SOCIAL SCIENCE

Scientific Diversity Interventions

Fair treatment of other scientists is an essential aspect of scientific integrity, warranting diversity interventions.

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Although the representation of women and racial or ethnic minorities within the scientific community has increased in recent decades, the overall pace of diversification remains relatively slow (*1*). A number of factors may be involved (*2*), but one possible explanation for this limited progress is that gender and racial or ethnic biases persist throughout academia (*1*, *3*).

In response, we propose a scientific approach to the design, assessment, and broad implementation of diversity interventions. We review evidence of positive and negative outcomes of existing interventions relevant to academic scientists. We then offer an evidence-based framework identifying elements of successful interventions (see the table). Finally, we discuss research needed to define success more rigorously and policy changes to encourage widespread adoption of successful programs.

Evidence suggests that academic scientists express "implicit" biases (*4*), which reflect widespread cultural stereotypes emphasizing white men's scientific competence (*1*, *3*). For example, both male and female science faculty members presented with the identical application for a laboratory position provided significantly higher evaluations and starting salaries when the application was attributed to a male versus female student (*1*). Black principal investigators were less likely to receive U.S. National Institutes of Health research funding than white colleagues (*3*).

In contrast to conscious and deliberate "explicit" biases, implicit biases are automatically activated and frequently operate outside of conscious awareness (*4*). Although likely unintentional, implicit biases undermine skilled female and minority scientists, prevent full access to talent, and distort the meritocratic nature of academic science (*1*, *3*).

Interventions, Impacts, and Backlash

To address these issues, the science community should adopt diversity interventions that reduce both implicit and explicit biases and require empirical evidence that such interventions are effective. Once identified, these interventions should be incorporated into existing training offered to scientists, such as courses in responsible conduct of research (RCR). These courses are already required for researchers who receive funding from U.S. federal granting agencies. Although U.S. guidelines for RCR course content contain critical topics, they do not include diversity issues generally or bias specifically (*5*). Because fair treatment of other scientists is an essential aspect of scientific integrity, RCR courses provide untapped opportunities to engage scientists in reflection on the adverse effects of bias.

Campuses should not simply transfer elements of staff diversity training programs into RCR courses, because most existing interventions are not evidence-based (*6*–*9*). Similarly, interventions shown to improve intergroup relations (e.g., cooperative intergroup contact) with other target groups (*6*–*8*) should not be adopted without tailoring to address issues specific to enhancing diversity in science. Many diversity programs rely primarily on lecturing as the method of instruction (*6*), overlooking the vast literature demonstrating that active learning techniques (i.e., those that dynamically engage participants in exercises, activities, and discussions) produce superior learning outcomes (*10*) and increase the effectiveness of diversity interventions (*8*). Interventions often induce ironic negative effects (such as reactance or backlash) by implying that participants are at fault for current diversity challenges (*9*, *11*). Although some interventions have been in place for decades, few have undergone evaluation to determine whether they produce measurable effects (*6*, *9*). A cohesive framework of the design elements and outcomes of successful interventions is needed to ensure that programs are scientifically rigorous and achieve desired objectives.

There are no randomized controlled trials (RCTs) evaluating the impact of diversity interventions on the behavior of academic scientists (*6*, *7*). A recent related RCT that tested established social psychology principles for bias reduction (e.g., stereotype replacement and counter-stereotypic imaging) generated promising results (e.g., reducing implicit bias) but used undergraduate psychology participants and measured self-reported intentions rather than actual behavior change (*7*). Although these results highlight the potential of diversity interventions to reduce bias and enhance diversity,

Components of effective scientific diversity interventions

Design Elements	Examples of Approaches
Grounded in current theory and empirical evidence (*6*–*8*)	Intervention design is guided by current evidence; Hypothesized mechanisms of change are explicitly identified (*6*–*8*)
Use active learning techniques so that participants engage with course content (*8*–*10*)	Participants engage with content through writing and speaking; Strategies such as problem-solving, group discussion, and quizzes are employed (*10*)
Avoid assigning blame or responsibility to participants for current diversity issues (*9*–*11*)	Facilitators employ language indicating that we all share responsibility for diversity; Presentation and analysis of the evidence that men and women express similar implicit bias toward women [e.g., (*1*, *18*)]
Include a plan for ongoing rigorous evaluation of the intervention's efficacy with different groups (*6*–*8*)	Interventions involve collecting longitudinal self-reported data on attitudes and intentions to change behavior; If these generate promising results, RCTs with behavioral measures will be conducted (*6*–*8*)
Measurable Outcomes	**Examples of measurements**
Increase participants' awareness of research on diversity issues (i.e., bias literacy) (*15*)	Pre/post surveys of content knowledge, short writing assignments, group problem-solving of case studies (*10*, *15*)
Decrease participants' explicit and implicit biases (*4*)	Test with standard methods (i.e., validated explicit attitude scales, implicit reaction-time measures) (*4*, *7*, *13*)
Increase participants' propensity to take action on diversity issues (*18*)	Self-reports of participants' own behaviors, as well as behavioral observations from departmental colleagues, students, and trained raters (*6*, *8*, *14*, *15*, *18*,)

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RCTs that have behavioral measures and academic scientist participants are required to validate interventions.

However, self-report and correlational studies can provide the evidence needed to warrant the more compelling (as well as costly and technically challenging) RCTs that must follow. Indeed, there is promising evidence that several interventions raise participants' awareness of diversity issues and reduce explicit and implicit biases (*4*, *6–8*, *12–17*), which suggests that large-scale RCTs of these programs are warranted. For example, the Workshop Activity for Gender Equity Simulation program enables participants to experience cumulative effects of subtle disadvantages and increases their awareness of gender-equity issues within academia (*12*).

An intervention involving a semester-long course on diversity lowered college students' scores on a computerized test of implicit racial bias more than an unrelated control course (*13*). Another program generated improvements in participants' diversity-related attitudes (e.g., increased awareness of advantages experienced by certain social groups) and actual behaviors (e.g., being inclusive; engaging in empathic listening; and actively addressing difficult, emotionally charged issues). Many of these changes persisted 4 months after the intervention and were also observed by participants' colleagues (*14*).

A recent study demonstrated that faculty and administrators from science departments who attended a theoretically grounded Bias Literacy Workshop reported significant increases in "bias literacy" (critical knowledge of bias and diversity issues) and demonstrated improved diversity-promoting behaviors (such as engaging in fair hiring practices) after the workshop (*15*). Although not RCTs, these findings suggest that certain diversity interventions can positively influence the attitudes and behavior of academics.

Other kinds of diversity interventions may paradoxically worsen bias and fail to improve diversity. Programs appear to be particularly counterproductive when they place pressure or blame on attendees, rather than presenting diversity as a shared community challenge and opportunity (*9*, *11*). A common approach urges participants to recognize their own personal culpability in perpetuating discrimination and to take corrective action by complying with societal egalitarian norms (*9*). This approach leads to backlash when its central message is perceived as accusatory, which diminishes participants' internal motivations to be nonprejudiced and induces higher levels of bias (*11*). Unintended outcomes highlight the importance of testing interventions before widespread implementation and underscore the need for an evidence-based framework of intervention elements and outcomes.

Framework for Design and Outcomes

We offer such a framework, based on available evidence on prejudice reduction strategies (*4*, *6–8*, *12–17*) and the vast literature establishing effective teaching practices (*8*, *10*, *16*). Specifically, interventions should incorporate four design elements and target at least three outcomes (see the table). An informal survey of current diversity interventions at research universities revealed that few incorporate all four, and many incorporate none of these elements.

As mixed results for existing interventions and occasional findings of backlash suggest, the first two outcomes (increased awareness and reduced bias) are necessary but not sufficient. Interventions must also enhance participants' action readiness and leave them motivated and equipped with tools to engage with diversity issues rather than paralyzed into avoiding them (*18*). Preliminary evaluation results of one program [which meets design elements (i) to (iv) and has been implemented with more than 700 science faculty members (*16*)] suggest that interventions can generate positive changes in action readiness and highlight the potential importance of this variable (*17*). Because readiness is strongly linked to behavior (*18*), these results may have encouraging implications for diversity-related outcomes.

On the basis of promising initial evidence that diversity interventions can be effective for academic audiences, we call for further research providing a scientific basis for diversity interventions. Interventions that meet the design elements in the table should now be rigorously assessed by RCTs comparing the efficacy of different interventions, elucidating the mechanisms underpinning effective interventions, and driving implementation of the most effective ones. Research aimed at identifying why successful diversity interventions work will be particularly important for designing new programs tailored to specific audiences, outcomes, and institutional contexts (*6, 8*). Research is also necessary to reevaluate intervention efficacy as biases change. For example, although explicit bias has decreased over time, implicit bias remains prevalent (*4*, *13*). Thus, interventions must also change to address evolving expressions of bias.

The U.S. federal funding agencies should add diversity issues (including implicit biases) to their mandated RCR course content guidelines (*5*) and make empirically validated diversity interventions available for widespread use. Worldwide national funding agencies and international bodies (e.g., the European Research Council) should consider similar policies. Active learning methods should be included, which may require redesign or reconsideration of currently accepted online trainings.

Without a scientific approach to diversity interventions, we are likely perpetuating the existing system, which fails to uphold meritocratic values by allowing persistent biases to influence evaluation, advancement, and mentoring of scientists. We may also inadvertently continue to fund ineffective interventions that—at best—superficially address diversity goals without producing measurable results, or—at worst—intensify biases. Applying our framework's straightforward criteria (drawn from theory and successful interventions) would bring diversity interventions in line with accepted scientific standards. A scientific approach to interventions aimed at reducing biases will increase meritocracy, diversity, and excellence throughout academic science.

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