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Perfectionism and performance among STEM students ☆

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ABSTRACT

We examined perfectionistic personality characteristics and their association with science self-efficacy beliefs and academic performance among college students in science, technology, engineering, and mathematics (STEM). We were especially interested in gender differences in effects given that women remain significantly underrepresented in several STEM areas. Participants were a large sample of undergraduate students (N = 450; 52% women) majoring or intending to major in a STEM field. Science self-efficacy and course grades were the main outcome variables; high school GPA was a covariate. Latent profile analyses based on measures of perfectionism and personality (conscientiousness, neuroticism) supported a three-class model of perfectionism. Perfectionism for men was not substantially associated with self-efficacy or grades. Although perfectionism also was not associated with self-efficacy for women, maladaptively perfectionistic women did perform significantly lower in their STEM-related courses compared with other groups. Results indicated that maladaptively perfectionistic women may be at risk for performance disappointments in STEM courses where women have traditionally been underrepresented. In contrast, adaptively perfectionistic women are strong academic performers in those courses. Intervention efforts aimed at addressing the so-called "leaky pipeline" might want to account for perfectionism and its adaptive and maladaptive implications for women pursuing STEM careers.

A critical gateway to the pursuit of a professional career in science, engineering, technology, and mathematics (STEM) fields is the attainment of an undergraduate degree. Although the proportion of women achieving degrees in several STEM fields has significantly increased in recent years, and, in some cases (e.g., biology), now surpasses that of men, women remain significantly underrepresented in other major fields (e.g., physics, computing disciplines, engineering) (National Science Foundation, Division of Science Resources Statistics, 2011). Indeed, the numbers of women in certain majors (e.g., computer science) continue to be low overall, and declining, despite intensive institutional efforts to recruit and retain women (Cohoon & Aspray, 2006). For example, in 1989, women comprised 30.8% of the undergraduate majors in computer sciences but by 2008, represented 17.7% of the majors in computer sciences. During that same time frame, the rates of women pursuing an engineering major have ranged from a low of 15.2% in 1989 to a high of 20.9% in 2002, and most recently (2008) 18.5% of the undergraduates majoring in engineering are women (National Science Foundation, Division of Science Resources Statistics, 2011).

These trends represent continuing threats to the formation of a diversified U.S. workforce in the scientific and technological fields and thus warrant further study of the motivational, career decision-making, and degree persistence trajectories of STEM students.

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Contemporary evidence more generally supports gender equity rather than differences in math and science-related abilities (Ceci, Williams, & Barnett, 2009; Spelke, 2005) and when average differences emerge, they tend to be rather small in magnitude (Lindberg, Hyde, Petersen, & Linn, 2010; see Ceci et al., 2009, for a discussion of "right tail" distributional differences). Thus, factors other than ability play important roles in STEM-related performance and persistence, such as organizational or contextual factors, interests, and psychological factors (Ceci et al., 2009). The present study is primarily concerned with identifying patterns of personality factors, more specifically the performance-linked personality characteristic of perfectionism, associated with STEM-related self-efficacy and academic performance. Predispositions such as personality traits have been hypothesized to play an important role in shaping the learning experiences that give rise to self-efficacy perceptions and performance-related outcomes which, in turn, develop and maintain task-related interests, choices, persistence behaviors, and future performance (Lent, Brown, & Hackett, 1994; Schaub & Tokar, 2005). Drawing from prior theory (Lent, 2005; Lent et al., 1994) and research (e.g., BarNir, Watson, & Hutchins, 2011; Rosander, Bäckström, & Stenberg, 2011; Stoeber, Hutchfield, & Wood, 2008), we contend that variant personality patterns associated with perfectionistic striving are likely to be differentially related to perceptions of science self-efficacy as well as to academic outcomes for STEM students. As such, perfectionism and its consequences potentially influence the course of career decision-making and persistence in STEM and correspondingly provide as yet untapped targets for intervention.

1. Personality and academic performance

Meta-analyses of literatures on personality and academic and vocational outcomes have supported a general convergence of interests and personality traits playing important roles in educational and career outcomes (Barrick, Mount, & Gupta, 2003; Feist, 1998, 2006; Larson, Rottinghaus, & Borgen, 2002; Richardson, Abraham, & Bond, 2012). One reason why personality is relevant for understanding academic outcomes is that traits increase the likelihood that behavior consistent with those traits (e.g., interest-related goals, motivations, competencies) will be expressed in any given situation. In other words, personality functions as an important distal predictor of more proximal academic behaviors that have implications for performance and educational outcomes (O'Connor & Paunonen, 2007; see also McAdams & Pals, 2007 and their account of dispositional traits and characteristic adaptations). Another reason is that personality characteristics provide additional explanatory value over and above cognitive ability in predicting performance (O'Connor & Paunonen, 2007; Poropat, 2009). Elsewhere, Schaub and Tokar (2005) presented findings suggesting that "individuals with different personality trait profiles may be drawn to, and perhaps even encouraged by others to seek out, different learning experiences (p. 322)." Taken together, these perspectives support a more nuanced study of the contribution of personality characteristics to college students' performance-related expectations and outcomes, particularly within academically-demanding STEM curriculums. To date, however, studies of the relations of personality to academic performance have generally focused on the impacts of global personality factors.

For example, Poropat (2009) (see also O'Connor & Paunonen, 2007) found a medium size effect ($d = .46$) for the association between Conscientiousness (constraint, will to achieve) and academic performance, whereas relatively small or negligible effects were observed for other personality factors. Poropat also determined that students with low Conscientiousness who were majoring in a program with a 10% overall failure rate would be twice as likely to fail compared with students who had high levels of Conscientiousness. Put in a more positive light, the effect size for Conscientiousness represented an increase of approximately a third of a grade point (.31) in terms of overall GPA for students. In fact, the overall effect for Conscientiousness was comparable to the size of effect typically observed when using intelligence to predict later academic performance. Clearly, Conscientiousness seems good for performance.

Facets of Conscientiousness may be especially important for those pursuing majors or careers in the sciences. Feist (1998) reported that the two strongest associations to emerge between personality traits and increased interest in science involved opposite poles of lower-level Conscientiousness dimensions. Characteristics such as being careful, disciplined, and self-controlled were more likely to be present among scientists than non-scientists, whereas the negative pole of the Conscientiousness dimension (i.e., characteristics such as low impulse control, direct expression of needs, difficulties with setting and managing performance-related tasks) were much less likely to be present among scientists. MacCann, Duckworth, and Roberts (2009) empirically-derived eight facets of Conscientiousness but found only one, Perfectionism, was positively associated with achievement test performance. Similarly, Rosander et al. (2011) found that, controlling for the global dimension of Conscientiousness, the lower-level Conscientiousness facet of "achievement striving" uniquely predicted academic outcomes in a high school sample.

2. Personality and the two faces of perfectionism

It seems reasonable to consider perfectionism as a facet of both Conscientiousness and Neuroticism. For instance, as a facet of Conscientiousness, striving to achieve is also consistent with a core feature of perfectionism, which typically is defined as a personality trait involving extremely high, self-imposed performance expectations or standards. Perfectionism can also denote a maladaptive combination of unrealistically high personal standards and excessively critical self-evaluation, consistent with Neuroticism, or stable propensities to experience negative affect. In fact, like Neuroticism, this maladaptive form of perfectionism has been linked to a wide range of problems (Blatt, 1995). On the other hand, the pursuit of high performance standards coupled with low levels of self-criticism can be viewed as an adaptive variant of the trait, given its positive association with academic adjustment and performance outcomes. Consistent with these conceptual points, studies of perfectionism have identified two major dimensions or factors of perfectionism, often referred to as Personal Standards Perfectionism (Perfectionistic Striving) and Self-Critical Perfectionism (Perfectionistic Concerns) (Stoeber & Otto, 2006). Results from factor analytic (e.g., Wheeler, Blankstein, Antony, McCabe, & Bieling,