of acceptance for evolution within the biology major that increased with class affiliation. This suggests that as students progressed in this major, they became more oriented towards one of its central ideas—evolution. Lang (2011) found a similar pattern when comparing the political values between incoming business majors and non-business majors at Bloomberg University in Indiana, USA. His findings suggest that business and economics majors score lower on environmentalism and awareness compared to other majors, with a strengthening of beliefs from freshmen to seniors.

In sum, the existing literature has compellingly demonstrated that educational attainment plays an important role in arbitrating attitudes towards a variety of social objects and, most notably, influences political orientation. Apart from this general consensus, however, the aforementioned research is largely equivocal on the conditions under which education exerts a liberalizing effect and the underlying process that accounts for this relationship. While various studies have examined the effect of studying discipline-specific constructs on attitudes towards that construct (e.g., biology major's beliefs concerning the evolutions of species—Paz-y-Miño & Espinosa, 2009; business majors' attitudes towards profit and economic gain—Wang et al., 2011; social science major's attitudes towards social change and status hierarchies—Guimond & Palmer, 1990), few have extended beyond discipline-specific relationships in order to investigate higher-order processes that account for the education-politics link. Is there a broader ethos that characterizes the sciences and that distinguishes it from the humanities? To what extent do these differences moderate the relationship between educational attainment and political attitudes?

Psychologists have long noted that personal values influence both the questions that are asked across academic disciplines and the methods used in arriving at the answers. Many scholars have consistently been concerned with the moral and social ramifications of their empirical endeavors (Howard, 1985; Kurtines, Alvarez, & Azmitia, 1990) and concede that intellectual inquiries are value-laden (Becker, 1968; Bhaskar, 1975; Fiske & Shweder, 1986; Howard, 1985; Toulmin, 1953). Given that the scientific method of acquiring information about the world uses empirical models based on impartiality, rationality and fairness, we predict that the study of scientific disciplines in particular facilitates lower social dominance—that is, less endorsement of the belief that social inequality between groups is acceptable (Pratto, Sidanius, Stallworth, & Malle, 1994)—and greater political liberalism.

We hypothesized that the same scientific ethos that serves to guide empirical inquiries also facilitates the development of more liberal political attitudes via concerns about social dominance and hierarchy. Given science's emphasis on rationality, impartiality, fairness, progress, and the idea that we are to use these rational tools for the mutual benefit of all people in society (Taylor, 2004), we predicted that studying science should lead to greater rejection of legitimizing myths that promote existing hierarchies and dominant social orientations. Given that social dominance hierarchies are maintained by the belief that existing social inequalities between groups are natural and acceptable (i.e., hierarchy-enhancing (HE) legitimizing myths), and undermined by the belief that

such social inequalities are unacceptable (i.e., hierarchy-attenuating (HA) legitimizing myths; Sidanius, Van Laar, Levin, & Sinclair, 2003), we predicted that the impartiality of science would render it more hierarchy-attenuating than hierarchy-enhancing.

Importantly, our prediction that social dominance orientation would emerge as a mediator in accounting for the predicted link between science education and political liberalism is consistent with current conceptualizations of SDO—namely, the Group Socialization Model, which posits that people’s social dominance orientation changes as a function of their social context (Guimond, Dambrun, Michinov, & Duarte, 2003). Empirical studies have supported this notion that SDO changes as a function of a variety of social factors, including power/status (e.g., belonging to subordinate vs. dominant groups—Sidanius & Pratto, 1999; Sinclair, Sidanius, & Levin, 1998), prestige (e.g., studying business and law vs. other fields—Sidanius, Pratto, Martin, & Stallworth, 1991; Guimond et al., 2003), and information about the role of nature vs. nurture in shaping behavior (e.g., believing in genetic determinism as a function of exposure to psychology—Dambrun, Kamiejski, Haddadi, & Duarte, 2009).

The present research builds upon the Group Socialization Model of SDO (Guimond et al., 2003) by examining the role of studying “hard” science versus social science or non-science fields on individuals’ social dominance and, subsequently, their political attitudes. The present studies diverge from previous findings related to socialization processes involved in the development of SDO, however, in two important ways. First, our focus is on comparing a different array of disciplines—i.e., science vs. non-science—rather than focusing on the potential prestige or opportunity for financial gain between different disciplines (i.e., business and law versus other fields). Second, we are interested in the repercussions of disciplines and SDO on a wide range of political attitudes, which previous studies have not tested. Third, we aim to revisit the issue of whether socialization or self-selection can account for the relationship between academic discipline and SDO. Given the mixed evidence on whether self-selection processes (e.g., Norman & Redlo, 1952; Pringle et al., 2010; Sidanius et al., 2003) or socialization forces (e.g., Lang, 2011; Paz-y-Miño & Espinosa, 2009) account for discipline-specific effects on social attitudes, further investigation is needed to understand the conditions under which these differential processes are at work.

We empirically examined the link between educational discipline and political attitudes across four studies. We predicted that being educated in a hard science discipline (i.e., one that relies on the systematic use of the scientific method as the primary way of acquiring information about the world), as opposed to a non-science or social science discipline, would predict greater political liberalism, and that this effect would not be accounted for by solely self-selection (Studies 1, 2). Furthermore, we predicted that an individual’s social dominance orientation (SDO—Pratto et al., 1994), would mediate the relationship between studying science and political liberalism (Study 2, 3). In Study 4, we directly assessed the predicted underlying mechanism presumed to drive these effects, the scientific ethos. We tested the extent to which the group difference findings from Studies 1-3 would replicate using individual differences in the endorsement of the scientific ethos to predict political liberalism.

## Study 1

Study 1 examined the relationship between individuals’ choice of academic discipline and political attitudes. Undergraduate students across disciplines completed a questionnaire concerning their choice of college concentration and their attitudes towards a variety of political issues, including healthcare (e.g., equal healthcare accessibility), the economy (e.g., government regulations of the free market), foreign policy (e.g., U.S. support of allies), and

social issues (e.g., abortion). We predicted that individuals in the hard sciences, or those who rigorously use the scientific method as the primary way of acquiring information, would exhibit more politically liberal attitudes across domains relative to individuals in the non-sciences and more social sciences. Specifically, we predicted that this effect would emerge among those who had substantive exposure to discipline-specific education (i.e., upper years), but not among those who had not (i.e., lower years).

## Method

### Participants and Procedure

One hundred and ninety-six students from a university in New England participated voluntarily in an online study. The average age was 20.60 years. For a complete breakdown of participants' major by gender and year, please see Table 1. Participants were recruited from the listservs of campus dormitories and received entry into a drawing for six \$25 Amazon.com gift cards in return for participation.

Table 1

Breakdown of participants for studies by field, gender, and class.

Study	Field	Gender (% male)	Class (% upperclassmen)
1	Science (44%)	25%	51%
	Social science (23%)	28%	34%
	Non-sciences (33%)	29%	46%
2	Science (44%)	21%	52%
	Social Science (22%)	27%	62%
	Non-sciences (34%)	21%	68%
3	Science (38%)	41%	-- <sup>a</sup>
	Social Science (31%)	6%	-- <sup>a</sup>
	Non-sciences (31%)	28%	-- <sup>a</sup>

<sup>a</sup>Study 3 relied on national sample of both current college enrollees and graduates, and thus class status in college was not computed given that a portion of the sample had graduated.

### Measures

Participants completed a political attitudes questionnaire that included 18 statements reflecting perspectives on current political issues.<sup>i</sup> The statements were varied to express both liberal and conservative beliefs (e.g., "Welfare programs make people dependent on the government for provisions" and "Welfare is necessary to bring fairness to American economic life"; see Appendix). Participants rated their level of agreement with each statement on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale was created by the authors to assess salient political issues that divided U.S. political liberals and conservatives. Composite scores for each of the four subcategories of political attitudes were computed. Responses to statements reflecting conservative attitudes were reversed coded so that for all composites, higher scores reflect more liberal attitudes. Given that we did not have any *a priori* hypotheses concerning the particular type of political attitude, they were averaged to yield an overall measure of political attitudes ( $\alpha = .58$ ;  $M = 3.89$ ,  $SD = 0.43$ ).<sup>ii</sup>

In addition, participants entered their intended or declared major (i.e., "what is your intended or declared major?") and year in college, along with basic demographic information (i.e., age, gender). Participants' choice of discipline was coded as science, social science, or non-science. Disciplines that relied on the systematic application of

empirical methods to construct consistent, predictive models of the physical and natural world (e.g., Gilbert, 1991) were coded as “science”; science disciplines included majors that belonged to the following six scientific fields: all forms of biology (50%), psychology (16%), chemistry (10%), all forms of physics (10%), all forms of engineering sciences (10%), and environmental science (4%). All other disciplines that did not meet this criteria were coded as social science or non-science; disciplines that focused on social phenomena but that nevertheless relied on systematic methods were coded as social science, and those that did not were coded as non-sciences. Social science disciplines included five majors: government/political science (38%), economics (25%), social studies (15%), sociology (19%), linguistics (2%). Majors that did not qualify as either a science or a social science were coded as non-sciences, which included a wide array of different majors, the most prevalent of which included history (38%), various languages and literatures (23%), and various forms of comparative studies (21%).<sup>iii</sup>

Finally, exposure (to discipline) was operationalized using year in college; first and second years were categorized as low exposure/lower years whereas third and fourth years were categorized as high exposure, or upper years.<sup>iv</sup>

## Results

There was no effect of gender, and no interactions involving gender on political attitudes (both  $F_s < 1$ ); thus, gender was not included in the analyses presented below.

An Analysis of Variance (ANOVA) with discipline and exposure (i.e., upper vs. lower year) revealed no main effect of exposure,  $F < 1$ , but a significant effect of discipline,  $F(2, 177) = 4.41, p = .013$ . Tukey’s post-hoc comparisons revealed that those studying hard sciences were more liberal relative to those in the social sciences ( $M_{\text{diff}} = 0.20, SE = 0.081, 95\% \text{ confidence interval (CI) } [0.0088, 0.39]$ ), and those in the non-sciences ( $M_{\text{diff}} = .17, SE = 0.072, 95\% \text{ CI } [-.0018, .34]$ ); those in the non-sciences and social sciences did not significantly differ ( $M_{\text{diff}} = .031, SE = 0.082, 95\% \text{ CI } [-.22, .16]$ ).

As predicted, a significant discipline by exposure interaction also emerged,  $F(2, 177) = 5.02, p = .008$ . Among those with less exposure (i.e., the lower years), those majoring in a hard science ( $M = 3.87, SE = 0.071, 95\% \text{ CI } [3.73, 4.01]$ ) did not differ from those majoring in a social science ( $M = 3.85, SE = 0.079, 95\% \text{ CI } [3.69, 4.00]$ ) or a non-science ( $M = 3.90, SE = 0.071, 95\% \text{ CI } [3.77, 4.05]$ ). In contrast, among those with more exposure (i.e., the upper years), those majoring in a hard science were more liberal ( $M = 4.15, SE = 0.070, 95\% \text{ CI } [4.01, 4.28]$ ) than those majoring in a social science ( $M = 3.73, SE = 0.11, 95\% \text{ CI } [3.51, 3.95]$ ) or a non-science ( $M = 3.76, SE = 0.078, 95\% \text{ CI } [3.61, 3.91]$ ).

## Discussion

Study 1 offered preliminary evidence for a divergence in political attitudes between individuals in hard sciences vs. social science and non-science disciplines. Across domains, those who are in scientific fields exhibited greater political liberalism compared to those in non-hard-scientific fields. Furthermore, we cast strong doubt on the self-selection explanation that posits the role of pre-existing individual differences in accounting for these effects. By demonstrating that the link between scientific study and political liberalism only holds for those who had relatively high levels of exposure to discipline-specific education (i.e., third and fourth years), but not those who had yet been extensively exposed (i.e., first and second years), these findings suggest that discipline-specific socialization processes—and not merely self-selection—account for the relationship between academic discipline and political attitudes. However, the question remains as to the underlying process that accounts for such a relationship. To

test our prediction that studying scientific disciplines promotes lower social dominance orientation, we conducted Study 2.

## Study 2

As a psychological construct, political liberalism has been linked to a number of different variables, including measures of resistance to change (e.g., openness to experience, uncertainty tolerance, integrative complexity, need for order/structure/closure, fear of threat and loss, dogmatism, intolerance of ambiguity—for review, see [Jost, Glaser, Kruglanski, & Sulloway, 2003](#)), attitudes towards inequality and social hierarchy (e.g., social dominance orientation—[Pratto et al., 1994](#)), and general cognitive abilities (e.g., intelligence or *g*—[Schoon et al., 2010](#)), to name a few. We posit that among these different correlates of political liberalism, social dominance orientation (SDO) should be particularly relevant to disciplinary differences between the sciences and non-sciences. Past work by [Sidanius et al. \(1991\)](#) has found that certain majors (i.e., business, law) were higher in SDO and racism than those in other majors, and that such an effect was moderated by college exposure; furthermore, [Van Laar, Sidanius, and Levin \(2008\)](#) found SDO to decrease as a function of exposure to specific courses. We contend that SDO should be particularly relevant here because science's emphasis on rationality, impartiality, fairness, progress, and the idea that we are to use these rational tools for the mutual benefit of all people in society ([Taylor, 2004](#)) should lead to greater rejection of hierarchy legitimizing myths and dominant social orientations. Existing research has shown that social dominance orientation (SDO) is a predictor of political attitudes ([Cohrs, Moschner, Maes, & Kielmann, 2005](#); [Pratto et al., 1994](#); [Pratto, Stallworth, & Conway-Lanz, 1998](#); [Pratto, Stallworth, & Sidanius, 1997](#); [Mirisola, Sibley, Boca, & Duckitt, 2007](#); [Van Hiel & Mervielde, 2002](#); [Whitley & Ægisdóttir, 2000](#)). Given that education has been shown to reduce the expression of SDO ([Sidanius, Pratto, & Bobo, 1996](#); [Sidanius, Sinclair, & Pratto, 2006](#)), we predicted that the effects of a science education on political liberalism would be mediated by social dominance, such that those who study science would be lower in SDO, and lower SDO would predict more liberal political attitudes.

To account for the possibility that other mechanisms may explain the link between science and political liberalism, we also tested a potential alternative mediator, individual differences in resistance to ambiguity and change. Like SDO, resistance to change has been consistently linked to political attitudes, and numerous studies using various operationalizations of this construct (e.g., openness to experience, uncertainty tolerance, integrative complexity, need for order/structure/closure, fear of threat and loss, dogmatism, intolerance of ambiguity) have found convergent evidence that those more resistant to change tend to be more politically conservative (for review, see [Jost et al., 2003](#)). Given that different disciplines rely on distinct methods for drawing conclusions and building models, an alternative explanation could be that the scientific method—which encourages the use of empiricism to continually test the validity of our existing models and their boundary conditions—promotes less aversion to ambiguity and change. Furthermore, this relationship between how individuals react to ambiguous or conflicting information and political attitudes has been confirmed with neuroimaging data ([Amodio, Jost, Master, & Yee, 2007](#)). Thus, one possibility is that individual differences in how people respond to ambiguity, contradiction, and change could play an important role in accounting for the link between studying science and political attitudes. To test this alternative explanation, we used an established individual difference measure that captures general attitudes towards ambiguity, contradiction and change (i.e., the Dialecticism Scale—[Choi & Choi, 2002](#); [Spencer-Rodgers, Peng, Wang, & Hou, 2004](#)); we subsequently examined its relationship to individuals' selection of major and political attitudes.

## Method

### Participants and Procedure

One hundred undergraduate students from the same university in New England as in Study 1 (78% female) participated voluntarily in the study (see Table 1). The average age was 20.36 years. Participants were recruited from the listservs of campus dormitories and entered into a raffle for six \$15 gift cards for local food-based establishments in return for participation.

### Measures

Prior to the political attitudes questionnaire, participants completed the Social Dominance Orientation Scale (SDO; Pratto et al., 1994;  $M = 2.52$ ,  $SD = 0.82$ ;  $\alpha = .85$ ).

Participants subsequently rated their agreement with three current controversial political issues: same-sex marriage, affirmative action, and the Affordable Care Act. These specific issues were chosen because of their relevance to the current political sphere and bipartisan nature (i.e., they are contested issues that tend to divide American liberals and conservatives). Participants indicated their support for each issue on a scale from 1 (*strongly do not support*) to 7 (*strongly support*). Responses on the three political issues showed acceptable levels of internal consistency ( $\alpha = .68$ ) and thus were averaged to form an overall political composite, with higher values reflecting greater liberalism ( $M = 5.27$ ,  $SD = 1.29$ ).

Finally, participants indicated their intended or declared college major from a list of all majors offered and their year in college, along with demographic information (age, gender, race, and subjective socioeconomic status).

Participants' majors were coded as hard science, social science, or non-science using the same criteria from the previous study; representation of majors were similar to that of Study 1: among the sciences, biology (51%) and psychology (33%) were by far the most represented; among the social sciences, political science/government (33%), economics (28%), and social studies (28%) were the primary fields represented; among the non-sciences, history (39%), comparative studies (19%), and various languages/literatures (13%) were the most commonly represented. Participants' exposure was also coded as high or low using the same criteria.<sup>v</sup>

## Results

There was no effect of gender and no gender by major interaction on political attitudes ( $ps > .28$ ). However, gender differences emerged on the mediator, SDO; women displayed lower levels of SDO than men,  $F(1, 87) = 5.41$ ,  $p = .022$ . However, because we did not make any a priori predictions about gender, gender was not related to the outcome variable of interest, and gender did not interact with the predictor variable, gender was not included in the analyses.

A univariate ANOVA revealed a marginal effect of major on political attitudes,  $F(2, 94) = 2.57$ ,  $p = .082$ . Examination of the means show that those in scientific disciplines showed more liberal political attitudes ( $M = 5.57$ ,  $SD = 0.99$ ) relative to those in social sciences ( $M = 4.96$ ,  $SD = 1.68$ ) and those in the non-sciences disciplines ( $M = 5.21$ ,  $SD = 1.12$ ); however, Tukey's post-hoc tests revealed that these differences were not significant (all  $ps > .13$ ). A marginal effect of exposure also emerged,  $F(1, 94) = 2.70$ ,  $p = .10$ , with those in the upper classes being more liberal ( $M = 5.45$ ,  $SD = 1.17$ ) than those from the lower classes ( $M = 5.10$ ,  $SD = 1.30$ ). As predicted, a significant major and exposure interaction emerged,  $F(2, 94) = 3.26$ ,  $p = .043$ . Among science majors, political attitudes were

more liberal among upper years ( $M = 5.93$ ,  $SD = 0.77$ ) than lower years ( $M = 5.17$ ,  $SD = 1.07$ ),  $M_{diff} = -0.75$ ,  $SE = 0.33$ , 95% CI [-1.46, -0.45]. Among non-science majors, political attitudes did not differ between upper years (i.e., those with high exposure,  $M = 5.05$ ,  $SD = 1.27$ ) and lower years ( $M = 5.54$ ,  $SD = 0.65$ ),  $M_{diff} = 0.49$ ,  $SE = 0.43$ , 95% CI [-0.36, 1.35]. Among social science majors, the difference emerged between upper ( $M = 5.33$ ,  $SD = 1.31$ ) and lower years ( $M = 4.33$ ,  $SD = 2.13$ ) was marginal,  $M_{diff} = -1.00$ ,  $SE = 0.52$ , 95% CI [-2.04, 0.040].

To test the possibility of mediated moderation, discipline (hard science vs. non-hard science), year (upper vs. lower classmen) and SDO were entered into a bootstrap analysis predicting political attitudes, as recommended for mediation analyses with small samples (see Hayes, 2013). In these analyses, mediation is significant if the 95% bias corrected and accelerated confidence interval (CI) for the indirect effect does not include zero (Preacher & Hayes, 2004; Preacher, Rucker, & Hayes, 2007). Results based on 1,000 bootstrapped samples indicated that the conditional direct effects of discipline on political attitudes for upper and lower classmen were non-significant ( $B = .10$ ,  $SE = 0.35$ ; 95% CI [-0.60, 0.80] and  $B = .14$ ,  $SE = 0.30$ ; 95% CI [-0.46, 0.75]). However, the conditional indirect effect of discipline on political attitudes was significant at high levels of SDO ( $B = .32$ ,  $SE = 0.13$ ; 95% CI [0.095, 0.64]), but not low levels of SDO ( $B = .03$ ,  $SE = 0.19$ ; 95% CI [-0.25, 0.50]). Taken together, these findings suggest that at least for those with significant exposure to their discipline (i.e., upperclassmen), studying science is associated with more liberal political attitudes because studying science leads to lower levels of social dominance orientation.

We also tested the alternative mediator, individual differences in resistance to ambiguity and change (i.e., dialecticism). While this individual difference measure significantly predicted political attitudes, as expected based on the past literature ( $r = -.21$ ,  $p = .036$ ), it did not predict choice of major between science vs. non-science ( $r = .057$ ,  $p = .57$ ).

In addition, we examined demographic variables like race and socioeconomic status as potential confounds given past findings that have suggested factors like race and class to be linked to both participation in specific academic fields (e.g., Lubienski, 2001; Tyson, Lee, Borman, & Hanson, 2007), and political spheres (e.g., Gilroy, 1991). Neither race nor class predicted choice of major or political attitudes (all  $ps > .21$ ).

## Discussion

Together, Studies 1 and 2 provided convergent evidence that studying science, relative to studying the non-sciences or social sciences, promoted more politically liberal attitudes across a variety of domains. However, both studies were conducted using samples from a singular New England University. Thus, to test the generalizability and replicability of the effects, Study 3 was conducted using a more diverse sample of participants and a more general measure of political liberalism.

## Study 3

### Method

#### Participants and Procedure

Fifty-eight participants (38% men;  $M_{age} = 23.31$  years) were recruited via Amazon Mechanical Turk (AMT) and word of mouth; see Table 1. Participants represented a diverse sample of enrollees and graduates from both

public and private colleges (55% public) and different regions in the US (Northeast—43%; Midwest—19%, South—14%, and West—8%); a small subset of non-US graduates also participated (16%). Past studies have demonstrated that AMT is a reliable source of data comparable to samples derived from more traditional methods (e.g., Buhrmester, Kwang, & Gosling, 2011; Horton, Rand, & Zeckhauser, 2011; Mason & Suri, 2012; Paolacci, Chandler, & Ipeirotis, 2010).

## Measures

As in the previous study, participants completed a measure of SDO (Pratto et al., 1994;  $M = 2.66$ ,  $SD = 1.11$ ;  $\alpha = .72$ ), along with information about their college and major. In addition, participants rated the degree to which they were political liberal on a scale from 1 to 7, with higher values reflecting greater liberalism ( $M = 4.87$ ,  $SD = 1.51$ ). Self-assessed political liberalism has been reliably used in many existing studies as a valid proxy for political orientation (e.g., Graham, Haidt, & Nosek, 2009; Inbar, Pizarro, & Bloom, 2009; Kanai, Feilden, Firth, & Rees, 2011; Lee, Sohn, & Fowler, 2013) that converges highly with other measures of political liberalism, including implicit measures of political liberalism (e.g., Graham et al., 2009) and attitudes on a wide range of political issues (e.g., Inbar et al., 2009).

Participants' majors were coded as hard science, social science, or non-science using the same criteria from the previous studies. Among the hard sciences, engineering sciences (38%), psychological/clinical sciences (29%), the various forms of biology (14%) were the most commonly represented; among the social sciences, economics (33%), sociology/anthropology (33%), and political science (17%); among the non-sciences, the various forms of arts (31%), comparative studies (26%), and languages (11%).<sup>vi</sup>

## Results

There was no effect of gender and no gender by major interaction on the dependent variable of interest, political liberalism (both  $F_s < 1$ ). However, there was a marginal effect of gender on the mediator, SDO; women displayed somewhat lower levels of SDO than men,  $t(55) = 1.88$ ,  $p = .065$ . However, given that we did not make any a priori predictions about gender, gender was not related to the outcome variable of interest, and gender did not interact with the predictor variable, gender was not included in the analyses.

A univariate ANOVA revealed a significant effect of major on political attitudes,  $F(2, 55) = 3.68$ ,  $p = .032$ . Tukey's posthoc tests revealed those in scientific disciplines were self-rated to be more politically liberal ( $M = 5.56$ ,  $SD = 1.26$ ) relative to those in social sciences ( $M = 4.61$ ,  $SD = 0.97$ ),  $M_{diff} = 0.98$ ,  $SE = 0.45$ , 95% CI [-0.10, 2.06],  $p = .084$ ,  $d = .84$ , and those in the non-science disciplines ( $M = 4.50$ ,  $SD = 1.88$ ),  $M_{diff} = 1.09$ ,  $SE = 0.45$ , 95% CI [0.01, 2.17],  $p = .048$ ,  $d = .66$ ; those in the social sciences did not significantly differ from those in the non-sciences,  $M_{diff} = 0.11$ ,  $SE = 0.47$ , 95% CI [-1.02, 1.25],  $p = .97$ .

To test whether the effects of major on political liberalism were mediated by SDO, we conducted the following regressions comparing hard science and non-hard-science majors. In the first regression equation, political liberalism was regressed on major (0 = hard science, 1 = non-hard science). This regression equation is similar to the ANOVA results reported above; as expected, major significantly predicted political liberalism,  $\beta = -.34$ ,  $p = .009$ . In the second regression equation, SDO was regressed on major. Those who studied science showed lower SDO relative to those who studies non-science majors,  $\beta = .29$ ,  $p = .043$ . Finally, in the third regression equation, political liberalism was regressed on major and SDO simultaneously. The results indicate that the effect of SDO remained significant,  $\beta = .46$ ,  $p = .001$ , whereas the effect of major did not,  $\beta = -.19$ ,  $p = .14$ .

As recommended for small samples, we used nonparametric bootstrapping analyses (see Preacher & Hayes, 2004; Preacher et al., 2007) to test the significance of SDO as a mediator of the relationship between discipline and political liberalism. In these analyses, mediation is significant if the 95% bias corrected and accelerated confidence interval for the indirect effect does not include zero (Preacher & Hayes, 2004; Preacher et al., 2007). Results based on 1,000 bootstrapped samples indicated that the total effect of major on political liberalism was significant ( $B = -1.05$ ,  $SE = 0.44$ ,  $p = .021$ ), as was the direct effect ( $B = -.64$ ,  $SE = 0.17$ ;  $p = .0008$ ). SDO mediated the relationship between discipline and political liberalism (CI [-.98, -.041]), such that participants who majored in the sciences showed lower levels of SDO, and through less SDO, they were more politically liberal. Because zero was not in the 95% confidence interval, the indirect effect was significantly different from zero at  $p < .05$  (two-tailed). Taken together, these findings are consistent with the hypothesis that majoring in a science is associated with increased political liberalism because doing so makes you exhibit less of SDO.

## Discussion

Studies 1-3 relied on choice of major to predict political attitudes, and found convergent evidence that majoring in a science-related field led to greater political liberalism. In explaining this effect, it was theorized that majoring in a science served as a proxy for endorsement of the broader scientific ethos, and endorsement of this ethos drove the effects on political attitudes. In order to directly assess the assumed underlying factor, endorsement of the scientific ethos, and assess the extent to which individual differences in this ethos would lead to the same results observed in the previous studies, Study 4 was conducted.

## Study 4

In line with past research on other dimensions (e.g., interdependence—Markus & Kitayama, 1991; Singelis, 1994; dialecticism—Chen, English, & Peng, 2006) that have highlighted the utility of employing both the individual-level and group-level approach for studying the same construct, Study 4 examined whether individual differences in endorsement of the scientific ethos would parallel the group-level effects between science and non-science majors. That is, Study 4 did not measure major and instead, measured belief in the scientific ethos as a predictor of political liberalism. An additional aim of Study 4 was to more stringently test the generalizability of our findings by relying on a different sample than those used in the previous three studies. Given that Studies 1 and 2 were both conducted at the same university, and Study 3 relied on an online sample, these offered limited opportunity to test the extent to which the present findings would generalize to other populations. Thus, Study 4 was tested on two new samples: undergraduates from a Canadian university and a community sample from the larger Boston area.

## Method

### Participants and Procedure

One hundred and eighteen participants (35% men) from the subject participation pools at York University in York, Canada ( $N = 33$ ) and the Decision Science Lab in Cambridge, Massachusetts ( $N = 85$ ) participated as part of larger studies. The former consisted of undergraduates enrolled in introductory psychology courses participating for course credit. The latter consisted of a community sample of paid participants recruited from the larger Boston area; to allow us to test the generalizability of the previous findings, participants who were not undergraduates at

the New England university sampled in Studies 1 and 2 were specifically recruited from the community in this latter sample.

## Measures

Participants completed a series of four questions about their endorsement of the scientific ethos that were specifically devised for the present study by the authors: “How much do you believe in science?”; “To what extent do you think that science is used for the benefit of society?”; “To what extent do you believe in rationality (as opposed to subjectivity)?” and “To what extent do you believe in impartiality and fairness as the best ways to acquire knowledge?” Participants responded to all questions on a 1 (*not at all*) to 5 (*very much*) scale. Responses to the four questions were averaged ( $\alpha = .63$ ) to yield an overall measure of scientific ethos endorsement. Higher scores reflected greater endorsement of science ( $M = 4.26$ ,  $SD = 0.56$ ).

In addition, participants completed the same SDO scale (Pratto et al., 1994;  $M = 2.50$ ,  $SD = 1.04$ ;  $\alpha = .89$ ), demographics, and political liberalism measure (i.e., “how politically liberal are you?”) used in Study 3 ( $M = 4.81$ ,  $SD = 1.70$ ). Number of responses varied by item due to omitted responses.

## Results and Discussion

Gender did not predict self-reported political liberalism, or endorsement of the scientific ethos ( $ps > .19$ ); however, gender was marginally associated with SDO,  $r = -.23$ ,  $p = .059$ . Women, on average, displayed lower levels of SDO than men. However, given that gender was not linked to our predictor or outcome variables, it was not included in the analyses.

As predicted, endorsement of the scientific ethos predicted greater self-reported political liberalism,  $\beta = .27$ ,  $t(104) = 2.88$ ,  $p = .005$ .<sup>vii</sup> Those who endorsed the scientific ethos self-reported to be more politically liberal. To test the replicability of the previous finding that the effects of science on political liberalism were mediated by SDO, we conducted the following regressions using self-reported political liberalism.

In the initial regression equation, political liberalism was regressed on endorsement of the scientific ethos, reported above. In the second regression equation, SDO was regressed on scientific ethos endorsement. Those who endorsed science more showed lower SDO relative to those who endorsed science less,  $\beta = -.21$ ,  $t(116) = 2.30$ ,  $p = .023$ . Finally, in the third regression equation, political liberalism was regressed on scientific ethos endorsement and SDO simultaneously. The results indicate that the effect of SDO remained significant,  $\beta = -.36$ ,  $t(104) = 3.86$ ,  $p < .001$ , whereas the effect of scientific ethos endorsement was not,  $\beta = .15$ ,  $t(104) = 1.69$ ,  $p = .094$ .

Once again, we used nonparametric bootstrapping analyses (see Preacher & Hayes, 2004; Preacher et al., 2007) to test the significance of SDO as a mediator of the relationship between science endorsement and political liberalism. In these analyses, mediation is significant if the 95% bias corrected and accelerated confidence interval for the indirect effect does not include zero (Preacher & Hayes, 2004; Preacher et al., 2007). Results based on 1,000 bootstrapped samples indicated that the total effect of scientific ethos endorsement on political liberalism was significant ( $B = .84$ ,  $SE = 0.29$ ;  $p = .0048$ ), but the direct effect was not ( $B = .48$ ,  $SE = 0.29$ ;  $p = .094$ ). SDO mediated the relationship between scientific ethos endorsement and political liberalism (CI [0.11, 0.67]), such that participants who endorsed science more showed lower levels of SDO, and through less SDO, they were more politically liberal. Because zero was not in the 95% confidence interval, the indirect effect was significantly different from zero at  $p < .05$  (two-tailed). Taken together, these findings are consistent with the hypothesis that endorsing

science is associated with increased political liberalism because the scientific ethos makes you exhibit less of SDO.

## General Discussion

Across four studies, we demonstrated the discipline-specific liberalizing effects of higher education. Relative to those studying non-sciences, students in the sciences exhibited greater political liberalism across a variety of domains (including foreign policy, healthcare, the economy) and a variety of social issues (e.g., gay marriage, affirmative action), as well as in general self-reported liberalism. These effects could not be accounted for merely by self-selection, but rather, emerged as the product of discipline-contingent socialization pressures. Furthermore, we elucidated one underlying mechanism that accounts for the relationship between science education and political liberalism, and demonstrated that those who study scientific disciplines are more politically liberal because they exhibit lower levels of social dominance orientation. Importantly, we replicated this mediational model using individual differences in endorsement of the scientific ethos.

These findings have several important implications. First, they offer a more nuanced look into the relationship between educational attainment and political attitudes. Although the existing literature has long noted that greater time spent in higher education is a powerful predictor of liberal political orientations (Feldman & Newcomb, 1969a, 1969b; Newcomb, 1943/1957), existing studies on the precise nature of the attitudinal effects of being educated have been limited in two major ways. First, they have been equivocal on the question of whether such effects are a product of self-selection or socialization (e.g., Hastie, 2007; Lang, 2011; Norman & Redlo, 1952; Paz-y-Miño & Espinosa, 2009; Pringle et al., 2010). Second, they have largely been limited to examining attitudes towards discipline-specific constructs (e.g., evolution of species, business profit, etc.). The present research addresses these questions left by the current literature and offers both more definitive support for the discipline-specific socializing effects of education and keener insight into the broader sociopolitical ramifications of such educational socialization.

Second, the present results suggest that the study of science itself holds normative implications and leads to political outcomes. Previous research has noted that science can be value-laden insofar as the extent to which personal values influence both the questions that are asked and the methods used in arriving at the answers (Becker, 1968; Bhaskar, 1975; Fiske & Shweder, 1986; Howard, 1985; Kurtines et al., 1990; Toulmin, 1953). These findings suggest that beyond what values scientists may introduce to the process of scientific investigation, the act of studying science itself produces important psychological and political consequences. These findings suggest that the same scientific ethos that serves to guide empirical inquiries also facilitates attitudes towards social dominance and hierarchy-attenuating myths more broadly. Consequently, these results can contribute to a better understanding socio-political attitudes, including how institutions influence the maintenance of existing social hierarchies.

Third, our findings offer further evidence for the Group Socialization Model of Social Dominance, or the conceptualization of social dominance orientation as a mediator that changes as a function of social context (Guimond et al., 2003). The present findings are consistent with previous empirical studies that have similarly demonstrated that SDO shifts as a function of the social environment (Dambrun et al., 2009; Guimond et al., 2003; Sidanius et al., 1991; Sidanius & Pratto, 1999; Sinclair et al., 1998) and has a mediating effect on the relationship between discipline and social attitudes (Dambrun et al., 2009; Guimond et al., 2003).

## Limitations and Future Directions

These contributions notwithstanding, the present research holds several limitations. Theoretically speaking, the alternative argument can be made that rather than science promoting more political liberal orientations, social constructionism (i.e., an idea prevalent in the social sciences) should be associated with political liberalism (e.g., Tomasi, 2001). Although the social constructionists framework has been employed to argue for both liberal ideologies (e.g., that race, gender, sexuality are modern inventions rather than biologically-based categories; as such, any inequalities between individuals on such bases are the product of socially-biased institutions and practices—Foucault, 1978; Halperin, 1990; Taylor, 2004) as well as conservative ones (e.g., that cultural practices of racial division led to genetically-based differences in intelligence between those racial groups today—Cochran, Hardy, & Harpending, 2006; Herrnstein & Murray, 1994), the same can arguably also be observed about science. However, the present empirical evidence suggests that relative to the scientific ethos, social constructionism may not be as reliably linked to liberal political orientation, given that science majors were consistently more liberal than social science majors. However, it is nevertheless possible that not all social science fields emphasize the notion of social constructionism equally, and this variability is not adequately captured by the present work.

This relates to the broader question of assumed homogeneity and representation of different majors within a discipline. Given that there is not equal representation of all majors and that within a discipline, variability across majors exists, one alternative explanation is that the present findings are limited to the group of most commonly represented majors in these studies. While the differential representation of majors is an inevitable outcome of certain majors being more impacted than others, the crux of our argument is about how studying and endorsing science—and specifically, the scientific ethos—influences political attitudes; this ethos is consistent across majors within the hard sciences, but is not central (or as central) in the social sciences and non-sciences. Thus, we contend that variability among the social sciences and non-sciences, while important and notable, are not directly relevant to our hypothesis. Furthermore, our finding that individual differences in endorsement of the scientific ethos produces effects parallel to that of majoring in a hard science provides concurrent evidence for our prediction. This latter finding was limited in that we did not measure major and endorsement of the scientific ethos simultaneously (i.e., within the same study), and our measure of the scientific ethos was a newly constructed scale that has not been previously validated. Future studies can more closely examine whether more nuanced distinctions exist as a function of studying different majors within a discipline. Additional studies can also aim to test the predictive validity of the scientific ethos measure in other theoretically meaningful contexts.

A related consideration is the extent to which these findings are generalizable across contexts. The present research contained individuals from a limited number of universities, most of which were based in the USA or Canada, and as such the question of how universal these patterns are across regional and cultural contexts remains an open question. This is particularly the case given that political systems vary widely and the polarization between liberals and conservatives studied here is largely a US-based one that may not apply in other countries. Additional research is needed to more closely examine these more nuanced considerations across disciplines, universities, and cultures.

More broadly, an additional limitation of the present studies is the reliance on cross-sectional, correlational data. As with previous studies on the effects of educational discipline on attitudinal outcomes (e.g., Dambrun et al., 2009; Feldman & Newcomb, 1969a, 1969b; Guimond et al., 2003; Hastie, 2007; Lang, 2011; McClintock & Turner, 1962; Newcomb, 1943/1957; Papaharitou et al., 2008; Sidanius et al., 2003; Thumin, 1972), we used cross-sectional samples across studies to examine the extent to which studying science predicted liberal attitudes. We did not directly manipulate individuals' choice of major or the scientific ethos, nor did we collect longitudinal data to

assess the degree of political orientation change throughout college. The cross-sectional nature of our studies may be particularly limiting insofar as they do not capture what happens in cases where students change their discipline, and the present studies did not assess this possibility. Similarly, the correlational nature of our findings does not rule out the alternative explanation that intelligence may be driving the observed effects (i.e., the possibility that more intelligent students opted for the hard sciences, and greater intelligence accounted for their increased political liberalism). The present studies did not measure intelligence and thus could not rule out this possibility; however, the findings that scientific ethos endorsement predicts political liberalism via SDO is strongly suggestive that there is something specific to subscribing to science that impacts political orientation. More longitudinal research methods are needed to assess how political orientation changes as a function of time spent in specific disciplines.

One final limitation of the present research is the reliance on explicitly reported political attitudes. Given the relative liberal environment of college campuses in general, one possibility is that disciplinary differences in social desirability concerns exist, and those in science-related disciplines explicitly reported greater political liberalism and lower social dominance because of such concerns regarding what is socially desirable. Future studies can more closely tackle these limitations by examining implicit political attitudes and their link to the explicit political attitudes reported here in order to investigate whether the disciplinary divergence in political orientation also extends to implicit measures of political orientation.

## Conclusion

In conclusion, the present work elucidates an important feature of how and when higher education emerges as a potent predictor of political attitudes. Four studies have offered convergent evidence that the liberalizing effect of education is moderated by discipline; those majoring in the hard sciences tend to display more liberal political attitudes than those in other disciplines. The scientific ethos that serves to guide empirical inquiries in the hard sciences facilitated the development of more liberal political attitudes via concerns about fairness and equality.

## Notes

i) Participants also completed additional questions on their attitudes towards the environment, but these were not included in the political liberalism composite because they did not theoretically reflect liberal versus conservative political attitudes.

ii) Given the suboptimal alpha, we also ran the analysis including the nature of the political topic as a factor to test if the effects are specific to certain political domains but not others. We conducted a mixed model ANOVA with major and class status (upper vs. lower years) as between-subject participant factors, along with subtopic as a within-subject participant factor, in predicting political attitudes. The results were consistent with the primary findings described in the main text (i.e., a main effect of major,  $F(2, 177) = 3.60, p = .029$ , as well as an interaction between major and exposure,  $F(2, 177) = 4.03, p = .019$ ). In addition, a main effect of subtopic emerged,  $F(3, 531) = 41.47, p < .001$ ; an examination of the means shows that participants were more liberal overall on topics related to healthcare and social issues than the economy or foreign policy ( $M_s = 3.83, 3.92, 3.99, 4.14$  and  $SD_s = 0.37, 0.38, 0.39, 0.23$ , respectively). However, no interactions involving subtopic emerged (all  $F_s < 1$ ).

iii) There were five cases where a participant indicated a double major; in all such cases, both majors belonged to the same discipline: history and East-Asian studies ( $N = 1$ ), history and literature ( $N = 2$ ), chemistry and physics ( $N = 1$ ), and physics and astrophysics ( $N = 1$ ). The breakdown of majors represented within fields reflects the first major indicated in these cases where two majors were included.

v) We collapsed across first/second years and third/fourth years for the same reasons outlined in Study 1. In addition, we re-ran our analysis including year in college as a factor; the same pattern of results emerged as those reported in the main text: a marginal effect of discipline emerged,  $F(2, 88) = 2.73, p = .071$ , and a significant interaction between discipline and

year,  $F(6, 88) = 2.45, p = .031$ . Examination of the means indicate that for science majors, liberalism generally increased over the years ( $M_s = 5.41, 5.12, 6.58, 6.05$  and  $SD_s = 0.88, 1.13, 0.88, 0.69$ , respectively), whereas for the other disciplines, this pattern did not emerge ( $M_s = 4.77, 5.83, 5.95, 5.12$  and  $SD_s = 0.50, 0.43, 1.57, 1.05$  for the non-sciences;  $M_s = 4.66, 4.00, 6.05, 4.61$  and  $SD_s = 2.50, 2.01, 0.70, 1.43$  for the social sciences).

vi) There were four cases of double majors, two that involved majors within the same discipline (anthropology/political science, english/history) and two that did not (psychology/english; psychology/history). In the two cases where one of the majors was a hard science and the other was not, they were coded as hard science, given that our hypothesis centers on exposure to science and double majors concentrating on a hard science meets that criteria. As with Study 1, representation of the different majors within a discipline reflect the first major indicated in all such cases of double majors.

vii) We also ran these analyses with sample (i.e., York University undergraduates; Decision Science Lab community participants) as a covariate. While the two samples did not differ in political liberalism,  $t(104) = 1.62, p = .11$ , or SDO,  $t(116) = 1.63, p = .11$ , they marginally differed in scientific ethos endorsement. Those from the Decision Science Laboratory exhibited greater endorsement of science ( $M = 4.31, SD = 0.58$ ) than those from York University ( $M = 4.11, SD = 0.49$ ),  $t(115) = 1.72, p = .089$ . However, including sample as a covariate in the analyses did not change the pattern of findings; belief in science remained a significant predictor of political liberalism,  $\beta = .26, t(104) = 2.74, p = .007$ .

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## Competing Interests

The authors have declared that no competing interests exist.

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## References

- Amodio, D. M., Jost, J. T., Master, S. L., & Yee, C. M. (2007). Neurocognitive correlates of liberalism and conservatism. *Nature Neuroscience, 10*(10), 1246-1247. doi:10.1038/nn1979
- Astin, A. W. (1979). *Four critical years: Effects of college on beliefs, values and knowledge*. San Francisco, CA: Jossey Bass.
- Bauman, Y., & Rose, E. (2011). Selection or indoctrination: Why do economics students donate less than the rest? *Journal of Economic Behavior & Organization, 79*(3), 318-327. doi:10.1016/j.jebo.2011.02.010
- Becker, L. C. (1968). Is science moral? *Journal of Religion & Science, 3*, 335-342.
- Bhaskar, R. (1975). *A realist theory of science*. Leeds, United Kingdom: Leeds Books.
- Buhrmester, M. D., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science, 6*, 3-5. doi:10.1177/1745691610393980
- Carter, J. R., & Irons, M. D. (1991). Are economists different, and if so, why? *The Journal of Economic Perspectives, 5*(2), 171-177. doi:10.1257/jep.5.2.171
- Chen, S., English, T., & Peng, K. (2006). Self-verification and contextualized self-views. *Personality and Social Psychology Bulletin, 32*, 930-942. doi:10.1177/0146167206287539

- Choi, I., & Choi, Y. (2002). Culture and self-concept flexibility. *Personality and Social Psychology Bulletin*, 28, 1508-1517. doi:10.1177/014616702237578
- Chibnall, J. T., Blaskiewicz, R. J., & Detrick, P. (2009). Are medical students agreeable? An exploration of personality in relation to clinical skills training. *Medical Teacher*, 31(7), e311-e315. doi:10.1080/01421590802638006
- Cochran, G., Hardy, J., & Harpending, H. (2006). Natural history of Ashkenazi intelligence. *Journal of Biosocial Science*, 38, 659-693. doi:10.1017/S0021932005027069
- Cohrs, J. C., Moschner, B., Maes, J., & Kielmann, S. (2005). The motivational bases of right-wing authoritarianism and social dominance orientation: Relations to values and attitudes in the aftermath of September 11, 2001. *Personality and Social Psychology Bulletin*, 31(10), 1425-1434. doi:10.1177/0146167205275614
- Dambrun, M., Kamiejski, R., Haddadi, N., & Duarte, S. (2009). Why does social dominance orientation decrease with university exposure to the social sciences? The impact of institutional socialization and the mediating role of "geneticism." *European Journal of Social Psychology*, 39, 88-100. doi:10.1002/ejsp.498
- Feldman, K. A., & Newcomb, T. M. (1969a). *The impact of college on students: Volume 1: An analysis of four decades of research*. London, United Kingdom: Jossey-Bass.
- Feldman, K. A., & Newcomb, T. M. (1969b). *The impact of college on students: Volume 2: Summary tables*. London, United Kingdom: Jossey-Bass.
- Fiske, D. W., & Shweder, R. A. (1986). *Metatheory in social science*. Chicago, IL: University of Chicago Press.
- Foucault, M. (1978). *The history of sexuality, Vol. 1: An introduction*. New York, NY: Pantheon.
- Frank, R. H., Gilovich, T., & Regan, D. T. (2000). Does studying economics inhibit cooperation? In T. Connolly, H. R. Arkes, & K. R. Hammond (Eds.), *Judgment and decision making: An interdisciplinary reader* (2nd ed., pp. 183-195). New York, NY: Cambridge University Press.
- Gilbert, S. W. (1991). Model building and a definition of science. *Journal of Research in Science Teaching*, 28, 73-79. doi:10.1002/tea.3660280107
- Gilroy, P. (1991). *'Ain't no Black in the Union Jack': The cultural politics of race and nation*. Chicago, IL: University of Chicago Press.
- Gaasholt, Ø., & Togeby, L. (1995). Interethnic tolerance, education, and political orientation: Evidence from Denmark. *Political Behavior*, 17(3), 265-285. doi:10.1007/BF01498597
- Graham, J., Haidt, J., & Nosek, B. (2009). Liberals and conservatives use different sets of moral foundations. *Journal of Personality and Social Psychology*, 96, 1029-1046. doi:10.1037/a0015141
- Guimond, S., Begin, G., & Palmer, D. L. (1989). Education and causal attributions: The development of "person-blame" and "system-blame" ideology. *Social Psychology Quarterly*, 52(2), 126-140. doi:10.2307/2786912
- Guimond, S., Dambrun, M., Michinov, N., & Duarte, S. (2003). Does social dominance generate prejudice? Integrating individual and contextual determinants of intergroup cognitions. *Journal of Personality and Social Psychology*, 84, 697-721. doi:10.1037/0022-3514.84.4.697
- Guimond, S., & Palmer, D. L. (1990). Type of academic training and causal attributions for social problems. *European Journal of Social Psychology*, 20, 61-75. doi:10.1002/ejsp.2420200106
- Guimond, S., & Palmer, D. L. (1996). The political socialization of commerce and social science students: Epistemic authority and attitude change. *Journal of Applied Social Psychology*, 26, 1985-2013. doi:10.1111/j.1559-1816.1996.tb01784.x

- Halperin, D. M. (1990). *One hundred years of homosexuality: And other essays on Greek love*. New York, NY: Routledge.
- Hastie, B. (2007). Cold hearts and bleeding hearts: Disciplinary differences in university students' sociopolitical orientations. *The Journal of Social Psychology, 147*(3), 211-241. doi:10.3200/SOCP.147.3.211-241
- Hayes, A. F. (2013). *Introduction to mediation, moderation and conditional process analysis*. New York, NY: Guilford Press.
- Herrnstein, R., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life*. New York, NY: Basic Books.
- Hodson, G., & Busseri, M. A. (2012). Bright minds and dark attitudes: Lower cognitive ability predicts greater prejudice through right-wing ideology and low intergroup contact. *Psychological Science, 23*(2), 187-195. doi:10.1177/0956797611421206
- Horton, J. J., Rand, D. G., & Zeckhauser, R. J. (2011). The online laboratory: Conducting experiments in a real labor market. *Experimental Economics, 14*, 399-425. doi:10.1007/s10683-011-9273-9
- Howard, G. S. (1985). The role of values in the science of psychology. *The American Psychologist, 40*, 255-265. doi:10.1037/0003-066X.40.3.255
- Inbar, Y., Pizarro, D. A., & Bloom, P. (2009). Conservatives are more easily disgusted than liberals. *Cognition and Emotion, 23*(4), 714-725. doi:10.1080/02699930802110007
- Jost, J. T., Glaser, J., Kruglanski, A. W., & Sulloway, F. J. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin, 129*, 339-375. doi:10.1037/0033-2909.129.3.339
- Kanai, R., Feilden, T., Firth, C., & Rees, G. (2011). Political orientations are correlated with brain structure in young adults. *Current Biology, 21*(8), 677-680. doi:10.1016/j.cub.2011.03.017
- Kurtines, W., Alvarez, M., & Azmitia, M. (1990). Science and morality: The role of values in science and the scientific study of moral phenomena. *Psychological Bulletin, 107*, 283-295. doi:10.1037/0033-2909.107.3.283
- Lang, K. B. (2011). The relationship between academic major and environmentalism among college students: Is it mediated by the effects of gender, political ideology and financial security? *The Journal of Environmental Education, 42*(4), 203-215. doi:10.1080/00958964.2010.547230
- Lee, J. J., Sohn, Y., & Fowler, J. H. (2013). Emotion regulation as the foundation of political attitudes: Does reappraisal decrease support for conservative policies? *PLoS ONE, 8*(12), Article e83143. doi:10.1371/journal.pone.0083143
- Livingstone, G., Derryberry, W. P., King, A., & Vendetti, M. (2006). Moral developmental consistency? Investigating differences and relationships among academic majors. *Ethics & Behavior, 16*(3), 265-287. doi:10.1207/s15327019eb1603\_6
- Lottes, I. L., & Kuriloff, P. J. (1994). The impact of college experience on political attitudes. *Sex Roles, 31*(1-2), 31-54. doi:10.1007/BF01560276
- Lubienski, S. (2001). *Are the NCTM "standards" reaching all students? An examination of race, class, and instructional practices*. Retrieved from ERIC database. (ED460862)
- Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review, 98*, 224-253. doi:10.1037/0033-295X.98.2.224
- Mason, W., & Suri, S. (2012). Conducting behavioral research on Amazon's Mechanical Turk. *Behavior Research Methods, 44*(1), 1-23. doi:10.3758/s13428-011-0124-6
- McClintock, C. G., & Turner, H. A. (1962). The impact of college upon political knowledge, participation, and values. *Human Relations, 15*(2), 163-176. doi:10.1177/001872676201500205

- McClosky, H. (1958). Conservatism and personality. *The American Political Science Review*, *52*(1), 27-45. doi:10.2307/1953011
- Mirisola, A., Sibley, C. G., Boca, S., & Duckitt, J. (2007). On the ideological consistency between right-wing authoritarianism and social dominance orientation. *Personality and Individual Differences*, *43*(7), 1851-1862. doi:10.1016/j.paid.2007.06.006
- Newcomb, T. M. (1957). *Personality and social change: Attitude formation in a student community*. New York, NY: Dryden Press. (Original work published 1943)
- Norman, R. D., & Redlo, M. (1952). MMPI personality patterns for various college major groups. *The Journal of Applied Psychology*, *36*(6), 404-409. doi:10.1037/h0053909
- Pascarella, E. T., & Terenzini, P. T. (1991). *How college affects students: Findings and insights from twenty years of research*. London, United Kingdom: Jossey-Bass.
- Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, *5*, 411-419.
- Papaharitou, S., Nakopoulou, E., Moraitou, M., Tsimtsiou, Z., Konstantinidou, E., & Hatzichristou, D. (2008). Exploring sexual attitudes of students in health professions. *Journal of Sexual Medicine*, *5*(6), 1308-1316. doi:10.1111/j.1743-6109.2008.00826.x
- Paz-y-Miño, G., & Espinosa, A. (2009). Assessment of biology majors' versus nonmajors' views on evolution, creationism, and intelligent design. *Evolution: Education and Outreach*, *2*(1), 75-83.
- Peng, K., & Knowles, E. D. (2003). Culture, education, and the attribution of physical causality. *Personality and Social Psychology Bulletin*, *29*, 1272-1284. doi:10.1177/0146167203254601
- Pratto, F., Sidanius, J., Stallworth, L. M., & Malle, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology*, *67*(4), 741-763. doi:10.1037/0022-3514.67.4.741
- Pratto, F., Stallworth, L. M., & Conway-Lanz, S. (1998). Social dominance orientation and the ideological legitimization of social policy. *Journal of Applied Social Psychology*, *28*(20), 1853-1875. doi:10.1111/j.1559-1816.1998.tb01349.x
- Pratto, F., Stallworth, L. M., & Sidanius, J. (1997). The gender gap: Differences in political attitudes and social dominance orientation. *The British Journal of Social Psychology*, *36*(1), 49-68. doi:10.1111/j.2044-8309.1997.tb01118.x
- Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*(4), 717-731. doi:10.3758/BF03206553
- Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Assessing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, *42*, 185-227. doi:10.1080/00273170701341316
- Pringle, C. D., DuBose, P. B., & Yankey, M. D. (2010). Personality characteristics and choice of academic major: Are traditional stereotypes obsolete? *College Student Journal*, *44*(1), 131-142.
- Schoon, I., Cheng, H., Gale, C. R., Batty, G. D., & Deary, I. J. (2010). Social status, cognitive ability, and educational attainment as predictors of liberal social attitudes and political trust. *Intelligence*, *38*(1), 144-150. doi:10.1016/j.intell.2009.09.005
- Sidanius, J., & Pratto, F. (1999). *Social dominance: An intergroup theory of social hierarchy and oppression*. New York, NY: Cambridge University Press.
- Sidanius, J., Pratto, F., & Bobo, L. (1996). Racism, conservatism, affirmative action, and intellectual sophistication: A matter of principled conservatism or group dominance? *Journal of Personality and Social Psychology*, *70*, 476-490. doi:10.1037/0022-3514.70.3.476

- Sidanius, J., Pratto, F., Martin, M., & Stallworth, L. M. (1991). Consensual racism and career track: Some implications of Social Dominance Theory. *Political Psychology, 12*, 691-721. doi:10.2307/3791552
- Sidanius, J., Sinclair, S., & Pratto, F. (2006). Social dominance orientation, gender, and increasing educational exposure. *Journal of Applied Social Psychology, 36*(7), 1640-1653. doi:10.1111/j.0021-9029.2006.00074.x
- Sidanius, J., Van Laar, C., Levin, S., & Sinclair, S. (2003). Social hierarchy maintenance and assortment into social roles: A social dominance perspective. *Group Processes & Intergroup Relations, 6*, 333-352. doi:10.1177/13684302030064002
- Sinclair, S., Sidanius, J., & Levin, S. (1998). The interface between ethnic and social system attachment: The differential effects of hierarchy-enhancing and hierarchy-attenuating environments. *The Journal of Social Issues, 54*, 741-757. doi:10.1111/j.1540-4560.1998.tb01246.x
- Singelis, T. M. (1994). The measurement of independent and interdependent self-construals. *Personality and Social Psychology Bulletin, 20*(5), 580-591. doi:10.1177/0146167294205014
- Spaulding, C. B., & Turner, H. A. (1968). Political orientation and field of specialization among college professors. *Sociology of Education, 41*(3), 247-262. doi:10.2307/2111874
- Spencer-Rodgers, J., Peng, K., Wang, L., & Hou, Y. (2004). Dialectical self and psychological well-being. *Personality and Social Psychology Bulletin, 30*, 1416-1432. doi:10.1177/0146167204264243
- Stubager, R. (2008). Education effects on authoritarian-libertarian values: A question of socialization. *The British Journal of Sociology, 59*, 327-350. doi:10.1111/j.1468-4446.2008.00196.x
- Taylor, C. (2004). *Modern social imaginaries*. Durham, NC: Duke University Press.
- Thumin, F. J. (1972). The relation of liberalism to sex, age, academic field and college grades. *Journal of Clinical Psychology, 28*(2), 160-164. doi:10.1002/1097-4679(197204)28:2<160::AID-JCLP2270280209>3.0.CO;2-Y
- Tomasi, J. (2001). *Liberalism beyond justice: Citizens, society, and the boundaries of political theory*. Princeton, NJ: Princeton University Press.
- Toulmin, S. (1953). *The philosophy of science*. New York, NY: Harper & Row.
- Tyson, W., Lee, R., Borman, K. M., & Hanson, M. A. (2007). Science, Technology, Engineering, and Mathematics (STEM) Pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk, 12*, 243-270. doi:10.1080/10824660701601266
- Van de Werfhorst, H. G., & de Graaf, N. D. (2004). The sources of political orientations in post-industrial society: Social class and education revisited. *The British Journal of Sociology, 55*(2), 211-235. doi:10.1111/j.1468-4446.2004.00016.x
- Van Hiel, A., & Mervielde, I. (2002). Explaining conservative beliefs and political preferences: A comparison of social dominance orientation and authoritarianism. *Journal of Applied Social Psychology, 32*(5), 965-976. doi:10.1111/j.1559-1816.2002.tb00250.x
- Van Laar, C., Sidanius, J., & Levin, S. (2008). Ethnic-related curricula and intergroup attitudes in college: Movement toward and away from the in-group. *Journal of Applied Social Psychology, 38*, 1601-1638. doi:10.1111/j.1559-1816.2008.00361.x
- Wang, L., Malhotra, D., & Murnighan, J. (2011). Economics education and greed. *Academy of Management Learning & Education, 10*(4), 643-660. doi:10.5465/ame.2009.0185
- Whitley, B. E., Jr., & Ægisdóttir, S. (2000). The gender belief system, authoritarianism, social dominance orientation, and heterosexuals' attitudes toward lesbians and gay men. *Sex Roles, 42*(11-12), 947-967. doi:10.1023/A:1007026016001

## Appendix: Political Attitudes Questionnaire (Study 1)

### Social issues

1. The government should legalize marijuana.
2. Government should not have the right to take a person's life away.
3. Abortions are primarily about a matter of choice.
4. I believe that government should define marriage as a union between a man and a woman.
5. Capital punishment acts as a strong deterrence for crimes.

### Economy

6. Taxes on higher income brackets are currently too low.
7. Welfare is necessary to bring fairness to American economic life.
8. The government needs to protect citizens from big corporations with things such as consumer agencies and regulations.
9. Welfare programs make people dependent on the government for provisions.
10. The government should use a flat tax as opposed to a graduated income tax.
11. A free market system with little government interference creates the greatest opportunity and the highest standard of living for all.

### Foreign policy

12. Maintaining our current defense spending is crucial to protecting US interests.
13. The government should solely provide aid to countries that support our interests.
14. Relying on military force to defeat terrorism creates animosity that leads to more terrorism.
15. Countries that support US foreign policies always deserve US support.
16. Negotiating without preconditions makes the United States appear weak.

### Healthcare

17. The government should provide equal health care benefits for all, regardless of their ability to pay.
18. I support a competitive, free market health care system instead of government provided health care.