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Do Factors that Differentiate Science and Nonscience Majors Predict Majoring in Science?

The need for more students in science is widely recognized as an important goal for Canadian higher education. One approach to understanding factors that promote participation in science compares students who major in science with those who do not. This approach consistently finds that science majors (as a group) differ from nonscience majors by sex (more men), family backgrounds (more parents in science), high school experiences in mathematics and science (better preparation and performance), vocational interests (more interest in science and science careers, less importance attached to working with people), cognitive dispositions (higher mathematics and science self-efficacy, greater preference for material with precise answers), and encouragement to pursue science (more encouragement, Betz, 1997; Brainard, Laurich-McIntyre, & Carlin, 1995; Lee, 1998; O'Hara, 1995; Rayman & Brett, 1993; Ware & Lee, 1988; Yauch, 1999). These results routinely form the basis of policies designed to increase participation in science at all decision points on the education pipeline (Blair & Lupart, 1997; Donaldson & Dixon, 1995; Rayman & Brett, 1993; Sonnert & Holton, 1996). The argument from differences to policies is straightforward: Start from success stories and introduce initiatives that target factors that differentiate science and nonscience majors (e.g., by challenging stereotypes of science as asocial and introducing mentoring programs). These policies will prove efficacious, however, only if factors that differentiate science and nonscience majors translate into meaningful predictors of majoring in science. But do they?

Method

To examine this question we use data from a sample of 121 science majors and 160 social science majors at a commuter university in a large city in Western Canada. Sixty-six percent of participants were women; 34% were men. Their average age was 24 years (*SD*=.27). Questionnaires were anonymous and con-

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fidential. Most questions were closed-ended, with participants checking off or circling responses that described them. Table 1 describes the variables used in the analysis.

Results

We began by asking whether sex, family background, high school experiences in mathematics and science, vocational interests, cognitive dispositions, and encouragement to pursue science differentiate science and social science majors. Results of mean difference tests presented in Panel A of Table 2 show that, except for family background, they do. More science majors are men. Compared with social science majors, science majors took more mathematics courses and more science courses in high school and achieved higher grades in these courses. They are more interested in science and science careers and attach less importance to working with people. Science majors are more confident in their mathematics and science abilities, express a stronger preference for material with precise answers, and received more encouragement to pursue science.

Panel B of Table 2 presents the results of a logistic regression that uses the same factors to predict majoring in science. We use logistic regression because our outcome variable, major, is a dichotomous, unranked variable with values of 1 (science major) and 0 (social science major). If the factors that differentiate science and social science majors also predict majoring in science, then sex, high school experiences in mathematics and science, vocational interests, cognitive dispositions, and encouragement to pursue science should all have statistically significant effects on majoring in science, net of each other. The effect of family background, by contrast, should be nonsignificant.

Two things are immediately obvious from our results. First, only seven of the 12 factors that differentiated science and social science majors were important in predicting majoring in science. The positive effects of sex (male), mathematics performance, interest in science, interest in a science career, science self-efficacy, preference for material with precise answers, and encouragement to pursue science reproduce findings from other studies (Brush, 1991; Lapan, Shaughnessey, & Boggs, 1996; Lee, 1998; Lips, 1992, 1995; Rayman & Brett, 1993; Schaefers, Epperson, & Nauta, 1997; Yauch, 1999). The nonsignificant effects of science preparation and science performance are consistent with recent research that suggests that high school experiences in mathematics are key for science majors (Lapan et al., 1996; Pajares & Graham, 1999). Our finding that preparation in mathematics does not affect majoring in science is consistent with the argument that compared with other academic domains mathematics is perceived to be more dependent on ability (Mura, Kimball, & Cloutier, 1987). The nonsignificant effect of mathematics self-efficacy does not support this argument, however, and highlights the importance of extending research on the domain specificity of self-efficacy (Marsh & Yeung, 1997; Pajares, 1996; Pajares & Graham, 1999) to consider both mathematics and science self-efficacy in the same studies. Finally, the result for the job preference of working with people may reflect a growing recognition that having a career in science does not preclude working with people.

Second, not all of the predictors of majoring in science were among the factors that differentiated science majors from their social science counterparts.

Table 1
Description of Variables (Both Analyses)[a]

Variable	Description
Major	Dummy variable, coded 1 if science major (biological sciences, chemistry, computer science, geology and geophysics, mathematics and statistics, physics and astronomy).
Sex	Dummy variable, coded 1 if male.
Family Background	
Father in Science	Dummy variable, coded 1 if father works in a science-related field.[b]
Mother in Science	Dummy variable, coded 1 if mother works in a science-related field.[b]
High School Experiences	
Mathematics Preparation	Dummy variable, coded 1 if student took an advanced mathematics course in high school.[c]
Science Preparation	Number of high school chemistry, biology, and physics courses, range is 3-9.
Mathematics Performance	Average grade in high school mathematics courses. Coded 1-5: 1 is below 50%, 5 is 80-100%.
Science Performance	Average grade in high school science courses. Coded 1-5: 1 is below 50%, 5 is 80-100%.
Vocational Interests	
Interest in Science	Level of interest in science. Coded 1-5: 1 is bottom 10%, 5 is top 10%.
Career Aspirations	Dummy variable, coded 1 if hopes to pursue a career in science.[b]
Importance of Working with People	Sum of opportunities to be helpful to others and working with people. Coded 1 if important in a career, range is 0-2.
Cognitive Dispositions	
Mathematics Self-Efficacy	Self-perceived mathematics ability. Coded 1-5: 1 is bottom 10%, 5 is top 10%.
Science Self-Efficacy	Self-perceived science ability. Coded 1-5: 1 is bottom 10%, 5 is top 10%.
Precise Answers	Preference for material with precise answers. Coded 0-2: 0 is preference for material with multiple interpretations, 1 is preference for material with multiple interpretations and precise answers, 2 is preference for material with precise answers.[d]
Encouragement to Pursue Science	Sum of encouragement to pursue science from fathers; mothers; peers; high school teachers, counselors, university professors or graduate teaching assistants; and mentors. Coded 1 if received encouragement, range is 1-5.

[a]All measures are based on self-reports.
[b]Based on classification of occupations used by Lewko, Hein, Garg, and Tesson (1993).
[c]Based on research demonstrating the predictive value of elective mathematics courses (Chipman & Wilson, 1985; Farmer, Wardrop, Anderson, & Risinger, 1995).
[d]Based on Pathways Project (Rayman & Brett, 1993).

Mother's occupation did not differentiate science and social science majors, but having a mother working in a science-related field had a significant negative effect on majoring in science. Mothers in science can demystify science for their children (Clarke, 1991), but our results suggest that this demystification may

Table 2
Mean Difference Tests (Panel A) and Logistic Regression Results (Panel B) (*N*=242)

Variable	*Panel A Mean Differences*		*Panel B Predictors of Majoring in Science*
	Science	*Social Science*	
Sex (Male)	.44	.25***	1.99***
Family Background			
Father in Science	.20	.22	–.45
Mother in Science	.15	.19	–1.08*
High School Experiences			
Mathematics Preparation	.69	.32***	.66
Science Preparation	7.71	6.31***	.18
Mathematics Performance	4.36	3.51***	.73*
Science Performance	3.99	2.79***	.19
Vocational Interests			
Interest in Science	4.40	3.28***	.73**
Career Aspirations	.74	.19***	1.90***
Importance of Working with People	.42	.57**	.23
Cognitive Dispositions			
Mathematics Self-Efficacy	3.65	3.01***	–.50
Science Self-Efficacy	4.01	3.20***	1.08**
Precise Answers	1.56	.68***	1.01***
Encouragement to Pursue Science	2.64	1.58***	.45**
–2 Log Likelihood			135.99
Model Chi-Square (df)			196.99 (14)***

***p<.001; **p<.01; *p<.05.

deter their children from pursuing science by providing a realistic picture of the demands of a science career. More fine-grained studies of the kinds of information and experiences provided by parents working in science may improve our understanding of this factor.

Taken together these results underscore the importance of abandoning the practice of using data on differences between science and nonscience majors to draw conclusions about factors that promote participation in science. Our results suggest that policies guided by the difference model may not target factors that influence students' decisions to choose or avoid a science major. But because our data are cross-sectional, temporal ordering may be problematic for some variables, and our results should be interpreted with appropriate caution. Studies using longitudinal data are needed to establish the direction of causality and thus the generalizability of our results.

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