Basic and Applied Social Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/hbas20

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Published online: 22 Nov 2013.

To cite this article: Nicole Kronberger & Ilona Horwath (2013) The Ironic Costs of Performing Well: Grades Differentially Predict Male and Female Dropout From Engineering, Basic and Applied Social Psychology, 35:6, 534-546, DOI: 10.1080/01973533.2013.840629

To link to this article: http://dx.doi.org/10.1080/01973533.2013.840629

BASIC AND APPLIED SOCIAL PSYCHOLOGY, 35:534–546, 2013

ISSN: 0197-3533 print/1532-4834 online
DOI: 10.1080/01973533.2013.840629

Routledge
Taylor & Francis Group

The Ironic Costs of Performing Well: Grades Differentially Predict Male and Female Dropout From Engineering

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Stereotype threat may not only affect academic performance and persistence but also the relationship between the two variables. An analysis of the trajectories of 2,397 individuals who began majors in engineering shows a gender gap in graduation rates for those with high and average GPAs. Survey data ($N = 455$) furthermore highlight that good grades, while reducing academic self-doubt, ironically accentuate female students' social discomfort, and that after dropout, women are more likely than men to show signs of disidentification. For a minority that is met with negative competence expectations, good intellectual performance is no guarantee for persistence.

C. M. Steele's (1997) *general theory of domain identification* has stimulated a myriad of studies addressing the ways in which stereotypes can impact intellectual functioning via "stereotype threat," a threat of confirming or being reduced to a negative stereotype. There are two major foci to the research program. As a situational concern, stereotype threat can depress the intellectual performance of stereotyped groups (C. M. Steele & Aronson, 1995; for a meta analysis, see Nguyen & Ryan, 2008); as a chronic experience, it pressures stereotyped individuals toward disidentification and avoidance of the domain. Disidentification is a coping mechanism (C. M. Steele, 1997), which represents a double-edged sword. Although avoidance of the domain relieves the individual from the aversive experience of being stereotyped, it entails considerable costs both for the individual and for society.

Of interest, most research has examined the effects of stereotype threat on either academic performance *or* domain avoidance; the relationship between the two variables has hardly been examined. To address this lacuna, we take the example of women in engineering and ask how performance relates to the group's persistence in the field. Engineering is a program in which women are widely stereotyped as less able to learn the contents (Appel, Kronberger, & Aronson, 2011); in which, across a wide range of countries, they represent a numerical minority, both among students and faculties (National Science Foundation, 2011; OECD, 2006); and that is full of symbols of an "all-boys club" (Margolis & Fisher, 2002). It is exactly factors like these—numerical underrepresentation (Inzlicht & Ben-Zeev, 2000, 2003; Purdie-Vaughns, Steele, Davies, Ditlmann, & Crosby, 2008; Sekaquaptewa & Thompson, 2003); a lack of role models (Marx & Roman, 2002; Stout, Dasgupta, Hunsinger, & McManus, 2011); or identity-related images, symbols, and setting features (Cheryan, Plaut, Davies, & Steele, 2009; Davies, Spencer, Quinn, & Gerhardstein, 2002; Murphy, Steele, & Gross, 2007)—that can constitute a "threat in the air" for stereotyped students (C. M. Steele, 1997).

In such "threatening environments" (Inzlicht & Good, 2006), stereotype threat is likely to depress both women's intellectual performance (Nguyen & Ryan, 2008; Quinn & Spencer, 2001; Spencer, Steele, & Quinn, 1999)[1] and domain identification. It undermines women's aspirations to enter male-stereotyped fields and to pursue male-dominated jobs (Cheryan et al., 2009; Davies et al., 2002; Davies, Spencer, & Steele, 2005; Good, Rattan, & Dweck, 2012; Gupta,

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[1]The results are more unequivocal in the lab than in real-world contexts (Cullen, Hardison, & Sackett, 2004; Cullen, Waters, & Sackett, 2006; Good, Aronson, & Harder, 2008; Huguet & Régner, 2007; Keller, 2007; Keller & Dauenheimer, 2003; Stricker & Ward, 2004).

Turban, & Bhawe, 2008; Schmader, Johns, & Barquissau, 2004), and for those self-confident enough to enter the domain nevertheless, it makes persistence difficult. Women in male-dominated fields are more likely to voice intentions to quit (J. Steele, James, & Barnett, 2002; von Hippel, Issa, Ma, & Stokes, 2011) and actually drop out more often from university courses such as engineering or computer sciences than men (Brandstätter, Grillich, & Farthofer, 2006; Singh, Allen, Scheckler, & Darlington, 2007). However, little is known on how performance relates to persistence in such environments, both for stereotyped and nonstereotyped students. Repeated poor performance will be a frustrating experience, increasing a student's tendency to escape the field. What happens, however, if a woman excels in a male-dominated field? Surely, one might argue, threat is overcome and she will be as likely to persist in the domain as a man. But is this the case?

GRADES AS FEEDBACK

The relationship between intellectual performance and persistence/avoidance has traditionally been addressed by dropout research. Grades (e.g. high school grade point average [GPA]) have been found to be a useful predictor for university dropout (Brandstätter et al., 2006; Gold & Souvignier, 2005; Robbins et al., 2004). However, grades not only are a measure of ability, skill, and effort but also represent an important feedback on how well students do and where further attention is needed (Crocker, Karpinski, Quinn, & Chase, 2003).

Stereotyped students regularly experience at least two doubts: uncertainty with regard to their ability, and uncertainty with regard to being socially accepted and belonging (Schmader, 2010; Steele, 1997; von Hippel et al., 2011; Walton & Cohen, 2007). In the face of such uncertainty, they tend to become more vigilant for cues indicating threat (Aronson & McGlone, 2009; Cohen & Garcia, 2008; Kaiser, Brooke Vick, & Major, 2006; Purdie-Vaughns et al., 2008). The feedback that students receive in the form of grades may constitute such a cue, affecting how stereotyped students react to the uncertainties. Depending on the feedback they receive, stereotyped students may be more or less likely to experience intrapsychic threat (self-doubt) or interpersonal (reputation) threat (Shapiro & Neuberg, 2007). The conclusions students draw with regard to their ability and belonging are important because dropout research indicates that a positive academic self-concept and good social integration are important dropout predictors beyond GPA (Robbins et al., 2004; Tinto, 1975). As stereotyped students need to contend not only with an evaluative threat but also with a social identity threat, grades may be interpreted differently by those stereotyped and those not, which in turn may affect differential persistence. In the following we review the literature on what is known about how grades relate to the experiences of academic self-doubt and social discomfort for stereotyped and nonstereotyped students.

INTERPRETING GRADES

Grades and Academic Self-Concept

Success and failure in a domain impact students' views of their ability (Bussey & Bandura, 1999), a relationship that appears to be comparable in samples of school students with varying gender composition, both in math and verbal domains (Möller, Pohlmann, Köller, & Marsh, 2009). Theorizing on negative stereotype internalization, however, suggests that stereotyped individuals, through continued exposure, internalize the negative expectations conveyed by a stereotype (e.g., Allport, 1954; Clark, 1965; for a summary, see Steele, 1997). This, in turn, should affect performance, motivation, effort, and efficacy (Bandura, 1977; Bonnot & Croizet, 2007a, 2007b; Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Schmader et al., 2004). In line with such reasoning, some research on female students in the computer sciences suggests a confidence gap for women who—at comparable performance levels—assess their abilities more critically than men; international studies, however, are inconsistent with regard to the confidence gap hypothesis (see Singh et al., 2007, for a review).

It is also possible that stereotyped students do not suffer from a confidence gap all of the time. Only in certain circumstances, such as being under stereotype threat, might they experience diminished self-confidence or make more internal attributions (Stangor, Carr, & Kiang, 1998; Steele & Aronson, 1995). Similarly, failure or negative feedback can *trigger* heightened levels of self-doubt with stereotyped women (Biernat & Danaher, 2012; Kiefer & Shih, 2006; Koch, Müller, & Sieverding, 2008). Women in engineering programs, for example, suffer considerable drops in self-esteem in response to receiving bad grades (Crocker et al., 2003); women also tend to interpret ambiguous feedback ("not bad") as objectively worse than men (Biernat & Danaher, 2012). Little is known on how stereotyped students interpret positive feedback. The often implicit assumption seems to be that good performance should demonstrate to students that they can do well and so protect them from exaggerated self-doubt.[2]

[2]Once stereotyped students in the field chronically employ the self-protective strategy of disidentification, they may show reduced reactivity to feedback and report even *less* self-doubt than majority students. Psychological disidentification implies that, to protect their self-esteem, stereotyped students disengage their self-feelings from their academic achievements (Major, Spencer, Schmader, Wolfe, & Crocker, 1998; Steele, 1997). This results in weakened correlations between self-esteem and academic outcomes (Morgan & Mehta, 2004; Osborne, 1997; Verkuyten & Thijs, 2004). However, as long as women are identified so that they care for succeeding in the domain, this response should be unlikely.

Grades and Social Experience

Good grades may not only strengthen a student's self-confidence but also boost a feeling of social comfort in the domain. Social belonging, which can be defined as the perceived quality of the social relations in a setting (Walton & Carr, 2012), is essential for sustained academic motivation and achievement (Cohen & Garcia, 2008; Keller & Dauenheimer, 2003; Steele, 1997; Walton & Cohen, 2007) and persistence (Robbins et al., 2004; Tinto, 1975). However, being stereotyped may make it difficult for students to feel socially welcome. The lower probabilities of graduating on time for Black and Hispanic compared to White students can be explained, in addition to grades, by the perceived campus racial climate and social life satisfaction (Fischer, 2010). Similarly, female students in the computer sciences often perceive the social climate as unwelcoming and cold (Singh et al., 2007). However, the results are not consistent. In a study by Walton and Cohen (2007), for example, Black and Latino students in information technologies but not women were affected by a threat to social belonging. The authors explain the finding by the ambivalent nature of stereotypes that tend to combine positive and negative ascriptions such as, for example, in the frequent depiction of women as incompetent but nice (Fiske, Cuddy, Glick, & Xu, 2002).

However, it is possible that not all women encounter the same ambivalent stereotypes (Cuddy, Fiske, & Glick, 2008). For many social groups, including different groups of women, there is a compensatory nature of the relationship between ascribed social qualities and competence (Judd, James-Hawkins, Yzerbyt, & Kashima, 2005; Kervyn, Yzerbyt, Judd, & Nunes, 2009). When a group is praised for one aspect, it is likely to be devalued on the other. Visibly successful women tend to be seen as competent but socially dislikeable (Eckes, 2002); they are likely to be met with respect but also resentment or envy by other men and women (Cuddy et al., 2008; Wojciszke, Abele, & Baryla, 2009). As a consequence, it is possible that high-performing women are confronted with different stereotypes than women who struggle intellectually.

The ironic prediction of social costs to good performance is consistent with the claim that the vanguard of a stereotyped group should be affected most by being stereotyped (Steele, 1997). Because students at the upper end of skills and motivation want to do well, they keenly try to prove the stereotype wrong. This can create a pressure not experienced by nonstereotyped students. High-performing women, when they are perceptive, may realize that confronting stereotypes is a Sisyphean task (Steele, 1997): No amount of success on their part can disprove the stereotype. Having repeatedly demonstrated that they can excel in the domain they should realize that female ability and belonging will be questioned independently of how well they perform. As a consequence, a good cumulative GPA ironically could *increase* rather than reduce the sense of being stereotyped, which in turn should decrease a student's sense of belongingness (Good et al., 2012). In support of such reasoning, high-performing female students in engineering report feeling uncomfortable about being disproportionally praised for achievements considered normal for male colleagues, being suspected of preferential treatment when performing on a high level, or on hardly ever being asked for help by their male peers, even if they could explain difficult subject matters (Horwath & Kronberger, in press). Ironically, the high-performing women seem to feel socially less comfortable than those performing on lower levels. Osborne and Walker (2006) hypothesized that stereotyped students are caught in a paradox. Although strong domain identification should lead to better academic outcomes, it at the same time should make the experience in the field more aversive. The authors examined the hypothesis for Black students highly identified with academia; they found that this group suffers a particularly high risk of withdrawal from school. We are not aware of any study addressing the hypothesis for women in male-dominated fields.

HYPOTHESES: MODELING THE PERFORMANCE–PERSISTENCE RELATIONSHIP

Based on the preceding considerations and on the propositions that, first, a student's cumulative GPA represents important feedback that carries differential meaning for stereotyped and nonstereotyped students, and second, that dropout from a program represents an important opportunity for stereotyped students to avoid the domain, the following alternative models conceptualizing the performance–persistence relationship can be formulated. The models differ in the degree to which they presume grades to influence students' subjective experiences and in the importance they place on intrapsychic (self-doubt) and social factors.

Generalized threat: Being stereotyped may represent such a pervasive threat that *all* stereotyped students experience heightened self-doubt and/or social discomfort. In this view, women should be less likely to persist than men at all performance levels.

Negative feedback induced threat: In this perspective, detrimental effects (particularly doubt on ability) are expected for stereotyped students in response to negative feedback. As a consequence, women should be less likely to graduate than men at poor but not at high performance levels.

Ironic threat: This model suggests that successful stereotyped students should experience social

discomfort, either because they are factually met with more resentment or because they are disappointed about the Sisyphean nature of disproving stereotypes. As a consequence, it is predicted that the graduation chances for women are depressed at high performance levels.

Multiple threat: It is also possible that stereotyped students experience different kinds of threat (Shapiro & Neuberg, 2007), depending on how well they do academically. Accumulated negative feedback may provoke increased self-doubt while positive feedback may go hand-in-hand with experiencing the situation as being socially aversive. As a consequence, the chances of graduation should be depressed for women at all performance levels. The pattern of the performance–persistence relationship should resemble the generalized threat model but the underlying mechanisms should be different.

No threat: This model can be considered the null hypothesis, suggesting that—because there is no social identity threat in the environment—men and women across performance levels should experience the situation similarly and show comparable chances of graduation.[3]

In the following we analyze the trajectories of individuals who registered for an engineering major with the goal of graduation in mind, which means that they at least initially were highly domain identified (Cullen et al., 2006). Later on they left the program as either graduates or dropouts. In Part 1 of the results section, we examine which of the alternative models best predicts the relationship between GPA and graduation/dropout for male and female students. To test whether the resulting pattern matches the subjective experiences as hypothesized by the respective model, in Part 2, we examine the degree to which stereotyped and nonstereotyped students across performance levels report on self-doubt and social discomfort and how these experiences relate to the chances of graduation. Although dropout can represent an extreme form of disidentification (it allows stopping any further contact with the domain), there are many possible reasons for dropout and students can also leave a program without disidentifying from the domain (e.g., they can move on to a better university to continue their studies or they can take on a job in the field before graduation). According to all of the models just described, however, dropout should imply that women—as a result of being chronically stereotyped—turn their back to the domain. Therefore, in Part 3, it is examined whether women actually avoid the field after dropout. Compared to male dropouts, we expect female dropouts to be more likely to take up a job or a course of studies *outside* the domain of engineering or the wider field of the natural sciences. Furthermore, for women, dropout should signify stereotypic failure that needs to be coped with. One possible self-protective response, for example, is to devalue the domain in which one felt devalued, rendering the domain psychologically irrelevant for the self (Steele, 1997). We expect women after dropout to become more likely to say that engineering never was important to them. Of course, men may also devalue the domain in a self-serving way once they have prematurely withdrawn from the major. However, because they should have less to explain than women, the effect should be weaker for men than for women.

Finally, chronic stereotype threat effects should add to social structural obstacles that pressure stereotyped individuals into disidentification (Steele, 1997). Societal gender roles, for example, influence schooling decisions, which in turn lead to preparational advantages, or disadvantages respectively. In engineering, women are more likely than men to enter university with experience gaps (Margolis & Fisher, 2002). Although such structural disadvantages should affect the likelihood of graduation, effects of gender and stereotyping should hold above and beyond effects of experience gaps.

METHOD

Design and Participants

Both administrative and survey data are used to examine the hypotheses just stated. Two engineering majors (computer sciences, mechatronics) at a Middle European University were chosen for being known as difficult programs in which women are underrepresented, both among students and faculty. As the selected majors share a number of classes, the two majors were treated in combination. The university's administration provided data on all persons who were active students in the programs at some point between 1993 and 2005 ($N = 4{,}846$).[4] In December 2005, these individuals were invited to participate in a survey (either by mail or e-mail). Eighteen months later, the administration provided students' educational status (i.e., whether the individual dropped out in the meantime,[5] had graduated or was still an active student in the program). To ensure confidentiality, the researchers only had access to anonymized data.

[3]In principle, it is also possible that—at poor and/or high performance levels—men suffer lower chances of graduation than women. However, we are not aware of any theoretical reasons that would suggest such a pattern.

[4]This means that some students enrolled before 1993; the average year of enrollment was 1995.

[5]Dropout is defined from the university's perspective rather than from a student's view. If a student stopped paying tuition fees and taking exams for a certain period, the student's status is defined as dropout.

The present study focuses on long-term trajectories of students who enter university with the idea of majoring in engineering and later leave university as either dropouts or graduates. Individuals who were students both at the time of the survey and 18 months later or who had not taken any exam are excluded from the analysis. Furthermore, students with a foreign university entrance qualification are not considered because virtually all of them appear as dropouts in the administrative data. A majority of them will have enrolled in student exchange programs and hence falsely appear as dropouts. The resulting sample comprises trajectories for 2,397 individuals ($n_{\text{dropout}} = 1{,}219$, $n_{\text{graduate}} = 1{,}178$). Out of these 197 are females. With a share of 12% among dropouts and 4% among graduates, they clearly represent a numerical minority and a highly select group. The full sample of trajectories constitutes the database for the first part of the analyses.

For more detailed analyses, the administrative data are combined with the survey data. For 455 of the 2,397 trajectories both types of data are available (19% of both male and female).[6] For some analyses, respondents to the survey are classified into two groups. The *retrospective* group includes respondents who had already graduated or dropped out at the time of filling in the survey, whereas the *prospective* group comprises respondents who were students at the time of filling in the survey but graduates or dropouts 18 months later. Overall the survey sample includes 21 female dropouts (11 retrospective, 10 prospective), 79 male dropouts (42 retrospective, 37 prospective), 16 female graduates (8 retrospective, 8 prospective), and 339 male graduates (283 retrospective, 56 prospective). Eleven respondents showed missing data on some of the survey questions (two male dropouts and nine male graduates, all in the retrospective subsample); these individuals were excluded from respective analyses.

Materials

In addition to information on *status* (graduate or dropout), university administration provided data on individuals' *age* at the time of the survey ($M = 31.21$, $SD = 5.43$) and on the following variables.

Experience gap. Although schools with a focus on mathematics, science, or engineering provide students with subject-specific training, other schools are less likely to prepare students in this way (coded as experience gap). In the total sample ($N = 2{,}397$), 27% of participants lack subject-related prior schooling, with clear gender differences: Twenty-four percent of the male and 63% of the female beginners enter university with experience gaps.

Cumulative GPA. An often used predictor of dropout is high school GPA. When university GPA is included as a predictor of dropout, high school GPA yields no incremental predictive validity but is mediated by university grades (Brandstätter & Farthofer, 2003; Brandstätter et al., 2006; Voelkle & Sander, 2008).[7] In the current context, accumulated GPA is taken as a form of feedback that may provide a cue to female students how to interpret their experiences in an environment in which they represent a minority and in which their competence is likely to be questioned. Consequently, GPA is based on all university exams a student has taken up to the point in time when the survey was fielded. GPA ranges from 1 (*failed*) to 5 (*excellent*), ($M = 3.08$, $SD = 1.03$) and, on average, comprises 96.41 exams for graduates ($SD = 17.39$, $Mdn = 97.00$) and 20.27 exams for dropouts ($SD = 27.33$, $Mdn = 8.00$).

In the survey, respondents provided data on the following aspects (mean scores are used for all of the following variables).

Self-doubt. Respondents indicated agreement (1 = *do not agree at all*, 5 = *completely agree*) with the following two items: "I do (did) not feel up to the intellectual requirements"; "I am (was) confident about getting on well in the near future" (recoded) (Cronbach's $\alpha = .63$).

Social discomfort. Participants responded to the question, "How would you describe the social climate in the program?" using the following 5-point bipolar scales: competitive versus cooperative, approachable versus inapproachable, intimidating versus encouraging, anonymous versus personal, problematic versus unproblematic, helpful versus unhelpful, optimistic versus pessimistic. Items were recoded and their scores averaged such that 1 denotes social comfort and 5 indicates social discomfort (Cronbach's $\alpha = .81$).

Domain importance. Respondents rated the importance of the following reasons for having chosen an engineering major (1 = *not at all important*, 5 = *very important*): "Because of interest in the subject"; "To participate in innovative technology developments"; "Because of interest in the methods, theories and insights of the discipline"; "Because it is fun being able to discuss difficult technology matters"; "Because I wanted to learn the theoretical foundations of the discipline" (Cronbach's $\alpha = .74$).

[6] A considerable portion could not be reached because of changes in address or family name.

[7] First-term university GPA has also been found to mediate the relationship between standardized test results and dropout (Brandstätter et al., 2006). This is important because in Middle Europe standardized testing is less common than in other countries, and students often cannot report SAT or GRE scores.

Reasons for dropout and behavioral disidentification. Respondents who already had dropped out at the time of responding to the survey indicated what kind of activities they engaged in after having dropped out. A variable was constructed to distinguish *behavioral disidentification* (further studies and/or job *unrelated* to engineering or to the natural sciences) from *continued identification* (further studies and/or job *related* to engineering or to the natural sciences). They furthermore indicated for 26 factors whether they played a role in their decision to drop out.

RESULTS

Part 1: Male and Female Persistence Across Performance Levels

In the following, we analyze trajectories of male and female graduates and dropouts in engineering majors. In a first step, we explore the GPA–graduation relationship for male and female students. In a logistic regression model predicting graduation by GPA, gender, and the GPA × Gender interaction, a significant gender main effect would point to a generalized threat or a combined threat model. A significant GPA × Gender interaction, in contrast, would point to a triggered threat or an ironic threat model (depending on the effect's direction). The absence of significant effects for gender or the interaction would suggest a "no threat" model.

In the total sample, as expected, more female than male trajectories end in dropout (74% vs. 49%). Male students' GPA is better ($M = 3.10$, $SD = 1.03$) than female students' GPA ($M = 2.89$, $SD = 1.08$; $B = .21$, $p = .006$) but once the variables age and experience gap are included in the regression model, gender no longer is a significant predictor of GPA ($B_{gap} = -.19$, $p < .001$; $B_{age} = .03$, $p < .001$; $B_{male} = .12$, $p = .13$).

Next, in the logistic regression of utmost interest, the dependent variable (1 = graduation, 0 = dropout) is regressed on GPA, gender, and the theoretically interesting GPA × Gender interaction. The results are presented in Table 1. The first model ($\chi^2 = 905.21$, $p < .001$; Nagelkerke $R^2 = .42$; the rate of correct group classification is 77% against 51% in the intercept-only model) suggests that the probability of graduation rises steadily with increasing GPA and that male students are more likely to graduate than female students. The significant GPA × Gender interaction indicates that the gender gap increases with higher levels of achievement. In a second model, the covariates age and experience gap are added. There is a significant change in explanatory power ($\chi^2 = 19.41$, $p < .001$; Nagelkerke $R^2 = .43$; 77% correct classification); experience gaps significantly reduce the probability of graduation. However, the inclusion of the variables does not change the interpretation of the prior results; the GPA × Gender interaction remains significant. Although at poor GPA levels (–1 *SD*), men and women do not differ in graduation chances ($B = .47$, $SE = .34$, $p = .17$), both at average GPA levels and 1 *SD* above the mean, the differences are significant (*M:* $B = .94$, $SE = .20$, $p < .001$; +1 *SD*: $B = 1.40$, $SE = .25$, $p < .001$).[8] The data suggest a pattern predicted by the ironic threat model.

In a third model we test whether the results hold both for individuals who participated in the survey and for those who did not. The model is rerun including the variable "survey participation" and all its interactions with the second model's predictors. The addition improves the explanatory power ($\chi^2 = 98.97$, $p < .001$; Nagelkerke $R^2 = .46$; 78% rate of correct group classification). There is a significant effect for participation, but none of the added interactions reaches significance. This means that although the survey subsample is biased in terms of

TABLE 1
Results of a Logistic Regression Analysis Predicting Graduation

Variable	*B*	SE_B	*Wald*	*Exp (B)*	*95% $CI_{Exp(B)}$*
Model 1					
Gender[a]	1.11***	.20	31.80	3.03	[2.06, 4.45]
GPA	1.07***	.21	26.58	2.91	[1.94, 4.38]
GPA × Gender	.47*	.22	4.60	1.60	[1.04, 2.45]
Constant	–1.13***	.19	35.89	.32	
Model 2					
Gender[a]	.94***	.20	21.50	2.55	[1.72, 3.79]
GPA	1.10***	.21	27.78	2.99	[1.99, 4.50]
GPA × Gender	.45*	.22	4.22	1.57	[1.02, 2.40]
Experience gap[b]	–.48***	.12	16.24	.62	[.49, .78]
Age	–.02	.01	2.38	.99	[.97, 1.00]
Constant	–.85***	.20	17.71	.43	
Model 3					
Gender[a]	.92***	.23	15.56	2.50	[1.59, 3.95]
GPA	1.01***	.23	19.03	2.75	[1.74, 4.32]
GPA × Gender	.51*	.24	4.46	1.67	[1.04, 2.69]
Experience gap[b]	–.37**	.13	7.76	.69	[.54, .90]
Age	–.01	.01	.47	.99	[.97, 1.01]
Participation (P)[c]	1.08*	.51	4.54	2.94	[1.09, 7.93]
P × Gender	.39	.50	.59	1.47	[.55, 3.95]
P × Experience gap	–.47	.33	2.02	.63	[.33, 1.20]
P × Age	–.01	.03	.06	.99	[.94, 1.05]
P × GPA	.42	.58	.53	1.53	[.49, 4.77]
P × GPA × Gender	–.57	.61	.86	.57	[.17, 1.89]
Constant	–1.10***	.23	22.22		

Note. The continuous variables in the model were centered at the mean. $N = 2{,}397$. GPA = grade point average.
[a]1 = male, 0 = female. [b]1 = gap, 0 = no gap. [c]1 = participation, 0 = no participation.
*$p < .05$. **$p < .01$. ***$p < .001$.

[8]For probing interactions, the Modprobe macro for SPSS was used (Hayes & Matthes, 2009).

TABLE 2
Results of Linear Regression Analyses Predicting Self-Doubt and Social Discomfort

	Self-Doubt *B (SE)*	*Social Discomfort* *B (SE)*
GPA	–.69 (.14)***	–.29 (.13)*
Gender[a]	–.80 (.17)***	–.04 (.15)
Perspective[b]	–.68 (.24)**	.47 (.22)*
GPA × Gender	.40 (.15)**	.13 (.14)
GPA × Perspective	.34 (.26)	.78 (.23)**
Gender × Perspective	.78 (.26)**	–.44 (.23)
GPA × Gender × Perspective	–.36 (.28)	–.67 (.25)**
Constant	2.44 (.17)***	2.30 (.15)***

Note. The grade point average (GPA) variable was centered at the mean. $R^2 = .23$ for self-doubt and .07 for social discomfort. $N = 444$.
[a]1 = male, 0 = female. [b]1 = prospective, 0 = retrospective.
*$p < .05$. **$p < .01$. ***$p < .001$.

comprising more graduates than the nonrespondent sample,[9] the moderated relationship between GPA and graduation holds both for survey respondents and nonrespondents.[10] Comparable results in both groups suggest that it is justified to proceed with analyses based on the survey subsample.

Part 2: Grades, Subjective Experience, and Persistence

Part 1 showed that women at medium to high performance levels are less likely than men to persist in the engineering domain. In this section, we address the question how students at different performance levels experience their situation. The pattern identified in Part 1 is best described by an ironic threat model, which expects high-performing stereotyped students to be concerned with a social (rather than intrapsychic) threat. The following analyses combine the administrative data with the survey data. By taking into account the perspective variable, it is acknowledged that some individuals were active students while others already were graduates or dropouts when responding to the survey.

Table 2 presents the results of two linear regression analyses. In the first model self-doubt is regressed on GPA, gender, perspective, and all interactions of these variables. The results indicate that the better a student's GPA the less pronounced the experienced self-doubt. However, the effect is qualified by gender differences and by significant Gender × Perspective and GPA × Gender interactions (see the upper part of Figure 1 for illustration). Women report more pronounced self-doubt than men in the retrospective sample but not in the prospective sample (retrospective: $B = –1.10$, $SE = .17$, $p < .001$; prospective: $B = –.06$, $SE = .19$, $p = .77$), and although there are no statistically significant gender differences among top performers (+1 *SD*: $B = –.25$, $SE = .17$, $p = .13$), the differences are significant at poor and average GPA levels (–1 *SD*: $B = –.82$, $SE = .18$, $p < .001$; *M*: $B = –.54$, $SE = .12$, $p < .001$).[11]

The regression model is recalculated for the dependent variable social discomfort (see the right part of Table 2 and the lower part of Figure 1). The results indicate that GPA affects social discomfort, but the relationship is qualified by a significant GPA × Gender × Perspective interaction. In the prospective sample GPA and social discomfort are virtually unrelated for men ($B = –.05$, $SE = .07$, $p = .53$), whereas for women there is a positive relationship between the variables ($B = .49$, $SE = .19$, $p = .01$). The better a female student's performance, the more likely she is to report social unease. Although there are no statistically significant gender differences at poor and average performance levels (–1 *SD*: $B = .29$, $SE = .27$, $p = .28$; *M*: $B = –.25$, $SE = .16$, $p = .11$), at high performance levels women are more likely than men to report social discomfort (+1 *SD*: $B = –.79$, $SE = .24$, $p < .01$). In the retrospective subsample, in contrast, better grades are related to reduced social unease (female: $B = –.29$, $SE = .13$, $p = .02$; male: $B = –.16$, $SE = .04$, $p < .01$); there are no gender differences at any of the performance levels (*B*s between –.23 and .04, all *p*s > .27).[12]

Table 3 finally presents the results of a logistic regression analysis addressing the question how students'

[9]Among nonrespondents to the survey, 78% of the female and 56% of the male trajectories end in dropout; among survey respondents the numbers are 58% for female students and 19% for male students.

[10]Simple slope analyses corroborate this conclusion. In separate analyses for the two subsamples, we test for differences at the total sample's mean GPA ($M = 3.08$), and 1 *SD* above and below the mean ($SD = 1.03$), controlling for experience gaps and age. For both survey respondents and nonrespondents, there are no significant gender differences at a performance level –1 *SD* (*no participation*: $B = .40$, $p = .29$; *participation*: $B = 1.36$, $p = .09$). At the mean and at higher performance levels (+1 *SD*), the gender differences are significant in both subsamples (*M*: *no participation*: $B = .92$, $p < .01$; *participation*: $B = 1.31$, $p < .01$; +1 *SD*: *no participation*: $B = 1.43$, $p < .01$; *participation*: $B = 1.25$, $p = .04$).

[11]All probings in this section are conducted at the mean and one standard deviation below and above the mean of the total sample ($M = 3.08$, $SD = 1.03$). Although the three-way interaction does not reach statistical significance, simple slope analyses indicate that in the prospective subsample there are no statistically significant gender differences at any of the performance levels (*B*s between –.07 and .01, all *p*s > .83). In the retrospective subsample, in contrast, men report less self-doubt than women across all performance levels with the difference being particularly pronounced at poor performance levels (–1 *SD*: $B = –1.36$, $SE = .22$, $p < .01$; *M*: $B = –.96$, $SE = .16$, $p < .01$; +1 *SD*: $B = –.57$, $SE = .21$, $p < .01$).

[12]For both self-doubt and social discomfort, the models are recalculcated including the variables experience gap and age. For neither of the dependent variables the explanatory power of the model increases (self-doubt: R^2 change = .00, $F = 1.11$, $p = .33$; social discomfort: R^2 change = .00, $F = 1.03$, $p = .36$).

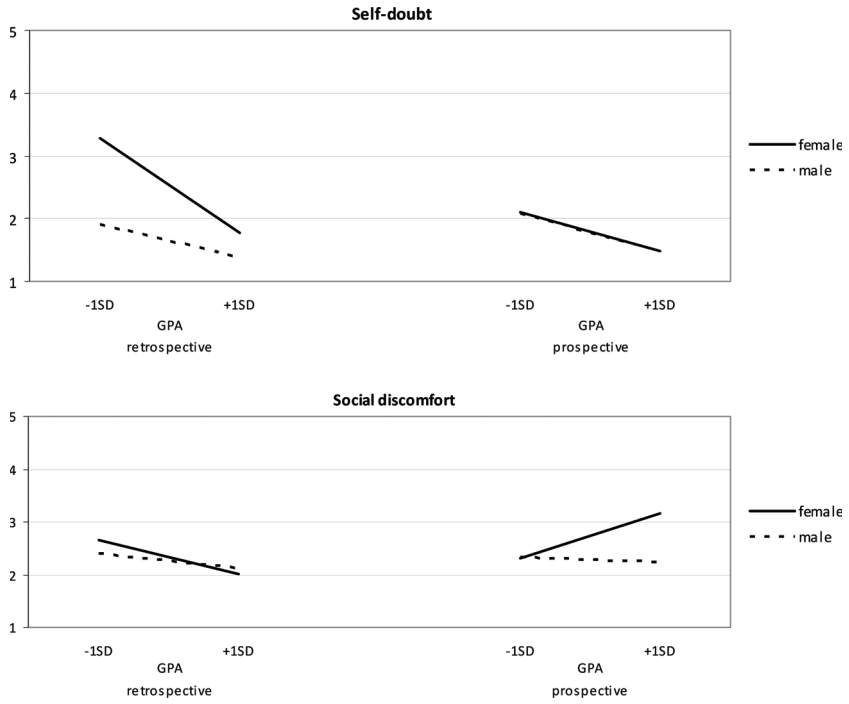

FIGURE 1 Self-doubt and social discomfort by gender across levels of grade point average (GPA). *Note.* The graph presents fitted values based on the regression analyses in Table 2. Values are plotted at the total sample's GPA mean ($M = 3.08$) and one standard deviation below and above the mean.

experiences relate to later graduation success. The analysis is based on the prospective sample only as the retrospective sample does not incorporate a longitudinal design. The results indicate that self-doubt and social discomfort predict graduation over and above GPA. To examine whether the relationship holds for men and women alike in a further model the interactions Gender × Self-Doubt and Gender × Social Discomfort are included. The change does not improve the model's explanatory power ($\chi^2 = 2.49$, $p = .29$), and none of the interactions reaches significance.

TABLE 3
Results of a Logistic Regression Predicting Graduation (Prospective Sample)

	Graduation	
	B (SE$_B$)	*Exp(B)*
GPA	2.25 (1.08)*	9.51
Gender[a]	.54 (.79)	1.72
GPA × Gender	–1.01 (1.12)	.36
Self-doubt	–1.03 (.40)*	.36
Social discomfort	–1.09 (.50)*	.34
Experience gap	–1.00 (.62)	.37
Age	–.28 (.07)**	.76
Constant	–.64 (.84)	.53
R^2 Nagelkerke	.56	

Note. The continuous variables in the model were centered at the mean. $N = 111$. GPA = grade point average.
[a]1 = male, 0 = female.
*$p < .05$. **$p < .01$.

In summary, the results suggest partially diverging experiences of male and female students across performance levels. In the prospective subsample, good grades reduce self-doubt for both men and women but ironically, for women, increase social discomfort. This is important as both self-doubt and social discomfort reduce the chances of graduation. In line with the results presented in Part 1, the processes observed for this sample lend support to an ironic threat model. Retrospectively students remember less self-doubt and less social discomfort the better their grades. Thereby, more self-doubt is reported by women than by men, particularly when having performed poorly.

Part 3: Dropout and Disidentification

The preceding analyses suggest depressed chances of graduation for medium- to high-performing women. Thereby the possibility has not yet been ruled out that the female dropouts leave the program for reasons other than being stereotyped (e.g., they may move on to another university to continue their studies or be offered a job in the field). The theory, however, suggests that women in engineering should suffer a pressure toward disidentification and hence be likely to leave the domain for good.

TABLE 4
Results of a Linear Regression Analysis Predicting Domain Importance

	Domain Importance B (SE)
Experience gap	.04 (.08)
Age	–.02 (.01)*
GPA	.08 (.04)
Gender[a]	.97 (.23)***
Perspective[b]	1.38 (.29)***
Status[c]	1.24 (.31)***
Gender × Perspective	–1.29 (.33)***
Status × Perspective	–1.71 (.45)***
Status × Gender	–1.06 (.33)**
Status × Gender × Perspective	1.58 (.48)**
Constant	2.99

Note. $R^2 = .08$
[a]1 = male, 0 = female. [b]1 = prospective, 0 = retrospective. [c]1 = graduate, 0 = dropout.
*$p < .05$. **$p < .01$. ***$p < .001$.

To test the claim, domain importance is regressed on gender, perspective, and status, and all the variables' interactions; GPA, age, and experience gaps are included as covariates. The results are presented in Table 4 (see Figure 2 for illustration). The significant three-way interaction between gender, status, and perspective highlights that there is one group that differs from the other groups, which is—as expected—female dropouts. Prospectively, both male and female students (no matter whether they later drop out or graduate) report high levels of domain importance. The same is true for male and female graduates and for male dropouts in the retrospective sample. All these groups do not differ in domain importance (ps > .05). Female dropouts in retrospect, in contrast, report significantly weaker domain importance than future dropouts in the prospective sample ($B = 1.37$, $SE = .26$, $p < .001$), 95% confidence interval [.83, 1.91], and all other groups (ps < .01). Female dropouts, retrospectively, say that the domain never was that important to them. Men who have dropped out seem to experience less need for rationalization; they have to cope with dropout but not with stereotypic failure. Male dropouts tend to remain more identified with the domain.[13]

Finally it is examined in what kind of activities former students engaged in after having dropped out. Only respondents who already had withdrawn from the program at the time of responding to the survey are considered. Although men and women virtually do not differ in the reasons given for dropout,[14] significantly more female than male dropouts indicate behavioral disidentification (75% of female vs. 30% of male students; Fisher's Exact Test, $p = .04$), which means that they took up a job and/or course of studies *unrelated* to engineering or to the natural sciences.

GENERAL DISCUSSION

Theoretical and Practical Implications

The presented research addressed the relationship between intellectual performance and persistence for men and women in an environment in which women represent

[13]Domain importance is related to domain identification but does not include the self-evaluative aspect, which is central to the latter concept. In a separate study ($N = 16$) we asked engineering and natural sciences students to rate the domain importance items, the six-item academic competence subscale suggested by Crocker et al.(2003), and a two-item domain identification measure used by Keller (2007). The correlations of domain importance with the two measures were $r = .57$ ($p < .05$) and $r = .68$ ($p < .01$), respectively, indicating considerable construct overlap in the measures of domain importance and domain identification.

[14]Respondents indicated for 26 factors whether they played a role in their decision for dropping out. The most frequently chosen factors were unfulfilled expectations with regard to contents (56%), difficulties with exams (56%), long duration (54%), ways of teaching (52%), and did not meet my expectations (48%). Fisher's Exact Tests (two-sided) suggest that there are no gender differences at conventional significance levels for 24 of the 26 factors. Male and female dropouts only differ in reporting on an "attractive alternative to the major" (49% vs. 9%, $p = .03$) and on "job-related pressure" (41% vs. 0%, $p = .01$). None of the male and female dropouts felt burdened with childcare.

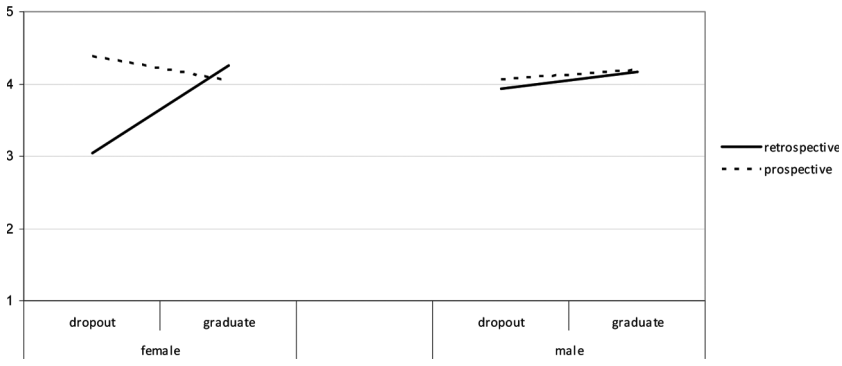

FIGURE 2 Domain importance by perspective, gender, and status. *Note.* The graph presents fitted values based on the regression model in Table 4.

a numerical minority and where they are confronted with a stereotype of inferior competence. Analyses of administrative data indicate that more female than male trajectories end in dropout. The results furthermore show a gender gap in graduation chances at medium to high but not at low levels of performance. Although good performance is an important predictor of graduation for both gender groups, it underpredicts persistence in the program for female compared to male students. The result holds even if experience gaps (lack of subject-specific preparation by prior schooling) are controlled for. Analyses of survey data further qualify the results. Good performance reduces self-doubt for men and women but ironically accentuates women's sense of social discomfort, at least for those in the sample who are active students; both self-doubt and social discomfort predict graduation over and above GPA. Female dropouts show stronger signs of psychological and behavioral disidentification than male dropouts, which can be interpreted as a self-protective response to being stereotyped. They tend to discount the importance of the domain and to leave the field for good, turning to other fields of work or study.

The results add to prior research in several ways. First, they add to dropout research by highlighting the importance of taking into account the heterogeneity of students (Voelkle & Sander, 2008). There is a need for paying closer attention to the differential validity of predictors, especially with regard to ethnic or gender differences (see also Aguinis, Culpepper, & Pierce, 2010; Berry, Clark, & McClure, 2011; Walton & Spencer, 2009).

Second, our study further adds to stereotype threat research by showing that it is not only academic performance or persistence but also the relationship between the two variables that is affected by stereotype threat. The data are best described by an *ironic threat model*: Compared to men, the persistence of women is depressed at high performance levels. As a consequence the study cautions against an all too narrow focus on intellectual performance as the primary dependent variable in stereotype threat research. Even if stereotyped students perform highly, stereotype threat may not be overcome.

Furthermore, the results extend stereotype threat research by providing insights on how processes develop over time. The comparison of successful and less successful trajectories of stereotyped and nonstereotyped students in a real-world context highlights that stigmatized dropouts engage in various defensive adaptations, so that over time they come to resemble the reputation conveyed by the stereotype. In retrospect, such changes in self-definition may be functional to cope with stereotypic failure.

The question for mediators of persistence is not only interesting from a theoretical point of view but also relevant for questions about policies in threatening environments (Marx, Brown, & Steele, 1999). If stereotypes—as suggested by the results—act on social fears (rather than intrapsychic doubt), then there is a need to create environments that negatively stereotyped groups can trust will be free of devaluation. Explicitly welcoming diversity may be a successful strategy for making women feel accepted and valued in engineering (Purdie-Vaughns et al., 2008; Steele, 1997). The provision of female experts and role models may further increase the feeling of connectedness (Stout et al., 2011). It has been suggested that stereotyped students, especially when having entered the field only recently, may benefit from advice that describes difficulties and belonging uncertainties as normal during times of transition (Good, Aronson, & Inzlicht, 2003; Walton & Cohen, 2007). For women who have been in the domain for a while and who have shown that they can excel, this may not be enough to mitigate their sense of social discomfort. Other strategies may be needed such as, for example, putting them in charge of prestigious tasks that demonstrate appreciation of their talents and contributions. To be helpful, programs need to convey that abilities and belonging are assumed rather than doubted (Cohen, Steele, & Ross, 1999; Steele, 1997). Finally, it should be noted that self-doubt need not be irrelevant to differential persistence in the domain, even if the female students in our study, as long as they were actively involved in the program, did not report heightened levels of self-doubt. In retrospect, female students indicated stronger self-doubt than their male peers. At the time being it seems safe to say that interventions boosting confidence will benefit male and female students alike.

Limitations and Directions for Future Research

Investigating numerical minorities in real-world contexts, such as women in engineering, poses a challenge in terms of setting up samples. However, by systematically combining subsamples of highly select groups, a consistent pattern emerged despite the smallness of the samples. Of course, more studies are needed to explore the validity of the results.

Furthermore, grades may underestimate the intellectual ability of negatively stereotyped students, including women in math-related fields (Walton & Spencer, 2009). It consequently is possible that the independent variable (GPA) was affected by stereotype threat effects. Once experience gaps and age were controlled for, in this study, men's and women's grades did not differ. If grades underestimated female students' true ability nevertheless, the ability–persistence relationship should be characterized by an even more pronounced gender gap than the performance–persistence relationship. However, there is a need for future research to clarify in what ways different threats of being stereotyped add up in real-world contexts. The question also is important from a practical point of view.

There is a need to examine how interventions that boost stereotyped students' performance affect the group's persistence in the domain. It is possible that small interventions have huge effects so that the same intervention will affect both performance and persistence. However, it is also possible that intervention packages are needed to improve different outcomes.

Finally, it remains an open question whether the results reported here are specific for women in engineering or also apply to other stereotyped groups in academia. Future research should address the nature of ambivalent stereotypes and how they play out in academic contexts. It is possible that women can afford to turn away from certain fields without giving up the option of making a career. The perceived lack of social fit in a domain may lead to a "we can but we don't want to" attitude with this group (Singh et al., 2007). However, there also may be a more general issue. Stereotyped group members who are successful and whose actual behavior seems to contradict the stereotype's expectations may feel particularly disappointed. The more they excel, the more they may feel that they will never be fully accepted and that the suspicion of inferiority cannot be mitigated. A similar effect has been hypothesized for different groups of immigrants. The so-called "integration paradox" (Ten Teije, Coenders, & Verkuyten, 2013; Tolsma, Lubbers, & Gijsberts, 2012) suggests that immigrants who are successful educationally and on the labor market become more (rather than less) sensitive to ethnic acceptance and discrimination. There clearly is a need for further research to address the question under what conditions good performance results in successful integration.

ACKNOWLEDGMENTS

This research was supported by the TEquality project, funded by the state of Upper Austria, and by a Marie Curie Fellowship within the Seventh Framework People Program (FP7/2007-2013) of the European Commission (PIEF-GA-2008-220999). We thank the TEquality project team for their support in conducting the research.

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