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ABSTRACT

This study explored the moderating effects of academic self-efficacy beliefs on the relationship of scholastic aptitude to academic performance (grade point average) and academic persistence (retention). Subjects, 105 students enrolled in a career planning course for science and engineering majors, were administered two measures of self-efficacy designed to assess expectations of personal efficacy for completing science and engineering majors (ERS) and for academic skills (AMS). The results of three separate analyses consistently revealed that AMS was a strong independent predictor of academic performance and persistence, and that the ERS, but not AMS, moderated the relationships between scholastic aptitude and academic performance and persistence. The direction of the moderator effect suggested that the academic performance and persistence of low aptitude students was facilitated by high self-efficacy beliefs, but that the performance and persistence of high aptitude students was unaffected by their self-efficacy beliefs. These findings have implications for future research on career self-efficacy, and for career and academic counseling. (Author/NB)

Effects of Self-Efficacy--Aptitude Incongruence on Career Behavior

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Abstract

This study explored the moderating effects of academic self-efficacy beliefs on the relationship of scholastic aptitude to academic performance (grade point average) and academic persistence (retention). Subjects, 105 students enrolled in a career planning course for science and engineering majors, were administered two measures of self-efficacy designed to assess expectations of personal efficacy for completing science and engineering majors (ERS) and for academic skills (AMS). The results of three separate analyses consistently revealed that AMS was a strong independent predictor of academic performance and persistence, and that the ERS, but not AMS, moderated the relationships between scholastic aptitude and academic performance and persistence. The direction of the moderator effect suggested that the academic performance and persistence of low aptitude students was facilitated by high self-efficacy beliefs, but that the performance and persistence of high aptitude students was unaffected by their self-efficacy beliefs. Implications for future research on career sel-efficacy, and for career and academic counseling, are discussed.

Effects of Self-Efficacy--Aptitude Incongruence on Career Behavior

Research on the role of self-efficacy expectations on career behaviors has found that self-efficacy is predictive of several important career criteria, such as academic grades and persistence (Lent, Brown, and Larkin, 1984, 1986, 1987), perceived career options (Betz & Hackett, 1981, 1983, 1986; Lent et al., 1987; Rotberg, Brown, & Ware, 1987), and career indecision (Taylor & Betz, 1983). Lent et al.'s (1986, 1987) findings also suggested that self-efficacy and academic aptitudes contribute independently and additively to predictive equations, with persons possessing strong academic self-efficacy and scholastic aptitudes generally achieving more favorable academic outcomes than those with lower self-efficacy and aptitude scores. These results suggest that self-efficacy beliefs are equally facilitative of academic performance and persistence across all levels of scholastic aptitude.

Alternatively, it could be argued that these significant direct effects of self-efficacy might be subsumed under more powerful interactive effects between self-efficacy and academic aptitude, suggesting that self-efficacy beliefs exert their most powerful influences on academic persistence and performance as moderators of aptitude-performance/persistence relationships (i.e., their influences on aptitude-performance/persistence relationships are stronger at some levels of aptitude than at others). For example, it may be that self-efficacy beliefs have primarily compensatory effects; facilitating the performance and persistence of students with low academic aptitudes, but

showing little or lesser effects on the performance and persistence of those with high academic aptitudes. Another possibility is that academic progress might be adversly affected among students with high academic aptitudes if their self-efficacy beliefs are low, but be unaffected among low aptitude students regardless of their efficacy beliefs. No studies, however, have yet studied these interactional possibilites.

Thus, the purpose of this study is to provide the first test of the interactive or moderating effects of self-efficacy beliefs on the relationship of academic aptitude to academic performance/persistence.

Method

Subjects

Subjects, the same as those employed in Lent et al. (1987), were 105 students (75 men and 30 women) enrolled in either of two sections of a 10-week career planning course for undergraduates considering science and engineering majors (see Lent et al., 1984 for a description of the career planning course). Participants were primarily freshmen and sophomores, with a mean age of 20 years (SD = 2.86). Their Preliminary Scholastic Aptitude Test (PSAT) scores (M = 56.58, SD = 7.27) and high school ranks (M = 83rd percentile, SD = 17.03 percentile points) revealed them to possess as a group rather high levels of scholastic aptitude.

Procedures and Instruments

Subjects completed measures of self-efficacy, career indecision, self-esteem, expressed vocational interests, and range of career

options in scientific and technical fields during the first and final class sessions (only the self-efficacy measures administered during the final class session were employed in this study).

Two measures of self-efficacy were used, Self-efficacy for educational requirements in technical and scientific fields, and self-efficacy for academic milestones. The first measure asked subjects to rate on a 10-point scale their confidence (1 = completely unsure to 10 = completely sure) in their ability to complete the educational requirements of each of 15 science and engineering fields. Average self-efficacy strength scores for educational requirements (ERS) were calculated by dividing the summed strength estimates by 15 (the number of fields included on the measure). The second measure required subjects to rate their confidence, on the same 10-point scale, in their abilities to perform specific accomplishments critical to success in most science and engineering majors (e.g., complete the mathematics requirements for most engineering majors). Confidence ratings were summed across items and divided by the total number of items (11) to obtain an average strength for a ademic milestones (AMS) score for each subject. Both scales showed adequate internal consistency reliability as estimated by Cronbach's alpha (.89 for both) and were only moderately correlated (r = .52), suggesting that they are measuring different dimensions of academic self-efficacy.

Preliminary Scholastic Aptitude Test (PSAT) scores, high school ranks, college grades in technical courses (TGPA), and declared majors for each participant were collected from university

records. The latter two measures were collected for each quarter during the year following participation in the career planning course and served to operationalize academic performance as TGPA one year after participating in the course and academic persistence as the number of quarters enrolled in the college of technology during the follow-up year (QTRS). PSAT scores and academic ranks were standardized and combined to form a composite index of academic aptitude.

Data Analysis

Direct and interactive effects of self-efficacy beliefs (AMS and ERS) on academic performance (TGPA) and academic persistence (QTRS) were tested in a series of four hierarchical multiple regressions (one for each of the two criterion variables and the two self-efficacy measures). Specifically, TGPA and QTRS were regressed, in separate analyses, on academic aptitude and self-efficacy by entering in order in each regression the standardized composite academic aptitude measure, standardized self-efficacy index, and a standardized self-efficacy X composite aptitude product term. The significance in additional variance accounted for by the self-efficacy measure (AMS or ERS) provides evidence for a direct effect of self-efficacy on academic performance and persistence. The signicance in additional variance accounted for by the product terms indicates an interaction of self-efficacy and academic aptitude on the criterion variable, suggesting that self-efficacy moderates the relationship between academic aptitude and criterion behavior if the plotted interaction clearly subsumes any extant main effects.

Results

Preliminary Analyses

Data were first analyzed to assess the degree of multicollinearity existing among independent variables and independent variable combinations by regressing each independent variable on all other independent variables. The results of these analyses revealed no significant multicollinearity in any of the four regressions (multiple correlations ranged from .18 to .22 in the two regressions employing AMS as the self-efficacy measure and from .15 to .20 in the two regressions using ERS as the self-efficacy measure).

Visual inspections of the plotted residuals for each regression detected no deviations from the regression assumption of linearity, but significant heteroscedasticity in both regressions that used AMS as the self-efficacy measure and in the regression of QTRS on aptitude, ERS, and their interaction. Thus, dependent and independent variable distributions were inspected for departures from normality, and nonnormally distributed variables were transformed in an attempt to reduce heteroscedasticity. A reinspection of residual plots after transformation revealed that homoscedasticity had been achieved. However, an inspection of the intercorrelation matrix of the transformed independent variables revealed that transformation had created substantial multicollinearity.

Since the effects of both heteroscedasticity and multicollinearity is to attenuate (but not invalidate) multiple regression, we decided to present the regression results of the original (i.e., not transformed) independent variables

for ease of interpretation, but to supplement these with two other analyses.

In the first, we divided subjects into high and low aptitude groups on the basis of a median split procedure, regressed QTRS and TPGA (in separate analyses) on AMS and ERS separately for high and low aptitude groups, and compared the resulting multiple correlations. Significant differences between the correlations obtained from high and low aptitude groups suggest that self-efficacy serves as a moderator of aptitude-performance/persistence relationships.

In the second, we also created high and low self-efficacy groups on the basis of median split procedures and then subjected QTRS and TGPA data to 2 (aptitude) X 2 (self-efficacy) analyses of variance. Significant interactions, if they subsume resultant direct effects, would be further evidence for an interaction of self-efficacy and aptitude on performance and persistence.

Primary Analyses

Tables 1 and 2 summarize the results of the three main analyses. As is evident, the interaction between ERS and aptitude on TGPA was significant across all three analyses, while the interaction of ERS and aptitude on QTRS was significant in all but the attenuated regression analysis. The direction of these significant interactions, as shown in Figure 1, supports a compensatory model, suggesting that self-efficacy had little effect on aptitude-performance/persistence relationships among students with high scholastic aptitudes, but that it served to facilitate the performance and persistence of the "low" aptitude students.

The AMS measure of self-efficacy demonstrated clear and significant direct effects, but no significant interactions, across all analyses. Figure 2 shows that the role of AMS-measured self-efficacy was to facilitate performance and persistence across all levels of scholastic aptitude.

Discussion

The results of this investigation revealed that the strength of students' beliefs in their ability to complete successfully a variety of science and engineering majors facilitated the the academic performance and persistence of "low" aptitude students, but had no effect on the performance or persistence of high aptitude students. The effect of self-efficacy, as operationalized by the ERS measure, was to increase the grade point average of "low" aptitude students by approximately 1 standard deviation unit (from a mean GPA of 2.07 for the low aptitude/low self-efficacy group to a mean GPA of 2.66 for the low aptitude/high self-efficacy group) and to render performance nearly equal to that of high aptitude students (mean GPAs of 2.93 and 2.91 for the high and low self-efficacy/high aptitude groups, respectively).

Nearly identical results were obtained for the academic persistence measure. The low aptitude/low self-efficacy group completed a little over one quarter ($\underline{M}$ = 1.78) in the school of science and engineering in the year after completing the self-efficacy measure, while the low aptitude/high self-efficacy group and the two high aptitude groups appeared to complete nearly all subsequent academic quarters ($\underline{M}$ = 3.13, 3.30, and 3.29 for the low aptitude/ high self-efficacy, high aptitude/high

self-efficacy, and high aptitude/low self-efficacy groups, respectively).

The counseling implications of these findings are clear, but must be tempered with one very important caveat. Students in this study were enrolled in a highly selective school of science and engineering and entered the study with rather high levels of academic aptitude as supported by their PSAT scores and high school ranks (see Subjects section). Further, those classified as "low" aptitude in this study demonstrated rather high levels of academic aptitude (PSAT $\underline{M}$ = 52.17) and past academic performance (High school rank $\underline{M}$ = 71.31). Thus, it should not be inferred from these data that the types of self-efficacy beliefs measured by ERS would show compensatory effects on the academic success of students with low absolute levels of academic apptitude.

Nonetheless, these data do suggest that academic counseling for students with requisite academic aptitudes and skills would benefit from attention to students' self-efficacy beliefs . Enhancing the self-efficacy beliefs of such students, especially their beliefs in their abilities to complete a variety of relevant majors, should, if the present data are robust across replications, facilitate their academic performance and promote increased persistence.

The other measure of self-efficacy (AMS) focused on students' more specific beliefs about their academic skills. This measure failed to show consistent moderating effects of self-efficacy on aptitide-performance/persistence relationships. Rather,

it demonstrated consistently powerful direct and additive effects on academic performance and persistence (i.e., was associated with improved performance and persistence across all levels of academic aptitude).

An explanation for these results is not immediately obvious, although several possibilities exist. First, ERS scores were more normally distributed, while AMS scores demonstrated significant negative skew (i.e., most students expressed high levels of confidence in their academic skills). Although these distribution differences are easily explainable (i.e., most students, on the basis of past experience, should have been quite confident in their academic skills), the result was that the AMS scores of the subjects classified as low self-efficacy were moderately high ($\underline{M}$ = 5.66 versus 4.37 for ERS). Thus, the classification of subjects into low self-efficacy groups on the basis of AMS was probably less valid than classifications made on the basis of ERS.

Second, ERS, as a more general and future-oriented measure, of academic self-efficacy may, in part, also be measuring such personal characteristics as achievement motivation, perseverance tendencies, and career choice certainty and it is these personality characteristics that account for the compensatory effects observed in this study.

These possibilities need to be studied in future research and the present findings need to be replicated with other student populations. Especially needed are studies with more heterogeneous groups of students (with respect to scholastic aptitude)

and no attempt should be made to generalize these findings to such groups or to use them to direct counseling interventions for heteorgeneous student groups until such studies are completed. Nevertheless, the results of this study continue to support the extension of self-efficacy theory to the understanding of career and academic behavior a. suggest some limited by important counseling implications.

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Table 1

Summary of Results of Two Analyses of the Direct and Moderating Effects of Self-Efficacy on Academic Performance and Persistence

	Analysis 1		Analysis 2	
Variables	R2	R2 change	High Apt.	Low apt.
TGPA				
Aptitude	.12	.12***		
AMS	.20	.08**	.26	.45
Apt X AMS	.22	.02		
ERS	.15	.03*	-.10	.38*
Apt X ERS	.19	.04*		
QTRS				
Aptitude	.05	.05*		
AMS	.16	.11***	.31	.46
Apt X AMS	.16	.00		
ERS	.09	.04*	-.03	.35*
Apt X ERS	.10	.01		

Note. N = 105 (75 men and 30 women). TGPA = grade point average in science and technical courses on year later. QTRS = number of quarters completed in the college of technology during the follow-up year. Aptitude = Preliminary Scholastic Aptitude Test and high school rank composite. AMS = self-efficacy for academic milestones. ERS = Self-efficacy for educational requirements. Analysis 1 = Multiple Regressions.

Analysis 2 = Correlations between self-efficacy and TGPA and self-efficacy and QTRS for high and low aptitude groups. Analysis 1 regressions were run separately for the two self-efficacy measures, but R^2 and R^2 change for aptitude are not repeated because aptitude was entered first in all regressions and will remain the same.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2

TGPA and QTRS Mean Scores for Aptitude X Self-Efficacy

	AMS[a]		ERS[b]	
Aptitude	High	Low	High	Low
High	3.12	2.77	2.93	2.91
	(3.63)	(2.88)	(3.30)	(3.13)
Low	2.63	2.16	2.66	2.07
	(3.06)	(2.12)	(3.29)	(1.78)

Note. TGPA = Grade point average in technical and scientic courses. QTRS = Number of quarters completed in the school of technology during the follow-up year. Aptitude = Preliminary Scholastic Aptitude Test and high school rank aptitude composite. AMS = self-efficacy for academic milestones. ERS = self-efficacy for educational requirements. Numbers in parantheses are mean QTRS. Numbers not in parantheses are Mean TGPAs.

[a]F for main effects of AMS and Aptitude both significant at $p < .001$ (TGPA) and $p < .05$ (QTRS).

[b]F for interaction subsumed main effects and significant at $p < .03$ (TGPA) and $p < .056$ (QTRS).

Figure 1

Relationship of Self-Efficacy (ERS) and Academic Aptitude to Academic Performance (TGPA) and Persistence (QTRS)

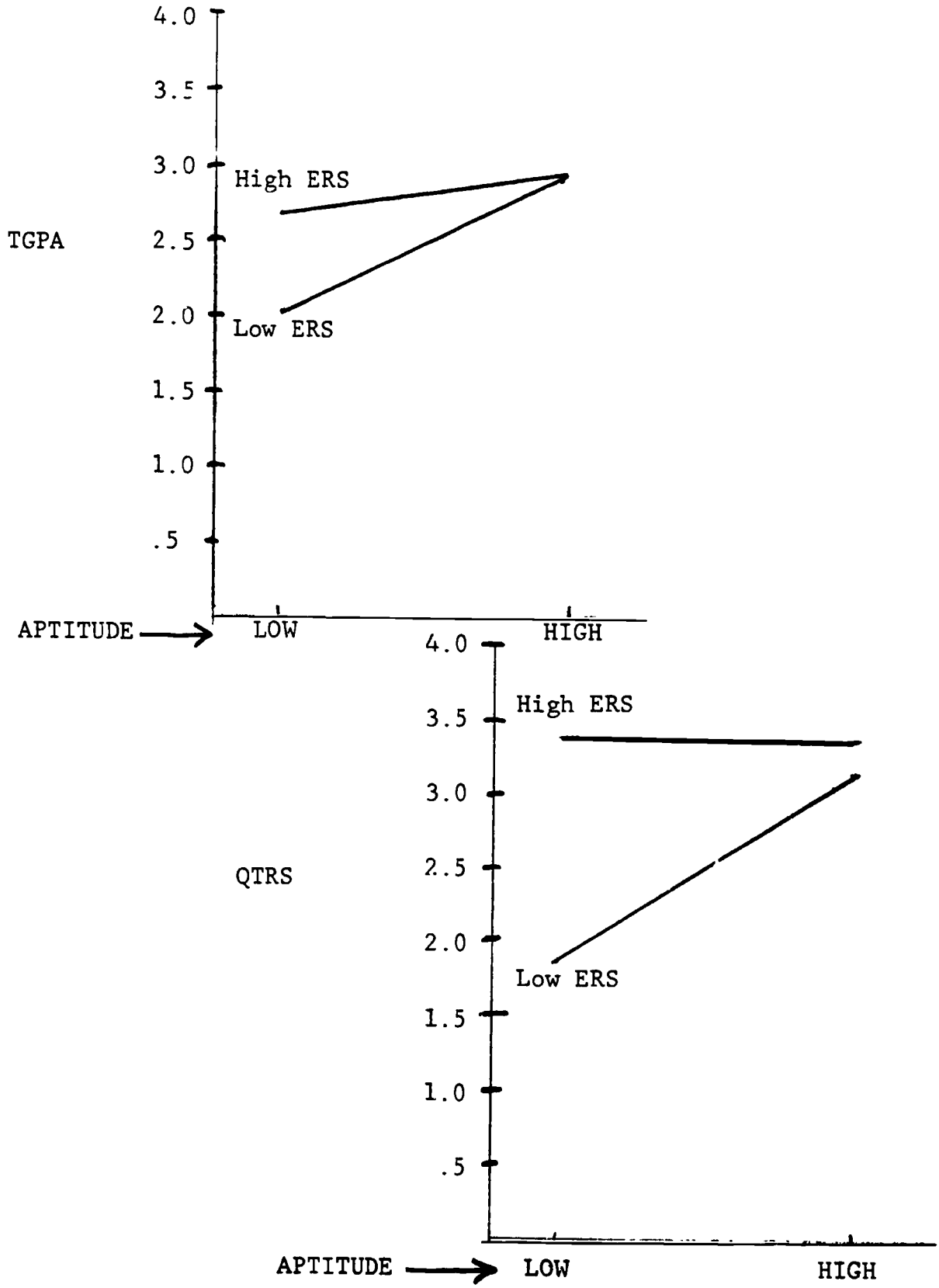

Figure 2

Relationship of Self-Efficacy (AMS) and Academic Aptitude to Academic Performance (TGPA) and Persistence (QTRS)