Social Cognitive Predictors of Academic Persistence and Performance in Engineering:
Applicability across Gender and Race/Ethnicity

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Abstract

We examined the utility of social cognitive variables in the longitudinal prediction of academic persistence and success of engineering students. The participants, 908 students enrolled in engineering majors at two state universities, completed measures of academic support, self-efficacy, outcome expectations, interests, satisfaction, positive affect, and intended persistence at the end of each of their first four semesters. In the current study, students' first and second semester responses were used to predict persistence and grade

performance in engineering by the end of six semesters. Path analytic findings indicated that second-semester persistence intentions, satisfaction with the major, self-efficacy, and social support each produced direct paths to persistence. Objective ability (mathematics SAT scores), outcome expectations, and interests were linked to persistence indirectly via their relations to other variables in the model. In addition, self-efficacy and objective ability jointly predicted grade performance. Results were stable across gender and racial/ethnic groups. Implications for research and practice on academic adjustment in engineering are considered.

Keywords: Social cognitive career theory; self-efficacy; outcome expectations; support; positive affect; interests; satisfaction; choice goals; persistence; performance

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Occupational census data reveal that women and most racial/ethnic minority groups remain significantly underrepresented in engineering (NSF, 2015). Much research has been aimed at identifying factors that attract women and students of color to (or repel them from) science, technology, engineering and mathematics (STEM) fields (Brown & Lent, in press). A growing literature has emerged employing social cognitive career theory (SCCT; Lent, Brown, & Hackett, 1994), in particular, as a conceptual framework for studying engagement and persistence in STEM majors and occupations. For example, SCCT has been applied in studies of female, male, and racially diverse college student samples in a variety of STEM fields (e.g., Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Lent, Brown, et al., 2005; Lent, Lopez, Sheu, & Lopez, 2011). (For recent reviews of this literature, see Brown & Lent, in press; Flores et al., 2014; Lee, Flores, Navarro, & Kanagui-Munoz, 2015).

SCCT consists of five interconnected models aimed at explaining various facets of career development, such as the formation of interests, the setting of choice goals, and the attainment of performance outcomes. With the exception of the interest and choice models, SCCT's models are often studied in isolation from one another. However, it is possible to combine the elements of these relatively distinct models into more integrated units that enable simultaneous study of multiple aspects of career development, such as interest in, satisfaction with, and persistence at, STEM academic majors. In the current study, we employed a model integrating features of SCCT's interest, choice, satisfaction, and performance models (Lent et al., 1994; Lent & Brown, 2006a) to predict the choice

stability and academic performance of female, male, and racially diverse engineering students.

Integrative Model of Engineering Major Persistence

Lent et al. (2013) have recently described a framework drawing on SCCT's segmental models of interest, choice, satisfaction, and performance to form a larger template for examining the academic adjustment of engineering majors. The integrative model, shown in Figure 1, includes environmental supports and resources, self-efficacy, outcome expectations, activity interests, environmental satisfaction, and choice goals (or persistence intentions) linked to specific academic domains. The model also includes cross-domain personality traits (e.g., positive affectivity) that have been linked both to domain satisfaction and self-efficacy beliefs (Lent & Brown, 2006a).

Many of the hypothesized relations among the variables in Figure 1 follow directly from SCCT's individual interest, choice, and satisfaction models. However, a unique feature of the model is its depiction of the ways in which interest and satisfaction operate in unison to promote persistence intentions. In particular, having interests that are consistent with one's major (and being able to pursue these interests) is posited to predict academic major satisfaction (path a). Such satisfaction is, in turn, assumed to nurture intentions (goals) to persist in one's major (path b). The path from interest to persistence intentions is seen as both direct (path c) and indirect (through satisfaction). That is, students are likely to remain in majors that allow them to perform activities they like and to experience an environment they find intellectually and interpersonally satisfying.

In a cross-sectional study, Lent et al. (2013) found that the integrative social cognitive model fit the data well in accounting for adjustment to engineering, as reflected by students' expressed satisfaction with, and intentions to persist in, engineering. Model-data fit was invariant across gender and racial/ethnic groups. Navarro, Flores, Lee, and Gonzalez (2014) and Lent et al. (2015) extended these findings by testing the integrative model longitudinally over two and three time points, respectively. Though not all hypothesized paths were supported, both of these studies found adequate overall model fit across gender and race/ethnicity. However, these studies operationalized adjustment in terms of subjective criteria (e.g., students' persistence intentions). The current study extends this line of research by using the integrative social model to predict objective adjustment criteria (e.g., demonstrated persistence over time).

Figure 2 adapts the integrative model to show how the social cognitive variables were expected to predict actual academic persistence, or retention, in engineering. We used students' responses to the SCCT measures at the end of their first two semesters (time 1 [T1] and time 2 [T2], respectively) to forecast persistence in engineering over the subsequent two years, encompassing four academic semesters (i.e., from the beginning of year 2 until the end of year three, or the sixth semester [time 6, T6]). Specifically, we focused on students who had both expressed an intention to major in engineering at T1 and who had recompleted the measures at T2. This procedure enabled us to test both direct and indirect (or mediated) paths to persistence (Cole & Maxwell, 2003). That is, by modeling certain T1 variables as being linked to T6 persistence via their relations to T2 predictors, we could examine hypothesized SCCT linkages that had received

relatively little prior longitudinal study, such as whether interests predict choice actions directly or indirectly (Lent et al., 2003).

In keeping with the integrative social cognitive model, we hypothesized three sets of relations: (a) direct links from T2 predictors to T6 persistence, (b) indirect links of T1 variables to persistence via particular T2 variables, and (c) bidirectional relations among particular T1 and T2 predictors. In particular, we expected that the degree of students' actual persistence in engineering by T6 would be predicted directly by their persistence goals, satisfaction with their majors, self-efficacy, outcome expectations, and perceived academic support at T2. We posited the following indirect paths from T1 predictors to T6 persistence: T1 positive affect and academic support would be linked to persistence indirectly via T2 self-efficacy; T1 self-efficacy would relate to persistence indirectly via T2 outcome expectations, satisfaction, support, and persistence goals; T1 interest would be linked to persistence via T2 self-efficacy, satisfaction, and persistence goals; and T1 satisfaction would relate to persistence through T2 persistence goals.

Mathematics SAT scores, obtained in high school, were also expected to predict persistence indirectly via T1 self-efficacy and its links to the T2 variables. Thus, certain predictors (e.g., self-efficacy) were expected to produce both direct and mediated paths to persistence; some were expected to yield indirect paths only (e.g., interest); and others only direct paths (e.g., persistence intentions). Finally, we posited that there would be reciprocal paths between T1 and T2 measures of positive affect, self-efficacy, and support; self-efficacy and interest; and interest and satisfaction, as shown in Figure 2. The rationales for the hypothesized direct, indirect, and reciprocal pathways we tested were derived both from the basic SCCT models and from prior research testing the

integrative (interest, choice, satisfaction, performance) model longitudinally (cf. Lent et al., 2015).

Prediction of Grade Performance in Engineering Majors

We examined students' grades as an additional behavioral index of their academic adjustment to engineering. Among its predictions, SCCT's performance model posits that objectively-assessed ability and self-efficacy will play complementary roles relative to academic and occupational performance, with the effects of ability being both direct and indirect, or partially mediated, through self-efficacy. In this scheme, self-efficacy helps determine how well people organize and enact their abilities (Lent et al., 1994).

Parenthetically, SCCT's performance model also specifies roles for outcome expectations and performance goals in relation to performance outcomes. We did not, however, include these variables in the prediction of grades because the measures of outcome expectations and goals in this study were structured around choice rather than performance goals (i.e., what activities students wish to perform rather than how well they plan to perform them). Therefore, this study was designed to provide only a partial test of SCCT's academic performance model.

Model Fit across Gender and Race/ethnicity

In addition to their viability in the larger sample, we were interested in assessing the extent to which the predictive models could be generalized across gender and racial/ethnic groups. Such a research focus can help establish the cultural and gender validity of SCCT's models and have useful implications for efforts to increase the diversity of the pipeline leading to STEM fields.

Predictive Utility of Self-Efficacy and Outcome Expectation Indices

A final goal of this study was to assess the predictive utility of two aspects of self-efficacy and two aspects of outcome expectations. In particular, academic milestone and coping efficacy have been used as indicators of self-efficacy, and intrinsic and extrinsic outcome expectations have been used as indicators of outcome expectations, in prior research (e.g., Lent et al., 2013). In this study, we examined which aspect of self-efficacy beliefs and outcome expectations may offer greater utility as predictors of the behavioral outcomes. This question of predictor specificity is important in a practical sense because it could lead to more efficient interventions aimed at modifying those aspects of self-efficacy and outcome expectations that are directly relevant to outcomes of interest.

Method

Participants and Procedure

Participants in the prediction of academic persistence were 908 engineering majors at two state universities in the mid-Atlantic region of the U.S. They were part of a larger project examining academic adjustment to engineering at different points in time, with prior reports examining adjustment both cross-sectionally (at the end of students' first academic semester; Lent et al., 2013), and longitudinally, between students' second and fourth semesters (at the end of two years; Lent et al., 2015). The focus of the earlier reports was on students' subjective appraisals of their adjustment (e.g., satisfaction and persistence intentions). The current study extended this inquiry by focusing on behavioral indicators of adjustment and over a longer time frame (encompassing six semesters, or three years). We limited the sample to those who had (a) completed all

measures at both T1 and T2 (i.e., at the end of their first and second semesters) and (b) expressed their intention to major in engineering on both occasions.

These inclusion criteria allowed us to examine the extent to which the social cognitive variables at T2 could predict subsequent persistence. They also enabled assessment of the temporal linkages of T1 predictors to persistence (e.g., are these linkages mediated by the T2 predictors, in accordance with SCCT assumptions?). In addition, the three assessment intervals (T1-T2-T6), and the behavioral nature of the persistence criterion, minimized overlap between the purview of the current study and those of the two prior reports emanating from this project.

Thirty-seven percent ($n = 332$) of the participants in this final phase of the project were women and 63% ($n = 576$) were men. Sixty-four percent were European American, 8% were African American, 22% were Asian American, and 4% were Hispanic; the remaining 2% listed other racial/ethnic designations. The participants had mostly been first-year students (99%) at T1, with a mean age of 18.21, $SD = .70$, at the outset of the study. The most frequently reported majors at T2 were mechanical (20%), aerospace (13%), civil (11%), chemical (10%), computer (8%), and electrical (7%) engineering. The prediction of grade performance involved a subset of the participants who had completed at least three of the four subsequent semesters beyond T2 as engineering majors ($N = 768$; 37% women; 37% students of color).

The students had been recruited via email invitations sent by research partners at the two universities. The data were gathered from two cohorts of students in successive academic years. Online measures were completed during the last three weeks of students' first (T1) and second (T2) academic semesters. In return for their participation

at each assessment interval, students received a \$15 gift certificate, redeemable at an online retail site. Academic persistence and performance data were gathered, with students' consent, from registrar records at T6 (semester six).

Instruments

The online measures, completed at both T1 and T2, included demographic and academic status questions, along with measures of trait positive affect and academic domain self-efficacy, coping efficacy, outcome expectations, social support, interest, satisfaction, and intended persistence in engineering.

Self-efficacy was assessed with a 4-item academic milestones scale (e.g., “how much confidence do you have in your ability to *excel* in your engineering major over the next semester”) and an 8-item barrier-coping scale (e.g., “how much confidence do you have in your ability to cope with a lack of support from professors or your advisor”). Students provided both types of self-efficacy ratings along a 10-point scale, ranging from *no confidence* (0) to *complete confidence* (9). Scores on each scale were calculated by dividing the summed item responses by the number of scale items, producing a possible score range of 0-9. Prior studies employing the milestones scale and the original version of the coping efficacy scale have reported coefficient alpha values of .90 and above and theory-consistent relations with outcome expectations, interest, satisfaction, contextual support, and persistence intentions (e.g., Lent et al., 2003, 2007).

Outcome expectations were divided into perceptions of extrinsic outcomes (5 items, e.g., “earn an attractive salary”) and intrinsic outcomes (7 items, e.g., “do work that gives me a feeling of accomplishment”) associated with earning a BS in engineering. The measures asked students to indicate the degree to which they expected that an

engineering degree would lead to each outcome, using a 10-point scale (*strongly disagree*, 0, to *strongly agree*, 9). Item responses were summed and divided by the number of items on each scale. The original scale on which these measures were based has yielded internal consistency reliability estimates of .88 and above and theory-consistent correlations with measures of self-efficacy, interests, and major choice goals (e.g., Lent et al., 2003, 2007). Lent et al. (2013) reported support for the two-factor structure of the current version of the scale, along with indications of acceptable internal consistency reliability (.85 and .93, respectively, for the extrinsic and intrinsic subscales), and validity estimates.

Environmental support was measured with seven items involving access to resources that might support progress in engineering (e.g., “[I] get encouragement from my friends for pursuing an engineering major”). Participants indicated their level of agreement with each statement on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*); item responses were summed and divided by 7. The original (Lent et al., 2007) and current versions (Lent et al., 2013) of this scale have produced alpha coefficients above .80 and correlated with measures of self-efficacy, outcome expectations, and academic satisfaction.

Interest was assessed with a 6-item scale tapping students’ interest in performing various engineering-related activities (e.g., “solving complicated technical problems”). This measure asked participants to indicate their degree of interest in performing each activity, using a 5-point (*very low interest*, 1, to *very high interest*, 5) scale. Item responses were summed and divided by 6. The original (Lent, Brown et al., 2003, 2005) and current versions (Lent et al., 2013) of this scale have produced coefficient alphas of

.80 and above, along with theory-consistent relations with measures of self-efficacy, outcome expectation, and choice goals.

The *academic satisfaction* scale consisted of six items reflecting students' satisfaction with their field of study (e.g., "I am generally satisfied with my academic life in engineering"). Responses were obtained along a 5-point (*strongly disagree* to *strongly agree*) scale, with item responses summed over item responses and divided by 6. This scale has yielded internal consistency estimates of .86-.91 and correlated with intended academic persistence and other social cognitive variables in prior studies (Lent et al., 2007, 2013).

Persistence goals were assessed with a 4-item scale (e.g., "I plan to remain enrolled in an engineering major over the next semester"), to which students respond using a 5-point scale, ranging from *strongly disagree* (1) to *strongly agree* (5). Summed item responses were divided by 4. Past studies using this scale have reported internal consistency reliability estimates of .93 and above (e.g., Lent et al., 2003, 2013) and found persistence goals to be strongly predictive of actual persistence in engineering (Lent et al., 2003). Because this scale tends to produce negatively skewed and kurtotic scores in engineering students (Lent et al., 2013), we used a rank transformation procedure to normalize the score distribution; ranks were then converted to *z* scores for subsequent analyses.

Trait positive affect was measured with the Positive Affect (PA) scale of the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), which taps the tendency to experience positive emotions across situations. Participants were asked to indicate the extent to which they *generally feel* 10 positive emotions (e.g.,

enthusiastic) along a 5-point continuum (1 = *very slightly or not at all*; 5 = *extremely*). Item ratings were summed and divided by 10. The PA scale has been found to produce adequate internal consistency and stability coefficients and to correlate with measures of domain and life satisfaction (e.g., Lent, Singley et al., 2005).

Behavioral persistence was assessed on a 0-4 scale, reflecting the number of semesters that students had remained in engineering beyond T2 (second semester); 0 meant that students left engineering after T2, while 4 indicated they had remained in engineering for all four subsequent semesters (i.e., the third through sixth semesters of college for most students). *Cumulative grades* were also calculated on 4-point scale, with a grade of A equivalent to a 4.0 grade point average in engineering.

Results

We first examined the relative predictive utility of the two aspects of self-efficacy and outcome expectations relative to major choice persistence. Specifically, persistence was regressed on the two self-efficacy scales and then on the two outcome expectation indicators. We found that only academic milestone self-efficacy explained significant unique variance ($\beta = .25$; $p < .05$); for coping efficacy, $\beta = .07$. Among the outcome expectation scales, intrinsic expectations alone accounted for significant variation in persistence ($\beta = .29$); for extrinsic expectations, $\beta = -.07$. We next regressed academic grades on the two self-efficacy scales. Though academic milestone self-efficacy ($\beta = .43$) and coping efficacy ($\beta = -.17$) each produced significant beta weights, the negative coefficient for coping efficacy appeared to reflect a suppressor effect (in that coping efficacy had produced a small, positive zero order correlation with grades, $r = .08$). Given the relative utility of academic milestone self-efficacy in predicting persistence

and grades, and of intrinsic outcome expectations in predicting persistence, we included them as the sole indicators of self-efficacy and outcome expectations in subsequent analyses.

Prediction of Persistence

Table 1 presents the means, standard deviations, and correlations of the variables in the full sample ($N = 908$) prediction of persistence. Students completed an average of 3.08 semesters, $SD = 1.20$, in engineering between T2 and T6, reflecting a fairly high continuing level of commitment to obtaining an engineering degree.

Four model variations were used to test our hypotheses about how the predictors would relate to one another and to behavioral persistence over time. First, we created a *Base* model containing (a) covariances among all of the T1 variables, (b) covariances among the errors of the T2 variables, (c) autoregressive paths between the T1 and T2 variables (shown as dotted line paths in Figure 2), and (d) direct paths from the hypothesized T2 predictors (support, self-efficacy, outcome expectations, satisfaction, and intended persistence) to behavioral persistence. Second, the Base model was compared to a *Unidirectional* model, which incorporated the Base model and added the unidirectional predictions from SCCT's integrative interest, choice, and satisfaction model (these predictions appear as solid line paths in Figure 2).

Third, we compared a *Bidirectional* model to the Base and Unidirectional models. This model built upon the Base and Unidirectional models by adding reciprocal paths between certain T1 and T2 variables (e.g., paths from interest to self-efficacy and from self-efficacy to interest); these are shown with dashed lines in Figure 2. The fourth model, a variation of the Bidirectional model, added direct paths from mathematics SAT

scores and T2 interest to T6 persistence. This last model was intended to assess whether prior ability and current interests serve as direct predictors of persistence, beyond their indirect roles via the other predictors.

Path analysis was used to test the model-data fit of the four model variations. This analysis involved the variance/covariance matrix of the measured variables and, given indications of multivariate non-normality, the robust maximum likelihood estimation procedures of EQS 6.2 (Bentler & Wu, 2014). Adequacy of model fit was assessed with the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). Hu and Bentler (1999) suggest that CFI values $\geq .95$, RMSEA values $\leq .06$, and SRMR values $\leq .08$ each reflect acceptable levels of fit.

Full sample analysis. The Base model produced adequate model fit across most of the fit indices; CFI = .956, SRMR = .115, RMSEA = .058, and S-B χ^2 (65, $N = 908$) = 262.86, $p < .001$. The Unidirectional model (CFI = .970, SRMR = .068, RMSEA = .055, S-B χ^2 [48, $N = 908$] = 180.47, $p < .001$) improved significantly on the fit of the Base model, Δ S-B χ^2 (17) = 81.38, $p < .001$. The Bidirectional model also yielded adequate fit across indices, CFI = .975, SRMR = .050, RMSEA = .054, S-B χ^2 (43, $N = 908$) = 155.98, $p < .001$, improving over both the Base (Δ S-B χ^2 [22] = 105.68, $p < .001$) and Unidirectional models (Δ S-B χ^2 [5] = 24.31, $p < .001$).

The fourth model, a variation of the Bidirectional model, also produced adequate fit, CFI = .975, SRMR = .050, RMSEA = .055, S-B χ^2 (41, $N = 908$) = 153.63, $p < .001$. However, it did not fit the data significantly better than the Bidirectional model (Δ S-B χ^2 [2] = 2.07, $p = .35$), and neither objective ability (.04) nor interest (.02) yielded

significant direct paths to persistence. The Bidirectional model, therefore, appeared to offer the more parsimonious alternative. It accounted for 32% of the variance in satisfaction and 24% of the variance in intended persistence at T2, as well as 17% of the variance in documented persistence at T6.

The path coefficients of the Bidirectional model are shown in Table 2. Consistent with expectations, actual persistence in engineering between T2 and T6 was significantly predicted by T2 persistence goals, academic satisfaction, and self-efficacy. However, the path from outcome expectations was not significant and the path from social support, though significant, was negative. The latter may have been due to a suppressor effect given that the zero order correlation between support and behavioral persistence had been positive and significant, though small.

In addition to the direct paths to behavioral persistence, a number of T1 variables were indirectly linked to persistence through intervening T2 variables. T1 self-efficacy produced indirect paths to persistence via T2 academic satisfaction and persistence intentions. Social support was indirectly related to persistence through satisfaction; positive affect through self-efficacy; and outcome expectations through persistence intentions. In addition, math SAT scores were linked to persistence indirectly through self-efficacy, and interests through satisfaction.

Many, though not all, of the T1 variables were linked to T2 variables in theory-consistent ways. Controlling for auto-regression, positive affect was predictive of support and self-efficacy; support and self-efficacy were predictive of outcome expectations; self-efficacy and outcome expectations were predictive of interests;

support, self-efficacy, and interests were predictive of satisfaction; and self-efficacy and outcome expectations were predictive of persistence intentions.

Several sets of bidirectional, or reciprocal, paths were also observed (see the bolded variables in Table 2). In particular, T1 social support and self-efficacy produced paths to T2 positive affect. In addition, T1 self-efficacy was predictive of T2 support, and T1 satisfaction was linked to T2 interests. Contrary to hypotheses, however, T1 interests did not yield a significant path to T2 self-efficacy.

Multiple-group analyses. Multiple-group analyses were next performed in order to test for invariance of the bidirectional model across gender and race/ethnicity. Path coefficients were constrained to be equal across gender, and the fit of this constrained model was compared with an unconstrained model in which the path coefficients were allowed to vary by gender. This procedure was then replicated to compare the model fit of race/ethnic majority and minority student groups. Model invariance can be inferred when the constrained model does not result in substantial deterioration in fit compared to the unconstrained model version.

We employed two criteria to compare the constrained and unconstrained models: the scaled difference in Satorra-Bentler (S-B) χ^2 statistic (Satorra & Bentler, 2001) and the difference in CFI values. The Δ S-B χ^2 value assesses whether the model variations produce statistically significant differences in fit, whereas the Δ CFI statistic reflects the practical significance of differences in model fit. It is a useful adjunct to the Δ S-B χ^2 criterion because the latter is affected by sample size and model complexity. Two models can be judged as practically invariant across groups if their differences in CFI values are less than .01 (Cheung & Rensvold, 2002).

Results of the multiple-group gender analysis indicated that the constrained (CFI = .969, RMSEA = .050, S-B χ^2 [121, $N = 908$] = 256.35, $p < .001$) and unconstrained models (CFI = .972, RMSEA = .056, S-B χ^2 [86, $N = 908$] = 207.38, $p < .001$) differed significantly on the statistical (Δ S-B χ^2 = 51.05, $p < .05$) but not on the practical criterion (Δ CFI = .003). The two models did not differ significantly on either criterion in the racial/ethnic group analysis; constrained: CFI = .973, RMSEA = .047, S-B χ^2 (121, $N = 908$) = 242.21, $p < .001$; unconstrained: CFI = .976, RMSEA = .053, S-B χ^2 (86, $N = 908$) = 195.18, $p < .001$; Δ S-B χ^2 = 48.77, $p > .05$; Δ CFI = .003. Together, these findings suggest that the bidirectional model fit the data comparably across the grouping variables.

Prediction of Grades

The SCCT performance model posits that self-efficacy will partly mediate the relation of objective ability to grade performance. We first examined the correlations among math SAT scores, T2 self-efficacy, and cumulative grades (mean GPA = 3.13, $SD = .54$, $N = 768$). SAT scores correlated significantly ($p < .001$) but to a small degree with self-efficacy ($r = .11$), and moderately with grades ($r = .32$). Self-efficacy also correlated moderately with grades ($r = .33$). To test the mediation hypothesis, we performed a hierarchical regression, entering SAT scores at step 1 of the equation and self-efficacy scores at step 2. (Path analysis was not used because the hypothesized relations among the three variables constituted a saturated model.) SAT explained 10% of the variance at step 1, with self-efficacy accounting for an additional 9% at step 2 (total $R^2 = .19$). However, the beta weight for SAT scores changed relatively little (from $\beta = .32$ to .29)

after controlling for self-efficacy ($\beta = .29$), suggesting that only a small part of the relationship between SAT and grades was mediated by self-efficacy.

To examine whether the relations of SAT and self-efficacy to grades differed by gender or racial/ethnic group, we performed a hierarchical regression in which the grade predictors were entered in successive blocks: (a) gender and race/ethnicity, (b) math SAT scores and T2 self-efficacy, and (c) four interaction terms (gender x SAT, gender x self-efficacy, race x SAT, race x self-efficacy (standardized scores were used to minimize multicollinearity between main effects and interaction terms). Controlling for gender and race/ethnicity ($R^2 = .01$), the block containing SAT ($\beta = .30$) and self-efficacy ($\beta = .32$) scores explained significant variation in grades ($\Delta R^2 = .23$), though the set of interaction terms did not account for additional significant variance ($\Delta R^2 < .01$); total $R^2 = .24$. This pattern of findings suggests that the relations of SAT and self-efficacy to grades were relatively stable across gender and race/ethnicity.

Discussion

The present findings extend those of earlier studies that have examined social cognitive antecedents of subjective adjustment to engineering majors, in particular, academic major satisfaction and persistence intentions (e.g., Lent et al., 2013, 2015; Navarro et al., 2014). The current study complemented the earlier subjective focus with an examination of social cognitive predictors of two aspects of behavioral adjustment to engineering majors. The findings generally support the utility of social cognitive mechanisms in understanding documented persistence and grade performance across gender and racial/ethnic groups in engineering undergraduates.

Consistent with expectations, we found that students' degree of persistence in engineering over four academic semesters (i.e., between their third and sixth semesters, T6) was significantly predicted by their persistence intentions, academic satisfaction, and self-efficacy assessed at the end of their second semesters (T2). Contrary to hypotheses, however, T2 outcome expectations were not significantly linked to persistence and, though social support was, its negative path coefficient was unexpected and likely due to the effects of statistical suppression. Consistent with Brown et al.'s (2008) meta-analysis of research on the SCCT persistence model, we found that the relation of objective ability (math SAT scores) to academic persistence was fully mediated by self-efficacy and goals.

Lee et al. (2015) similarly found that the pathway from objective ability (math/science ACT scores) to students' persistence in engineering majors was fully mediated by other model variables, including self-efficacy and goals. However, their study also included a measure of college GPA indexing students' actual prior performance in college. GPA was predicted by ACT scores and was, in turn, linked to students' subsequent persistence, both directly and via the self-efficacy/goals pathway. Only prior grades and persistence goals produced direct paths to persistence. In an earlier study of engineering majors, Lent et al. (2003) similarly found that persistence goals fully mediated the relation of self-efficacy (and interests) to persistence.

Further research is needed to clarify the nature of the relations of prior academic performance, self-efficacy, and persistence goals to subsequent behavioral persistence. It is reasonable to assume that prior college performance may serve as a more potent and proximal guide to students' future college accomplishments than does more temporally

distal ability test scores. However, the latter may still be valuable in predicting academic performance, especially in newer students who lack a college performance history.

Our inclusion of both T1 and T2 predictors allowed us to examine indirect paths to persistence that are suggested by SCCT's integrative model of interest, choice, satisfaction, and performance. These indirect pathways reflect the hypothesized interplay among the predictors of persistence. Several sets of indirect links were observed, controlling for autoregressive paths. In particular, T1 self-efficacy was linked to persistence via T2 persistence goals and academic satisfaction; T1 outcome expectations via T2 persistence goals; T1 interest and social support via T2 satisfaction; and T1 positive affect via T2 self-efficacy.

Consistent with SCCT's interest and choice hypotheses and/or meta-analytic findings (Sheu et al., 2010), we found that T2 outcome expectations were predicted by T1 self-efficacy and social support, and that T2 interests were predicted by self-efficacy and outcome expectations. In addition, reciprocal linkages between interests and satisfaction, posited by Lent et al. (2015), were observed. Specifically, T1 interests were linked to T2 satisfaction and vice versa, suggesting that pursuit of one's interests promotes satisfaction and that satisfaction with one's academic environment, in turn, nurtures or confirms interests. We also found support for a path from T1 self-efficacy to T2 interests, rather than a reverse path from T1 interests to T2 self-efficacy. This unidirectional pathway has been found in some (e.g., Lent et al., 2008; Navarro et al., 2014) prior studies, though other studies have reported bidirectional paths between the two constructs (e.g., Lent et al., 2010; Nauta, Kahn, Angell, & Cantarelli, 2002).

Reciprocal pathways were also observed between positive affect, self-efficacy, and social support. In particular, while T1 positive affect was predictive of both T2 self-efficacy and social support, T1 self-efficacy and social support also predicted T2 positive affect. Lent, Taveira, Sheu, and Singley (2009) had also found such a reciprocal set of relations, and Lent et al. (2015) had observed unidirectional paths from self-efficacy and support to positive affect. The present findings, then, offer additional evidence that, rather than functioning only as a fixed trait predictor of other variables, positive affect can also be seen as a criterion variable that is somewhat sensitive to students' perceptions of their capabilities and social resources within an important life sphere.

Turning to grades as an adjustment criterion, SAT scores and self-efficacy were found to contribute comparably and largely independently to the prediction of grades. SCCT posits that the relation of objective ability to academic success will be partly mediated by self-efficacy (Lent et al., 1994). Although our results are technically consistent with partial mediation, most of the relationship of SAT scores to grades was direct (.29) rather than indirect (.03). Meta-analytic findings likewise indicate that the magnitude of the direct path from objective ability (e.g., SAT) measures to college grades is likely to exceed that of its indirect pathway through self-efficacy (Brown et al., 2008). Thus, students are likely to benefit when they both enter college with sufficient levels of objectively measured ability and when they view their capabilities confidently once enrolled in college.

A secondary goal of this study had been to explore the predictive efficiency of alternative indicators of self-efficacy and outcome expectations. Studies applying SCCT to engineering students have often employed measures of both academic and coping self-

efficacy (e.g., Lent et al., 2013; Navarro et al., 2014), though some researchers have used an academic self-efficacy scale alone (e.g., Flores et al., 2014; Lee et al., 2015). Our findings suggest that the academic milestone self-efficacy scale may serve as a sufficient indicator of self-efficacy relative to performance and persistence criteria. Likewise, our findings suggest that the intrinsic outcome expectation scale may be a useful indicator of outcome expectations in model tests predicting interests and choice goals in engineering. Further study would be useful to confirm those aspects of self-efficacy and outcome expectations that offer the most utility in predicting or promoting particular outcomes.

The study's limitations provide a window on future research needs. In particular, we focused on the further persistence of students who had already been in engineering for two semesters, which enabled examination of mediational pathways over a multi-year timeframe. However, this strategy did not allow us to home in on the process of earlier attrition from engineering. It would be useful to devote more study to social cognitive factors that forecast persistence or attrition decisions before the end of the first semester. Second, our prediction of grades was flawed from a social cognitive measurement perspective (Lent & Brown, 2006b) in that most of our predictors were structured around academic engineering content, whereas the cumulative GPA criterion included performance in both engineering and non-engineering coursework. This less than optimal matching of the dependent variable to the predictors is likely to have lowered the variance accounted for in grades. Future research might specifically examine GPA in engineering and required STEM courses. Third, our sample of racial/ethnic minority students included groups that are differentially represented in engineering (e.g., African American and Asian American students). There is a continuing need for research

directed more specifically at the engagement of racial/ethnic groups that are underrepresented in engineering and other STEM fields.

In sum, the present study extended earlier findings applying SCCT to the adjustment of engineering majors by focusing on the prediction of behavioral indicators of academic success and persistence over time and across gender and racial/ethnic groups. The study's design enabled examination of factors that are linked to persistence, either directly (e.g., persistence goals, satisfaction), indirectly (e.g., social support), or both (e.g., self-efficacy). They also confirmed the dual predictive contributions of objective ability and self-efficacy to the grade performance of engineering majors. At a practical level, the findings offer additional support for the design of interventions, focused on relatively malleable social cognitive factors (e.g., access to social support, information about intrinsic occupational rewards, and demographically similar models), that may help to expand the gender and racial/ethnic diversity of the engineering pipeline.

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Table 1. Means, Standard Deviations, Reliability Coefficients, and Correlations among Predictors of Persistence

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	M	SD
1. T1 Self-efficacy	--															8.04	1.34
2. T1 Outcome expect's	.38 ^a	--														8.57	1.16
3. T1 Support	.36	.45	--													3.87	.71
4. T1 Interest	.34	.51	.32	--												3.97	.63
5. T1 Academic satisfac	.42	.53	.51	.52	--											3.95	.80
6. T1 Persist intentions	.40	.48	.35	.40	.51	--										4.69	.64
7. T1 Positive affect	.41	.51	.46	.49	.57	.41	--									3.83	.61
8. T2 Self-efficacy	.56	.29	.26	.28	.37	.38	.35	--								7.69	1.62
9. T2 Outcome expect's	.30	.57	.36	.37	.44	.40	.42	.52	--							8.26	1.38
10. T2 Support	.31	.35	.56	.29	.43	.26	.38	.42	.51	--						3.69	.78
11. T2 Interest	.30	.40	.29	.61	.45	.30	.40	.39	.55	.45	--					3.81	.75
12. T2 Academic satisfac	.36	.38	.39	.40	.59	.39	.41	.56	.59	.61	.61	--				3.76	.92
13. T2 Persist intentions	.31	.36	.26	.29	.35	.52	.28	.52	.57	.37	.42	.58	--			4.53	.93
14. T2 Positive affect	.27	.35	.33	.35	.42	.24	.55	.42	.52	.54	.53	.59	.37	--		3.72	.67
15. Math SAT	.15	-.14	-.10	-.05	-.03	.02	-.12	.14	-.08	-.06	.03	.04	.07	-.08		678.04	70.58
16. Behavioral persistence	.14	.13	.10	.14	.19	.22	.12	.29	.24	.14	.23	.33	.40	.15	.10	3.08	1.20

Note. N = 908. T1 = end of 1st semester; T2 = end of 2nd semester. exp = expectations; satisf = satisfaction. ^a $r \geq .07, p < .05$.

Table 2

Path Coefficients in the Bidirectional Longitudinal Model Predicting Actual Persistence by the End of 6 Semesters

Dependent Variable	Predictors	Path Coefficient from Predictor to Dependent Variable
T1 Self-Efficacy	SAT-Math in HS	.20*
T2 Positive Affect	T1 Positive Affect	.45*
	T1 Social Support	.08*
	T1 Self-Efficacy	.06*
T2 Social Support	T1 Social Support	.47*
	T1 Positive Affect	.08*
	T1 Self-Efficacy	.12*
T2 Self-Efficacy	T1 Self-Efficacy	.52*
	T1 Positive Affect	.08*
	T1 Social Support	.02
	T1 Interests	.02
T2 Outcome Expectations	T1 Outcome Expectations	.45*
	T1 Self-Efficacy	.09*
	T1 Social Support	.11*
T2 Interests	T1 Interests	.48*
	T1 Self-Efficacy	.10*
	T1 Outcome Expectations	.06*
	T1 Academic Satisfaction	.07*

T2 Academic satisfaction	T1 Academic Satisfaction	.35*
	T1 Positive Affect	.02
	T1 Social Support	.10*
	T1 Self-Efficacy	.15*
	T1 Outcome Expectations	.01
	T1 Interests	.07*
T2 Intended Persistence	T1 Intended persistence	.34*
	T1 Academic Satisfaction	-.04
	T1 Self-Efficacy	.14*
	T1 Outcome Expectations	.12*
	T1 Interests	.01
	T1 Social Support	.05
T6 Actual Persistence	T2 Intended Persistence	.29*
	T2 Academic Satisfaction	.18*
	T2 Self-Efficacy	.10*
	T2 Outcome Expectations	-.04
	T2 Social Support	-.10*

Note. T1 = end of 1st semester; T2 = end of 2nd semester; T6 = end of 6th semester. SAT-Math taken in high school. Reciprocal paths are shown in bold font.

* $p < .05$, one-tailed.

Figure 1. Integrative model of interests, satisfaction, and choice stability

Figure 2. Longitudinal model predicting behavioral persistence at the end of six semesters. *Note.* Dotted lines = autoregressive paths; dashed lines = hypothesized reciprocal paths. Covariances among variables at time 1 and time 2 are not shown.