

A Randomized Controlled Trial of Mentoring Interventions for Underrepresented Minorities

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Abstract

Purpose

To conduct a randomized controlled trial to evaluate the effects of different mentoring interventions on the basic psychological need satisfaction of underrepresented minorities and women in academia.

Method

Participants were 150 mentor/protégé dyads from three academic medical centers and eight other colleges and universities in western and central New York, randomized from 2010 to 2013 into mentor training (using principles of self-determination theory); peer mentoring for protégés; mentor training and peer mentoring for protégés combined; or control/usual practice.

Protégé participants were graduate students, fellows, and junior faculty who were from underrepresented groups based on race, ethnicity, gender, or disability.

The primary analysis was a comparison of intervention effects on changes in protégés' satisfaction of their basic psychological needs (competence, autonomy, and relatedness) with their mentor. They completed a well-validated, online questionnaire every two months for one year.

Results

There was no significant effect at the end of one year of either mentor training or peer mentoring on protégés'

psychological basic need satisfaction with mentor specifically or at work in general. Exploratory analyses showed a significant effect of the mentor-based intervention on the protégés' overall psychological need satisfaction with their mentor at two months, the time point closest to completing mentor training.

Conclusions

This randomized controlled trial showed a potential short-term effect of mentor training on changing basic psychological need satisfaction of underrepresented scholars with their mentors. Despite the lack of sustained effect of either mentor training or peer mentoring, these short-term changes suggest feasibility and potential for future study.

High-quality mentoring is important for success in academic and health care careers.^{1,2} Mentors provide knowledge and advice in their area of expertise, and they support the psychosocial needs of protégés to establish a professional identity, develop networks, and acculturate within their field. Despite the breadth of these roles, few mentors receive formal training. A survey of 46 federally funded clinical translational research centers showed that only 13 offered formal mentor training.³

Mentoring is particularly important for the success and retention of minorities and women,^{2,4} who may have limited

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access to mentors and can face additional professional challenges including bias, prejudice, lack of confidence, a sense of isolation, and disparate cultural expectations. Racial and ethnic minorities in academic medicine often feel isolated, which contributes to attrition from academic careers.^{5,6} Both women and minorities are susceptible to self-doubt and the imposter syndrome, in which individuals harbor serious doubts about their abilities and qualifications, despite evidence to the contrary.⁷⁻⁹ Because mentoring often occurs across differences in race, ethnicity, and gender, mentors may be unaware of (or uncomfortable with addressing) the role of bias and discrimination in their protégés' careers.¹⁰

Optimal theoretical approaches and methods for addressing the mentoring needs of these underrepresented groups have not been identified. Beech et al⁴ described 13 mentoring programs for minority faculty that are generally perceived to be successful, most of them based on the traditional one-on-one mentoring model. Others have

described supplemental peer mentoring programs and social networks to address protégés' needs for career development in a supportive, nonthreatening, and collaborative environment.^{2,11-13} These studies describe some of the important characteristics of effective mentoring, but little theoretically based, empirical evidence is available to demonstrate which mentoring or mentor training approaches are most likely to be successful for academics from underrepresented groups.¹⁴

Self-determination theory (SDT) is a macro theory of human motivation with strong empirical support¹⁵⁻¹⁷ that may help to address these mentoring challenges. SDT posits that people are most likely to experience optimal well-being and persist in their work when they experience relatedness to a community of others, feel ownership over the goals they pursue, and perceive a sense of competence and accomplishment in their activities. Thus, mentors, peer networks, and work environments that support protégés'

needs for relatedness, autonomy, and competence may be more likely to foster positive protégé outcomes.

We hypothesized that mentoring interventions would provide greater supports for psychological need satisfaction in protégés from underrepresented groups, theoretically increasing the likelihood of their future professional success. To test this hypothesis, we conducted a randomized controlled trial of mentoring interventions for groups of mentor–protégé dyads: One intervention was directed at the mentors (SDT based), another was directed at the protégés (supplemental peer mentoring), and a third combined the two. A control group of protégés received only “usual practice” mentoring through their existing mentors, who were not formally trained. In this report, we evaluate the impact of mentor training and peer mentoring on protégés’ psychological need satisfaction with their mentor specifically and in the workplace overall.

Method

Study design and participants

We conducted a multicenter, randomized controlled trial from 2010 to 2013 with participants from three academic medical centers (State University of New York [SUNY] University at Buffalo, SUNY Upstate Medical University, and University of Rochester) and eight other colleges and universities in western and central New York: D’Youville College School of Pharmacy; Le Moyne College; Rochester Institute of Technology; Roswell Park Cancer Institute; SUNY–Buffalo State College; SUNY College of Environmental Science and Forestry; SUNY at Geneseo; and Syracuse University. Three cohorts of mentor–protégé dyads from health care and other scientific disciplines were recruited. Each cohort participated in the study for one year. We randomly assigned each dyad to one of four groups: mentor training; provided to the mentors only; peer mentoring; peer mentoring groups for the protégés only; combined training; both mentor training and peer mentoring; or control: usual practice.

After institutional review board approvals, we invited potential subjects at all 11 locations to participate through e-mails or

letters that were sent to centrally available lists of graduate students, postdoctoral fellows, and faculty; lists of individuals with career development awards; and mentors from institutional research inventories. We also gave presentations at faculty meetings and posted print advertisements and flyers. Protégés were graduate students, fellows, or junior faculty who were underrepresented based on self-identified racial or ethnic group: Hispanic (any race), African American or black, American Indian or Alaskan Native, and Native Hawaiian or Pacific Islander; gender in their field (e.g., women in biomedical research or health care, men in nursing); or disability. For graduate students, we also considered lower socioeconomic status as a criterion for underrepresentation, using being a first-generation college graduate as a proxy measure. To enter the study, each protégé was required to have a mentor who was willing to complete all questionnaires and participate in the intervention if randomized to mentor training. We provided an incentive payment of \$10 per submitted questionnaire to each participant, \$50 to mentors who completed the training, and \$100 to protégés who completed the peer mentoring intervention.

Interested protégés and mentors completed an enrollment questionnaire that allowed eligibility screening. Mentors and protégés separately provided written informed consent. On completion of the consent process, the study coordinator randomly assigned each mentor–protégé dyad to one of the four study groups (Figure 1) and a study ID number, which was used for the duration of the study to ensure anonymity of subsequent questionnaire responses. The computer-generated randomization plan was stratified by geographic region (Buffalo, Rochester, and Syracuse) and included permuted blocks to promote balance over time in the numbers of dyads assigned to each treatment group within each region. The intervention assignments were contained in sealed envelopes within sets for each region, prepared by a biostatistical programmer. To randomize a dyad, the study coordinator selected the next available sealed envelope from the set for that dyad’s region.

Mentor training. This intervention was planned to include not only basic knowledge about SDT theory and skills but

also application of this learning. Mentors first attended a two-hour workshop to learn about the SDT-based mentoring model, which emphasized support for competence, autonomy, and relatedness; provision of practical supports (structure, extrinsic compensation, equity) for protégés within their workplace; and how to discuss issues of diversity. Each mentor was tasked with conducting an interview with his/her protégé according to the guidelines taught in the workshop. Mentors were explicitly told that the emphasis of the interview was not to problem-solve or provide evaluation but, rather, to listen to their protégés and understand what their lives were like in keeping with SDT principles, including how they experienced the workplace as supportive or unsupportive of any diversity issues that they may feel are personally relevant. Investigators (J.G.L., C.A.M., and D.S.) then conducted one-hour individual interviews with mentors to encourage reflection about what they had learned from their protégés and to reinforce use of this information. Mentors invested a total of approximately five hours in these activities.

Peer mentoring. The peer mentoring intervention, based on social capital theory,^{18,19} was designed to address protégés’ needs for trustworthiness and reciprocity with similar peers and to reduce feelings of isolation, through social networks in which they would share both informal and formal knowledge about academic and institutional professional culture and identity in a supportive environment. Although not explicitly an SDT-based approach, many of the functions could support needs for competence, autonomy, and relatedness. We formed groups of two to six protégés at the start of each cohort. Group assignment was based primarily on career stage; and when possible, gender, race, and region were also matched according to individual preference. Each cohort began with a three-hour face-to-face meeting of all protégés assigned to peer mentor groups. Groups were introduced to each other and offered background information about peer mentoring, the importance of individual development plans (including autonomously defined goals and resource planning), and advice on types of mentoring relationships. Groups then met independently at least monthly to pursue self-directed learning (autonomy)

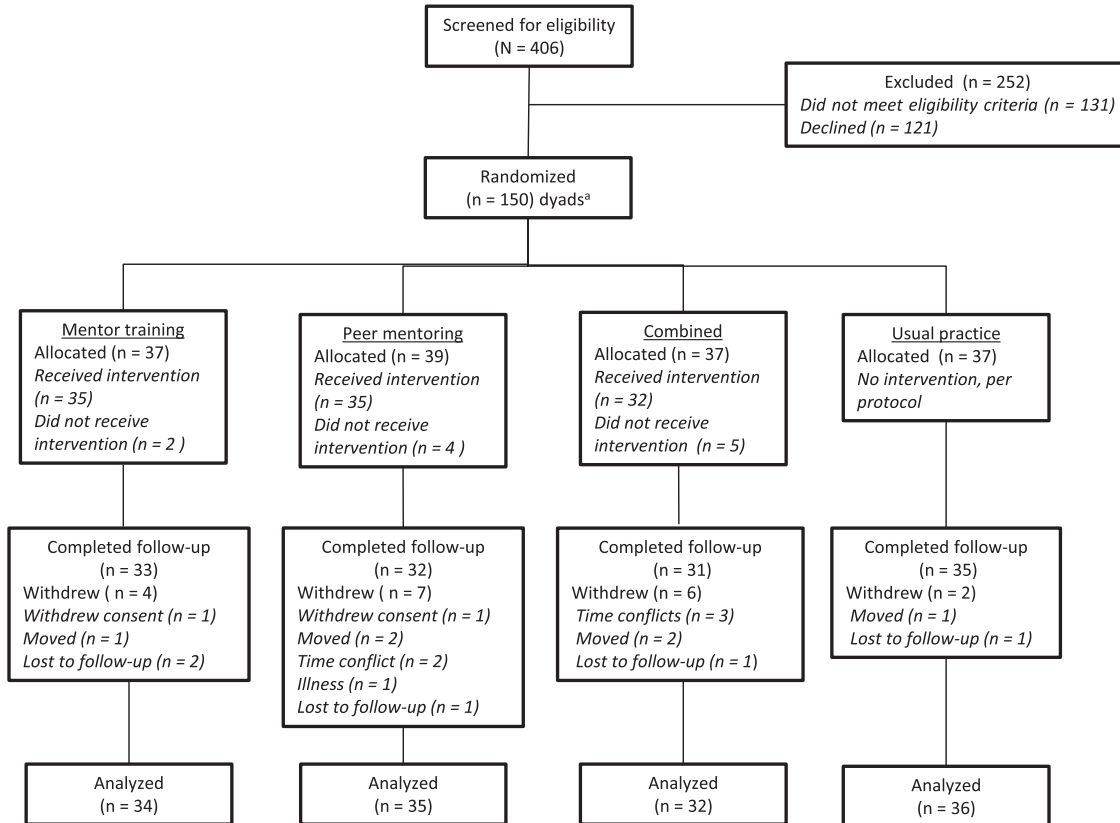


Figure 1 Flow of mentor–protégé participants through a multicenter randomized controlled trial of mentoring interventions, 2010–2013. ^aThe authors randomized 154 protégé–mentor dyads, but 4 were excluded before intervention because of schedule conflicts. At least one member of each of these dyads was later re-randomized with a new protégé or mentor, as appropriate, and is counted among the 150 dyads randomized in the figure. The authors analyzed data from all participants who completed at least one postbaseline survey (including those who withdrew before month 12).

and mutual support (relatedness). Over the year, we held three additional meetings of all protégés assigned to peer mentor groups to provide networking opportunities across groups and workshops on professional development topics chosen by the participants (relatedness and competence).

Combined training. The combined intervention group had both mentor training for the primary mentors and peer mentor groups for the protégés.

Control group. Dyads in the control group pursued their usual mentoring routine(s), which varied according to school, discipline, department, and protégé’s academic level (e.g., graduate student versus faculty member). They had access to professional development opportunities normally offered by their university, but were not specifically encouraged to pursue them. They completed the same questionnaires as those in the intervention groups. We offered control group mentors the

opportunity for mentor training after their final questionnaires were completed.

Outcome measures

Protégés completed a questionnaire at the start (baseline) and end of the study (one year) and at two-month intervals in between. For each measure described below, we asked participants to use a seven-point Likert-type scale to describe the extent to which statements were “not at all true” (1) to “very true” (7). Evidence for the validity of both questionnaires has been published.^{20,21}

Need Satisfaction with Mentor. We used the nine-item Need Satisfaction Scale to assess need support from one’s mentor.²⁰ Sample items included “I feel that my mentor provides me with choices and options” (autonomy), “My mentor conveys confidence in my ability to do well at my work” (competence), and “I feel that my mentor cares about me as a person” (relatedness). A principal component factor analysis with varimax rotation was performed, and results indicated that all items loaded highly

on one factor (all loadings > 0.70) and together showed excellent internal consistency ($\alpha = 0.95$). We calculated subscales for each need by taking the mean of the items for each need, and an overall scale score by taking the mean of the need subscales, such that higher scores indicated a mentor who was more supportive of the protégé’s basic psychological needs. Change in this score from baseline to month 12 served as the primary outcome variable for the study.

Need Satisfaction at Work overall. We used 21 items from the Work Climate Questionnaire²¹ to measure the extent to which participants’ needs for autonomy, competence, and relatedness were met within their overall work environment. Sample items included “I feel pressured at work” (autonomy), “I have been able to learn interesting new skills on my job” (competence), and “People at work care about me” (relatedness). We calculated subscales for each need by taking the mean of the items for each need, and an overall need satisfaction score was

calculated by taking the mean of the three need subscales. Higher scores indicated greater need fulfillment in the workplace.

Statistical analysis

Sample size determination. We determined that a sample size of 30 dyads per group would provide 90% power to detect a difference of 1.2 points in the mean score of the primary outcome variable between any of the experimental intervention groups and the control group, using a Bonferroni-adjusted significance level of $0.05/3 = 0.017$ (two tailed) and assuming a standard deviation of 1.2 points. To account for an anticipated 20% attrition rate, we planned for 152 dyads total (38 dyads/group).

Models for testing the main hypotheses.

In the primary statistical analyses, we used a repeated-measures analysis of covariance model (i.e., the mixed-model repeated-measures [MMRM] analysis strategy)²² that included change from baseline in Need Satisfaction with Mentor score as the dependent variable and treatment group as the independent variable of interest. Geographic region and baseline Need Satisfaction with Mentor score were included as covariates. We included the following in our model: Month (categorical variable), the interaction between treatment group and month, and the interaction between baseline Need Satisfaction with Mentor score and month. We used an unstructured covariance matrix for model fitting. This model yielded pairwise comparisons between each experimental intervention group and the control group separately at each month, with month 12 being of primary interest. We also performed exploratory analyses on month 2 outcomes to examine the short-term effects of the interventions.

We used this model to compute treatment effects and their associated Bonferroni-adjusted 98.3% confidence intervals (CIs). We also performed main effect comparisons (peer mentoring versus no peer mentoring; mentor training versus no mentor training). We performed similar analyses for the Need Satisfaction at Work score. The analyses included data from all protégés who completed at least one postbaseline survey. Similar MMRM analyses were performed to determine whether changes over time in outcomes were associated with gender, race, ethnicity, or region.

Results

We screened 406 protégé–mentor dyads, of which 150 were randomized, between 2010 and 2013 (Figure 1). Most of the protégés were female (83%), and 47% belonged to a racial or ethnic minority group (Table 1). The majority of dyads (59%) were from the health professions. Almost half (48%) of the protégés were junior faculty, 42% were graduate students, and 10% were postdoctoral fellows. Attrition rates were not significantly different for the four study groups (Figure 1).

For all protégé groups, the Need Satisfaction with Mentor score (i.e., protégés' need for competence, autonomy, and relatedness with mentor) declined significantly from baseline (mean = 5.72, SD = 1.16) to month 12 (mean = 5.33; mean change = -0.39 ; 95% CI -0.54 to -0.23 ; $P < .0001$), although mean scores were quite high at both time points. This decline did not significantly differ by gender, racial/ethnic group, or geographic region (Table 2). The mean protégé Need Satisfaction at Work scores were moderately high and remained quite stable for the entire sample from baseline (mean = 5.20, SD = 0.92) to month 12 (mean change = -0.005 ; 95% CI -0.11 to 0.13 ; $P = .93$). We found no significant differences in these mean changes based on gender, race, ethnicity, or geographic region (Table 2).

We found no significant differences at month 12 among the intervention groups with respect to mean changes in the composite score for Need Satisfaction with Mentor (Table 3). However, exploratory analyses showed that at month 2 (approximately one month after mentors began the intervention), protégés in the mentor training group had a 0.45-point-higher mean Need Satisfaction with Mentor composite score ($P = .008$) compared with protégés in the control group (Table 3), and that the main effect of mentor training was 0.32 points ($P = .007$). These effects at month 2 (mentor training versus control) were also apparent for each subscale: autonomy (effect = 0.49; 98.3% CI -0.01 to 0.99; $P = .02$), competence (effect = 0.47; 98.3% CI -0.04 to 0.99; $P = .03$), and relatedness (effect = 0.56; 98.3% CI -0.03 to 1.16; $P = .02$). Differences between groups were not significant at month 12 or at other intervening time points (Supplemental Digital Appendix 1 at <http://links.lww.com/ACADMED/A324>).

Finally, we conducted a similar analysis to examine possible differences among intervention groups in the mean change in Need Satisfaction at Work from baseline to 12 months. No differences among groups were evident for mean changes in composite scores for Need Satisfaction at Work at month 12 or at

Table 1

Characteristics of Protégés in a Multicenter, Randomized Controlled Trial of Mentoring Interventions at Baseline, 2010–2013

Characteristic	No. (%) of intervention groups				No. (%) all groups
	Mentor training	Peer mentoring	Combined	Control	
Gender					
Male	6 (16)	5 (13)	9 (24)	6 (16)	26 (17)
Female	31 (84)	34 (87)	28 (76)	31 (84)	124 (83)
Ethnic category					
Hispanic or Latino	5 (14)	5 (13)	4 (11)	6 (16)	20 (13)
Not Hispanic or Latino	32 (86)	34 (87)	33 (89)	31 (84)	130 (87)
Racial category					
Asian	4 (11)	7 (18)	4 (11)	4 (11)	19 (13)
Black/African American	7 (19)	10 (26)	9 (24)	10 (27)	36 (24)
Pacific Islander	0 (0)	1 (3)	0 (0)	0 (0)	1 (1)
White	22 (59)	18 (46)	22 (59)	18 (49)	80 (53)
Unknown/other/ ^{>} 1 race	4 (11)	3 (8)	2 (5)	5 (14)	14 (9)
Other characteristics					
Disability	3 (8)	4 (10)	2 (5)	1 (3)	10 (7)
First-generation college graduate	13 (35)	15 (38)	14 (38)	9 (24)	52 (35)

Table 2

Subgroup Differences in Mean Changes From Baseline to Month 12 in Protégé Need Satisfaction with Mentor and Need Satisfaction at Work Composite Scores, From a Multicenter, Randomized Controlled Trial of Mentoring Interventions, 2010–2013^a

Comparison	Group difference	95% confidence interval	P value
Need Satisfaction with Mentor score			
<i>Gender</i>			
Women versus men	0.09	-0.32, 0.50	.66
<i>Race and ethnicity</i>			
Black/Hispanic versus non-Hispanic white	-0.22	-0.58, 0.13	.21
Black/Hispanic versus Asian	-0.42	-0.94, 0.09	.10
White versus Asian	-0.20	-0.68, 0.28	.41
<i>Location</i>			
Rochester versus Buffalo	0.14	-0.23, 0.51	.46
Rochester versus Syracuse	0.20	-0.20, 0.60	.32
Buffalo versus Syracuse	0.06	-0.40, 0.51	.80
Need Satisfaction at Work score			
<i>Gender</i>			
Women versus men	0.16	-0.16, 0.48	.34
<i>Race and ethnicity</i>			
Black/Hispanic versus non-Hispanic white	0.02	-0.25, 0.29	.90
Black/Hispanic versus Asian	-0.09	-0.50, 0.31	.65
White versus Asian	-0.11	-0.49, 0.27	.57
<i>Location</i>			
Rochester versus Buffalo	0.03	-0.26, 0.33	.81
Rochester versus Syracuse	0.07	-0.24, 0.38	.64
Buffalo versus Syracuse	0.04	-0.32, 0.39	.83

^aSubgroup differences are estimated from a repeated-measures analysis of covariance model that includes terms for subgroup, month (categorical), the interaction between subgroup and month, the baseline value of the outcome variable, and the interaction between the baseline value of the outcome variable and month. See method section for description of scoring and calculation of composite scores.

any other time point (Table 4). With respect to the specific components of Need Satisfaction at Work, we found no significant differences by intervention group in mean changes for the subscales for autonomy, competence, or relatedness.

Discussion

Our randomized controlled trial evaluated the impact of two interventions on the mentoring relationships of underrepresented groups in academia with respect to their basic psychological needs for autonomy, competence, and relatedness. We explored the extent to which each intervention was able to change support for protégés’ basic psychological needs both with their mentor and in their workplace.

Overall, protégés who had a mentor who participated in the SDT-based mentor

training program perceived greater need satisfaction from their mentors in the period just following their mentor’s training (two months), but this was not sustained through month 12. Moreover, a comparable positive effect at two months was not observed in the combined training group. It may be relevant that need satisfaction levels of protégés in the mentor training group were quite high at both baseline and month 12. Our intervention involved mentors’ participation in a relatively brief workshop (two hours); application of this knowledge by conducting an interview with their protégés regarding their experience of support for autonomy, competence, relatedness, structure and equity of the workplace, and support for diversity; and discussion of using the information to better support the protégé during a follow-up interview with workshop staff. Hence, total intervention

time for the mentors was approximately five hours.

Our short-term results at two months support previous reports showing that training to promote autonomy-supportive workplace behavior has a positive impact.^{23,24} It is surprising that this effect was not observed in the combined training group. The decline in Need Satisfaction with Mentor scores over 12 months suggests that more extended or intensive mentor training in need supportiveness may be required to facilitate sustained improvement in protégé psychological need satisfaction. Pfund et al²⁵ have shown that a faculty development program with several formal sessions was associated with improved protégé-assessed mentoring skills for three months after the intervention, although they did not report whether these mentors sustained their improved skill for an entire year. Our intervention may benefit from enhancements in duration and intensity, but it is also possible that when protégés’ need satisfaction levels are sufficiently high at baseline, mentor training is unlikely to demonstrate strong improvements over time. Our positive short-term results from this exploratory analysis require further study.

In our study, peer mentoring did not appear to affect protégés’ Need Satisfaction with Mentor or Need Satisfaction at Work scores. In contrast, others have found that peer mentoring groups can help foster professional skill acquisition and an inclusive climate, which could contribute to a sense of psychological need satisfaction at work.^{13,26–28} This difference in findings might be explained by the fact that most of the prior work was conducted in single departments or institutions and among individuals at a single professional stage. Moreover, none were randomized controlled studies.

Our sample required us to create peer mentor groups that were quite heterogeneous with respect to discipline and institution, making it more difficult for the intervention to influence overall workplace climate. Furthermore, some features of the structure and content of the peer intervention may have reduced the likelihood of a positive impact on need satisfaction with one’s mentor.

Specifically, protégés were able to choose the focus of their peer meetings, so they may not have focused explicitly on improving their relationship to their mentors. In addition, because the

small-group peer mentoring sessions were not facilitated, discussions could have developed a negative tone over time that may have focused on problems with mentors. Given that we did not

observe an improvement in the Need Satisfaction with Mentor score in either the peer mentoring or the combined training groups, some factor in the peer mentoring sessions is likely to be the source of this finding. Although effects on Need Satisfaction with Mentor or Need Satisfaction at Work scores were not found, other positive outcomes related to peer group interactions, such as quality of time spent with mentor and breadth of subject matter covered, were found and are reported elsewhere.²⁹

Table 3

Effects of Mentoring Interventions on Composite Scores for Need Satisfaction with Mentor Composite Score, From a Multicenter, Randomized Controlled Trial of Mentoring Interventions, 2010–2013^a

Month	Comparison	Mean group difference	Confidence interval ^b	P value ^c
2	Mentor training versus usual practice	0.45	0.05, 0.85	.008
	Peer mentoring versus usual practice	0.04	−0.36, 0.44	.82
	Both versus usual practice	0.23	−0.18, 0.65	.18
	Mentor training main effect ^d	0.32	0.09, 0.55	.007
	Peer mentoring main effect ^d	−0.09	−0.33, 0.15	.46
12	Mentor training versus usual practice	0.30	−0.24, 0.85	.18
	Peer mentoring versus usual practice	0.08	−0.46, 0.62	.72
	Both versus usual practice	0.08	−0.48, 0.63	.74
	Mentor training main effect ^d	0.15	−0.17, 0.47	.35
	Peer mentoring main effect ^d	−0.07	−0.40, 0.25	.65

^aIntervention effects are estimated from a repeated-measures analysis of covariance model that includes terms for group, month (categorical), the interaction between group and month, region, the baseline Need Satisfaction with Mentor score, and the interaction between the baseline Need Satisfaction with Mentor score and month. Group comparisons are shown for mean changes from baseline at months 2 and 12.

^bConfidence intervals are 98.3% for the comparisons of each individual intervention group with usual practice and 95% for the main effects of the mentor training and peer group interventions.

^cStatistical significance was set at a level of .017 for the individual group comparisons and .05 for the group (main effect) comparisons.

^dThe mentor training main effect refers to the comparison of those receiving mentor training (either alone or in combination with peer mentoring) and those not receiving mentor training (peer mentoring alone or usual practice). The peer mentoring main effect refers to the comparison of those receiving peer mentoring (either alone or in combination with mentor training) and those not receiving peer mentoring (mentor training alone or usual practice).

Table 4

Effects of Mentoring Interventions on Need Satisfaction at Work Composite Score, From a Multicenter, Randomized Controlled Trial of Mentoring Interventions, 2010–2013^a

Month	Comparison	Group difference	Confidence interval ^b	P value
2	Mentor training versus usual practice	−0.10	−0.45, 0.25	.50
	Peer mentoring versus usual practice	−0.07	−0.42, 0.28	.63
	Both versus usual practice	−0.14	−0.50, 0.22	.34
	Mentor training main effect ^c	−0.08	−0.29, 0.12	.41
	Peer mentoring main effect ^c	−0.06	−0.26, 0.15	.58
12	Mentor training versus usual practice	−0.04	−0.46, 0.38	.84
	Peer mentoring versus usual practice	0.03	−0.40, 0.45	.88
	Both versus usual practice	−0.04	−0.46, 0.39	.84
	Mentor training main effect ^c	−0.05	−0.29, 0.20	.69
	Peer mentoring main effect ^c	0.01	−0.23, 0.26	.92

^aIntervention effects are estimated from a repeated-measures analysis of covariance model that includes terms for group, month (categorical), the interaction between group and month, region, the baseline Need Satisfaction at Work score, and the interaction between the baseline Need Satisfaction at Work score and month; group comparisons are shown for mean changes from baseline at months 2 and 12.

^bConfidence intervals are 98.3% for the comparisons of each individual intervention group with usual practice and 95% for the main effects of the mentor training and peer group interventions.

^cThe mentor training main effect refers to the comparison of those receiving mentor training (either alone or in combination with peer mentoring) and those not receiving mentor training (peer mentoring alone or usual practice). The peer mentoring main effect refers to the comparison of those receiving peer mentoring (either alone or in combination with mentor training) and those not receiving peer mentoring (mentor training alone or usual practice).

Our study has several limitations. First, across all groups, we found that need satisfaction with one's mentor was high at baseline and remained quite high at month 12. Likewise, protégés' need satisfaction at work was high at baseline and at 12 months. These data suggest that participants' willingness to enroll in the study may have reflected a relatively high-functioning, established, and committed mentor–protégé partnership compared with that available to nonparticipants. Selection bias may therefore have limited our ability to detect meaningful differences between groups over the course of 12 months. In future work, it will be important to recruit protégés and mentors with greater diversity in their baseline need satisfaction. Another possibility would be to study only those who are just beginning their work (new to position/role) or their protégé–mentor relationships, in order to observe the full impact of each intervention over time. Another possibility, as previously discussed, is that our intervention to develop mentors' support of protégés' basic psychological need satisfaction was insufficient in length or intensity to demonstrate a significant sustained effect.

There are several important strengths of our study. First, our interventions are theoretically driven. Most interventions simply focus on building protégé competence and implement a set of techniques to support goal achievement. Our interventions draw attention to the importance of supporting autonomy and relatedness as well as competence, and our results provide empirical support for focusing on these needs. A second strength of our study is that the intervention recommends that protégés and mentors discuss macro-level requirements that are important for any well-functioning workplace, such as structure, resources, and equity,

as well as explicitly discussing diversity issues and supports that the protégé cites as personally meaningful. Third, we employed a rigorous, randomized controlled study design to evaluate the utility of different mentoring interventions, a design that is rarely used in this context. Finally, we enrolled and retained a sample from an underrepresented professional population who are typically difficult to engage and sustain, yet our retention rate over one year was remarkably high (87.3%). Our diverse sample of graduate students, postdoctoral fellows, and faculty from multiple scientific disciplines and several institutions enhanced generalizability of the results.

In conclusion, we found that a brief, educationally sound, mentor-directed intervention had a short-term positive effect on protégés' basic psychological needs satisfaction with their mentors. Long-term maintenance of these effects was not found, however, possibly because the mentor intervention was too brief. To our knowledge, this is the first randomized controlled trial among underrepresented minority and women protégés to suggest evidence of an effect of mentor training on protégés' psychological need satisfaction with their mentors. Although the effect was not sustained, the multicenter nature of our cohort suggests that this finding may be generalizable, and have potential for reproducibility. Tests of more intensive versions of the mentor training are planned. Other future reports will address positive effects of our mentoring interventions on protégés' academic productivity, retention in academics, and social networks.

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