

## ARTICLE

# Motivation, Belongingness, and Anxiety in Neuroscience Undergraduates: Emphasizing First-Generation College Students

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The growth of undergraduate neuroscience programs nation-wide demonstrates that interest in this field is escalating. By understanding what motivates neuroscience undergraduates to do well and how they generally feel toward their major and environment, educators will be better able to attend to the needs of their neuroscience students. Thus, the present study aimed to characterize the psychosocial profiles of neuroscience majors in the U.S., with a particular interest in potential differences by generation in college, school type, and gender. For this, U.S. institutions that offer a neuroscience major were identified, and program directors/coordinators were asked to share a study survey with neuroscience majors at their school. The survey, which included demographics and measures of motivation, sense of belongingness, and anxiety, was completed by 756 students from 69 different institutions. Results showed that first-generation college

students had lower academic performance (i.e., GPA), which was mediated by differences in motivation, and test- and trait-anxiety. Further, students from Liberal Arts Colleges reported valuing neuroscience courses more than students at National Universities, and the desire to meet others' expectations, value of neuroscience course work, and anxiety were higher among female neuroscience students than males. Finally, test-anxiety was the strongest correlate of academic performance. These insights help identify potential targets for developing new teaching and advising strategies that could be employed to facilitate success among all neuroscience undergraduates.

*Key words: neuroscience major; motivation; belongingness; anxiety; academic performance; first-generation students.*

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Neuroscience is an interdisciplinary field that integrates psychological and biological methods to understand the structure and function of the brain. Growing interest in this field has led to the expansion of undergraduate neuroscience programs across the U.S. According to the Department of Education-National Center for Education Statistics, the number of institutions offering a Neuroscience major has increased from 104 in 2011 (Ramos et al., 2011) to 168 in 2018. In order to better attend to the needs of the growing neuroscience student body, it is crucial for educators to understand the different motivations for pursuing neuroscience among undergraduates, as well as how they generally feel toward their major and academic environment. Identifying these factors could facilitate the development of effective teaching and advising strategies, targeting students based on their particular psychosocial profile.

Motivation, belongingness and anxiety were selected as psychosocial features of interest for the present project, given existing evidence suggesting that they are predictive of important educational outcomes. For example, among undergraduates, different facets of motivation predict academic performance (Diseth and Kobbeltvedt 2010): autonomy and efficiency are associated with higher grades, while avoidance and resignation are associated with lower grades (Richardson et al., 2012). The basic human need for belongingness (Maslow 1962) is also predictive of outcomes in the educational setting, as students who feel connected to their school obtain higher grades than those who lack a sense of belongingness (Walton and Cohen 2007; Strayhorn 2012). Another important predictor of academic

performance in college students is anxiety; both test-anxiety and trait-anxiety impair learning, which can result in poorer educational outcomes (Chamorro-Premuzic and Furnham 2003; Chapell et al., 2005). These prior findings suggest that students who feel autonomous and efficient, who feel they belong in their academic environment, and who experience lower levels of anxiety, obtain higher grades. To date, however, these general patterns have not been explored among the growing neuroscience undergraduate population.

Together with characterizing the psychosocial features of neuroscience undergraduates, the present study also explores how motivation, belongingness, and anxiety vary according to school type, gender, and generation in college. The majority of undergraduate neuroscience programs in the U.S. are offered at either National Liberal Arts Colleges or National Universities (Pinard-Welyczko et al., 2017), and while both types of school offer high-quality education, each has a distinctive learning environment. For example, most Liberal Arts Colleges offer exclusively undergraduate degrees, whereas National Universities typically include undergraduate and postgraduate education programs. Further, colleges typically have a lower student-to-faculty ratio, resulting in smaller class sizes and greater prospect of interaction with instructors. This type of information is publicly available, allowing soon-to-be high school graduates to determine which type of school best aligns with their personal and professional goals, and preferred environment. Further, demographics within different majors show that women are underrepresented in STEM (Science, Technology, Engineering and Math) fields (National Science

Foundation, & National Center for Science and Engineering Statistics, 2017); this fact has both discouraged females from pursuing careers in STEM-related fields, and negatively impacted the sense of belongingness among female college students in STEM majors (Rainey et al., 2018). Despite previous work characterizing neuroscience course requirements in different programs and racial diversity among neuroscience graduates (Ramos et al., 2011; Pinard-Welyczko et al., 2017; Ramos et al., 2017), little to no work has assessed the experience of first-generation college students in neuroscience. It is well-established that while in college, first-generation students suffer academically and encounter greater obstacles than continuing-generation students (Dennis et al., 2005; Stephens et al., 2014); as such, determining which psychosocial characteristics vary by generation in college can help identify potential targets for intervention that might be particularly beneficial to this at-risk student population. In sum, past research suggests that psychosocial features of neuroscience undergraduates may vary by school type, gender, and generation in college, though no known research has explicitly explored this possibility.

In brief, the present study attempted to fill gaps in our knowledge by characterizing the motivational states, feelings of belongingness, and anxiety levels experienced by neuroscience undergraduates, while also exploring how these psychosocial characteristics vary by school type, gender, and generation in college. Further, we evaluated how motivation, sense of belongingness, and anxiety associate with academic performance (i.e., grade point average; GPA). By offering insight into the psychosocial characteristics that predominate in neuroscience majors and examining if these factors are associated with academic performance, our findings have the potential to inform neuroscience educators about possible targets for intervention to improve the college experience for all neuroscience majors.

## MATERIALS AND METHODS

Prior to initiating data collection, the study protocol was submitted to the Institutional Review Board (IRB) at UNC-Chapel Hill. The protocol received an IRB exemption given that all collected data were anonymous. For the study, institutions in the U.S. that offer a neuroscience major were identified using the College Navigator in the Department of Education-National Center for Education Statistics website (N=168). Program directors and coordinators from these institutions were contacted via email and asked to distribute a link to the study survey among undergraduate students majoring in neuroscience at their institution. The Qualtrics survey included measures of motivation, sense of belongingness, and trait-anxiety, together with demographic and other personal information (see below for more details). Statistical analysis was conducted with data from 756 students from 69 different institutions; details regarding the demographic makeup of the sample are described below.

### Measures

The study survey contained a 10-item demographic and personal information questionnaire that asked participants

to report their gender, age, school name, major, current overall GPA, year in college, enrollment status (e.g., full-time, part-time or other), employment status (e.g., full-time, part-time or unemployed), school pay (e.g., responsible for all, some or none of tuition expenses), and highest level of education of their primary caregiver when they were growing up (i.e., parental education). Specifically, the continuing-generation student group was comprised of students who selected “college graduate” or “graduate school” as the highest level of education of their primary caregiver, while the remainder formed the first-generation student group (i.e., those students whose primary caregiver had not completed a college degree). In addition to the demographics survey, participants completed six well-validated measures to evaluate aspects of the undergraduate experience and motivation toward their neuroscience major; for internal reliability alphas ( $\alpha$ ) and the Likert scale for each questionnaire, see Table 2.

### Motivation

Three scales were used to evaluate participants' motivation toward their neuroscience major/coursework. The Student Motivations for Attending University (SMAU) scale, originally developed as a way to understand why students chose to pursue higher education in Canada (Cote and Levine 1997), was modified to reflect an individual's motivation to attend university and study neuroscience. This scale is subdivided into 5 subscales, each representing a type of motivation for attending college: 1) career-materialism (i.e., wants to get a job, money and/or status), 2) personal-intellectual development (i.e., seeks personal growth and knowledge), 3) humanitarian (i.e., desires to help others), 4) expectation driven (i.e., wishes to fulfill the expectations of others), and 5) default (i.e., lacks better alternatives). The intrinsic value and test-anxiety sub-scales of the Motivated Strategies for Learning Questionnaire (MSLQ) were included to assess students' intrinsic interest in and perceived importance of neuroscience coursework (i.e., intrinsic value), and their worry and cognitive interference while taking exams (i.e., text-anxiety), respectively (Pintrich and de Groot 1990). The Expectancy-Value-Cost (EVC) Survey of Student Motivation, which evaluates an individual's motivation for engaging in a task based on their expectation of being successful and the value/cost relationship associated with completing a task (Barron et al., 2017) was modified to assess students' motivation toward their neuroscience major. This survey assesses three fundamental components of student motivation: expectancy (i.e., do they think they can do well in neuroscience courses?), value (i.e., do they want to do well in neuroscience coursework?), and cost (i.e., do they have the time, energy, and resources to do well in neuroscience classes?).

### Sense of Belongingness

The Social Connectedness Scale (SCS) and Social Assurance Scale (SAS), were administered to evaluate students' sense of belongingness (Lee and Robbins 1995). The SCS assesses an individual's opinion about themselves in relation to the people around them and their immediate environment, whereas the SAS gauges the need for

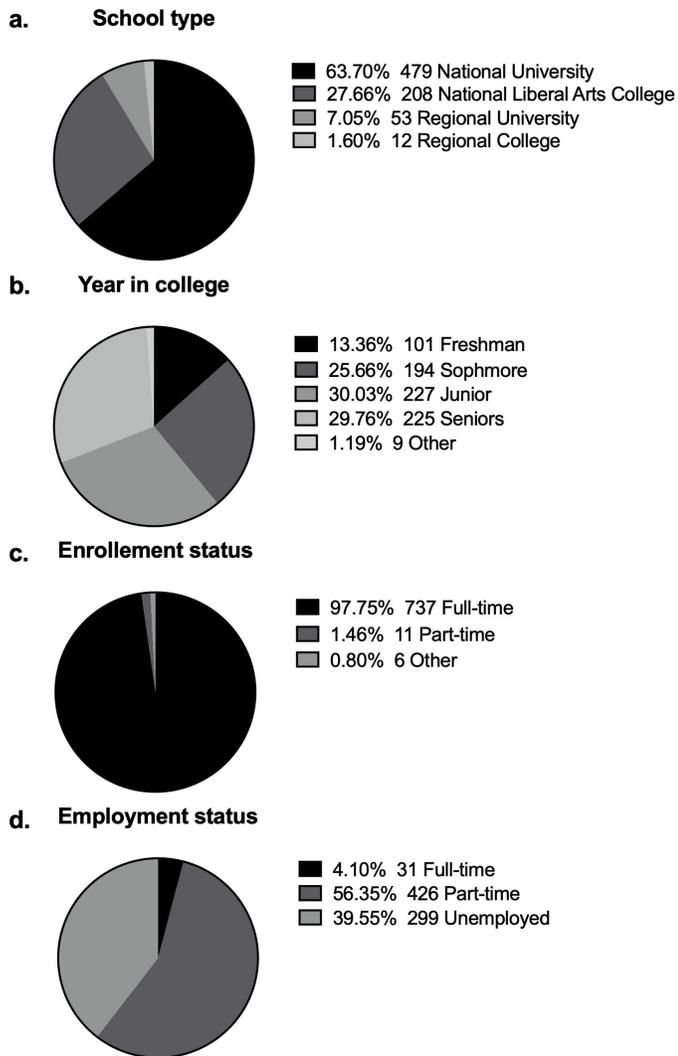


Figure 1. Distribution of student's school type (a), year in college (b), enrollment status (c) and employment status (d).

reassurance about belongingness within a social network.

**Anxiety**

The trait subscale from the State-Trait Anxiety Inventory (STAI) was used to assess anxiety (Spielberger et al., 1970).

**Statistical Analysis**

Prior to analysis, data from participants who failed to complete at least part of each of the individual study surveys were excluded, leaving a total sample of 788 with complete data. From these, 32 were further excluded because the participant was less than 18 years of age, the school name was not provided or "other" was selected as a major over neuroscience. Thus, the final sample size was 756 from which missing demographic/GPA data were as follows: 1 gender, 6 major, 4 school type, 2 enrollment status, 2 parental education, and 14 GPA.

Descriptive statistics were computed for all study

Gender (n, %)	
Male	173, 22.9%
Female	569, 75.3%
Other	13, 1.7%
Age	
Range	18-46
Mean ± SD	20 ± 1.99
Major (n, %)	
Neuroscience	750, 99.2%
Did not specify	6, 0.8%
Grade point average	
Range	2.1-4.0
Mean ± SD	3.56 ± 0.36
Generation in college (n, %)	
First-generation	181, 23.9%
Continuing-generation	573, 75.8%

Table 1. Demographics and schooling information of students in the study sample.

variables. Independent sample *t*-tests were used when comparing two groups (e.g., female vs. male; first-generation vs. continuing-generation), and general linear models were used when comparing more than two groups (e.g., school type differences). If the omnibus general linear model was statistically significant, multiple comparisons were calculated using Tukey's method. Additionally, correlations were used to evaluate the relationship between psychosocial factors and academic performance (i.e., GPA). For all analyses, a  $p \leq 0.05$  was used to indicate statistical significance, and effect sizes (e.g., Cohen's *d* (d) or eta-squared ( $\eta^2$ )) were calculated for significant analyses and interpreted according to published guidelines (Cohen 1988).

Given that a primary goal of this study was to identify psychosocial factors that could be targeted to improve academic performance for first-generation students, we also conducted mediational analyses to determine which psychosocial factors, if any, mediated observed associations between generation in college and academic performance. In these mediation models, we tested the significance of the indirect effect (a x b) with 95% confidence intervals, bootstrapping for 5000 iterations.

**Demographics**

To examine differences by school type, schools were categorized into National University (n=29), National Liberal Arts College (n=29), Regional University (n=9) and Regional College (n=2), according to the 2018 U.S. News and World Report Best Colleges magazine. Of the 756 participants, 75.3% (n=569) were female and 63.7% (n=479) attended a National University. For additional details regarding the study sample, see Table 1 and Figure 1.

Self-reported GPA was collected as a proxy of academic performance. In the sample, this measure ranged from 2.1-4.0, with a mean of 3.56. In addition to the 14 participants who skipped the GPA item, 1 reported a GPA higher than 5.0 leaving a final sample of 741 for analyses involving GPA. Four students reported a GPA higher than 4.0 but lower than

Questionnaire	Subscales	Items	Scale range	Range in present sample	Mean $\pm$ SD	Internal reliability ( $\alpha$ )
SMAU; 1 (strongly disagree) to 6 (strongly agree)	Career-materialism	5	5-30	7-30	24.5 $\pm$ 4.04	0.752
	Personal-intellectual development	5	5-30	9-30	26.0 $\pm$ 3.66	0.778
	Humanitarian	4	4-24	4-24	20.7 $\pm$ 3.28	0.798
	Expectation driven	5	5-30	5-30	18.2 $\pm$ 6.76	0.854
	Default	4	4-24	3-24	6.9 $\pm$ 3.75	0.825
MSLQ; 1 (not true for me) to 7 (very true for me)	Intrinsic value	9	9-63	14-63	53.8 $\pm$ 7.0	0.874
	Test-anxiety	4	4-28	4-28	15.0 $\pm$ 6.94	0.909
EVC Survey; 1 (strongly disagree) to 6 (strongly agree)	Expectancy	3	1-6	2.3-6	5.3 $\pm$ 0.69	0.805
	Value	3	1-6	2.3-6	5.7 $\pm$ 0.46	0.816
	Cost	4	1-6	1-6	2.9 $\pm$ 1.02	0.780
SCS; 1 (strongly agree) to 6 (strongly disagree)	Connectedness, Affiliation and Companionship	8	8-48	8-48	34.28 $\pm$ 8.28	0.946
SAS; 1 (strongly agree) to 6 (strongly disagree)	Affiliation and Companionship	8	8-48	8-48	31.21 $\pm$ 8.52	0.858
STAI; 1 (almost never) to 4 (almost always)	Trait-anxiety	20	20-80	20-80	44.0 $\pm$ 11.37	0.929

Table 2. Motivation constructs, belongingness and anxiety measures (N=756 for all).

5.0, and they were assigned a 4.0 GPA for the purpose of analysis, given that most schools use a 1-4 GPA scale.

## RESULTS

### Characterizing Motivation, Belongingness and Anxiety in Neuroscience Undergraduates

Means, standard deviations (SD), and ranges for each of the psychosocial measures of interest are provided in Table 2. In brief, across the different motivation constructs assessed, students ranked personal-intellectual development and value (i.e., wanting to do well in their coursework) the highest. In contrast, they ranked default motivation (i.e., lack of better alternatives) the lowest. For sense of belongingness, both connectedness and affiliation were rated relatively high, indicating that overall, these students feel like they fit-in in with others and their environment. For anxiety measures, SD values were high, demonstrating substantial variability.

### School Type Differences

With regard to motivation, there was a significant effect of school type on intrinsic value ( $F(3,748)=4.336$ ,  $p\leq 0.05$ ,  $\eta^2=0.017$ ), and post-hoc tests revealed that students at National Liberal Arts Colleges reported greater intrinsic interest in and perceived importance of neuroscience coursework than students at National Universities ( $p\leq 0.05$ ). Cost also varied significantly across the different school types ( $F(3,748)=2.868$ ,  $p\leq 0.05$ ,  $\eta^2=0.011$ ), with students at

Regional Universities perceiving their neuroscience major as more energy demanding than students at National Universities, National Liberal Arts Colleges, and Regional Colleges (all  $p\leq 0.05$ ). No other motivation constructs differed significantly across school types. Further, belongingness measures from the SC and SA scales, trait-anxiety, and GPA were also not significantly different across school types.

### Gender Differences

With regard to gender differences, expectation-driven motivation ( $t(740)=1.955$ ,  $p\leq 0.05$ ,  $d=0.17$ ), test-anxiety ( $t(740)=-1.946$ ,  $p\leq 0.05$ ,  $d=0.43$ ), and the desire to do well in neuroscience coursework (i.e., value;  $t(740)=2.080$ ,  $p\leq 0.05$ ,  $d=0.17$ ) were higher in females than males. In contrast, default motivation ( $t(740)=1.955$ ,  $p\leq 0.05$ ,  $d=0.16$ ) was higher in males than females. No other significant gender differences in motivation constructs were detected. Parallel to the results for test-anxiety, trait-anxiety was higher in females relative to males ( $t(740)=2.904$ ,  $p\leq 0.05$ ,  $d=0.26$ ). Measures of belongingness from the SCS and SAS, and GPA, did not vary by gender.

### Generation in College Differences

Turning to generation in college differences, personal-intellectual development ( $t(752)=-2.483$ ,  $p\leq 0.05$ ,  $d=0.21$ ) and expectation-driven motivations ( $t(752)=-6.766$ ,  $p\leq 0.05$ ,  $d=0.57$ ) were higher among continuing-generation students

	Grade point average	
	Pearson correlation	p-value
SMAU career-materialism	0.003	0.940
SMAU personal- intellectual development	0.048	0.188
SMAU humanitarian	-0.061	0.099
SMAU expectation driven	-0.060	0.104
SMAU default	-0.178*	0.000
MSLQ intrinsic value	0.065	0.077
MSLQ test-anxiety	-0.317*	0.000
EVC expectancy	0.075*	0.042
EVC value	-0.061	0.098
EVC cost	-0.244*	0.000
SCS	-0.018	0.615
SAS	-0.021	0.567
Trait-anxiety	-0.175*	0.000

Table 3. Correlations of psychosocial factors with grade point average (GPA), N=741. Asterisk (\*) indicates  $p \leq 0.05$ .

than first-generation students. Further, continuing-generation students reported higher GPA than first-generation students ( $t(737)=-3.159, p \leq 0.05, d=0.28$ ). On the other hand, motivation by the lack of better alternatives (i.e., default;  $t(752)=2.221, p \leq 0.05, d=0.19$ ), test-anxiety ( $t(752)=2.498, p \leq 0.05, d=0.21$ ), and trait-anxiety ( $t(752)=2.297, p \leq 0.05, d=0.19$ ) were higher among first-generation students compared to continuing-generation students. There were no significant generation in college differences in the belongingness measures from the SC and SA scales, or in the other motivation metrics.

**Associations between Psychosocial Factors and GPA**

Believing that one can do well in neuroscience coursework was weakly associated with academic performance; specifically, greater trust of oneself ( $r=0.075, p \leq 0.05$ ) was associated with higher GPA. Further, default motivation, cost, test-anxiety and trait-anxiety were all significantly associated with GPA, with moderate effect sizes. Specifically, students who are motivated by the lack of better alternatives ( $r=-0.178, p \leq 0.05$ ) or who perceive their neuroscience major as very energy demanding ( $r=-0.244, p \leq 0.05$ ) have significantly lower GPAs. Similarly, higher test- ( $r=-0.317, p \leq 0.05$ ) and trait-anxiety ( $r=-0.175, p \leq 0.05$ ) were associated with significantly lower GPA. For the list of all correlations, see Table 3.

**Mediations of The Relationship Between Generation In College And GPA**

For mediational analyses, the independent variable was generation in college and the dependent variable was GPA, and each psychosocial characteristic that varied by generation in college was tested as a possible mediator.

Figure 2 lists the unstandardized coefficients for the a x b path in the models, as well as the coefficients and 95% confidence intervals for these indirect effects. Results indicate that the indirect effect of generation in college on GPA was mediated via expectation-driven motivation (a x b effect= -0.02, 95% CI= -0.036, -0.003), default motivation (a x b effect= 0.01, 95% CI= 0.001, 0.025), test-anxiety (a x b effect= 0.03, 95% CI=0.017, 0.129), and trait-anxiety (a x b effect=0.01, 95% CI=0.001, 0.025). Together, these data suggest that all four of these psychosocial factors are significant mechanisms linking generation in college with academic performance.

**DISCUSSION**

The present study characterized the psychosocial features of neuroscience undergraduates, and explored how motivation, belongingness and anxiety vary according to generation in college, school type, and gender. Overall, the data indicate that neuroscience undergraduates are mostly motivated by a desire to gain personal-intellectual development and least motivated by the lack of better alternatives (i.e., default motivation). Moreover, results demonstrate that despite feeling a high sense of belongingness among peers and the environment, these students experience high anxiety levels. There were also interesting differences in several of the psychosocial features addressed as a function of generation in college, school type, and gender. Below, we discuss the present findings, and how they may be used to inform the development of teaching and advising strategies to help neuroscience undergraduates thrive, especially those who might be at-risk for poor academic outcomes.

**Psychosocial Mechanisms Linking Generation in College and Academic Performance**

One of the primary goals of the present study was to fill gaps in our knowledge regarding how psychosocial characteristics of neuroscience majors vary as a function of their generation in college. This work is critical for providing insight into possible targets for intervention to improve

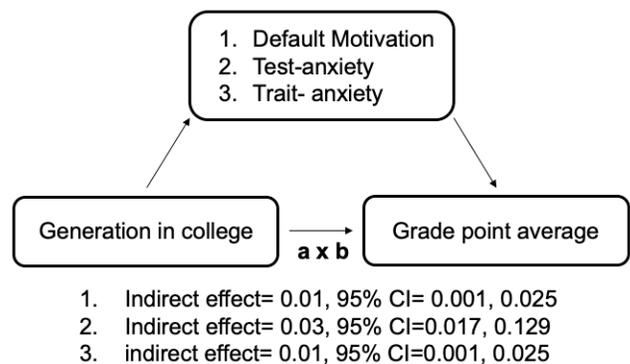


Figure 2. Mediation analysis models. For all models, the independent variable was generation in college, the dependent variable was GPA, and psychosocial characteristic that varied by generation in college were tested as mediators. Indirect pathways for default motivation, test-anxiety and trait-anxiety were all significant,  $p \leq 0.05$ .

academic performance for first-generation students, who are typically at-risk for negative academic outcomes. Results indicated that motivation constructs of personal-intellectual development and wanting to fulfill the expectations of others were rated higher among continuing-generation students, while default motivation (i.e., lack of better alternatives) was rated higher among first-generation students. First-generation students also reported higher levels of test- and trait-anxiety than continuing-generation students. Further, consistent with past work in this area (Chen 2005), first-generation college students in this sample had lower GPAs than continuing-generation students. Analysis examining if motivation and/or anxiety could mediate the association between generation in college and GPA demonstrated that expectation-driven motivation, default motivation, test-anxiety and trait-anxiety are all significant mediators of this interaction. Taken together, these results suggest that interventions designed to target facets of motivation and anxiety may help improve academic outcomes for first-generation college students who are studying neuroscience. Indeed, developing intervention strategies that help this vulnerable student population succeed academically is of paramount importance for the diversification of the neuroscience field (Haak 2002; Margherio et al., 2016; Ramos et al., 2017).

This pattern of findings is consistent with results from previous work examining how continuing-generation and first-generation students differ in terms of their motivations for pursuing higher education, and their experiences once they enroll in college. Indeed, continuing-generation students' enrollment motivations are likely facilitated by growing up with family members who have attended college, which may increase expectations to also obtain a degree (McCarron and Inkelas 2006). In contrast, first-generation students, who may not have been exposed to the same family dynamics, might attend college instead so that they can later pursue a higher paying job, given a perceived lack of better alternatives (Terenzini 1995; Bui 2002). Further, higher anxiety among first-generation students may result from overall heightened stress, and perhaps also a lack of knowledge regarding the college system. Differences in college preparedness due to attending less well-funded high schools where exposure to advanced coursework is limited (Riehl 1994; Engle 2007), varying expectations about college based on familial experiences (Dennis et al., 2005), and frequent exposure to stressful experiences due to individual experiences (Terenzini 1995; Aronson et al., 1998; Mehta 2011), could also contribute to higher test- and trait-anxiety in this student population. In sum, findings suggest that interventions that focus on decreasing default motivations and anxiety may improve academic outcomes for first-generation college students.

### **School Type and Gender Differences in Psychosocial Characteristics**

In addition to examining the associations between generation in college and psychosocial characteristics, we explored how the type of school attended and gender influenced motivation and anxiety among neuroscience undergraduates. Four primary findings from these analyses

are worth noting. First, students enrolled in a National Liberal Arts College reported greater intrinsic interest in and perceived importance of their neuroscience coursework than students enrolled in National Universities. Second, students from Regional Universities rated the cost of their neuroscience education (e.g., time, energy, and resources necessary to do well in neuroscience classes) higher than students from all other school types. Third, wishing to fulfill the expectations of others (i.e., expectation-driven) and wanting to do well in neuroscience coursework (i.e., value) were significantly higher among females, while the perception of not having any better alternatives (i.e., default) was significantly higher in males. Finally, female participants reported higher test- and trait-anxiety than males. These findings are largely consistent with prior work in the literature that has also documented school type and gender differences in motivation and anxiety among college students; here, we extend this work to show similar effects specifically among neuroscience majors.

Although our study cannot answer *why* these school type and gender differences exist, other research suggests possible mechanisms leading to these effects. For example, evidence demonstrating that frequent student-faculty interactions can increase students' motivation and academic self-concept (Komarraju et al., 2010) and that Liberal Arts Colleges traditionally have a lower student-to-faculty ratio, suggests that student-faculty interactions may contribute to the association between greater intrinsic interest in and importance of neuroscience coursework among students at Liberal Arts Colleges. Of course, it is also possible that pre-existing differences in motivation between students influences the type of institution they choose to attend, thus contributing to these effects. Similarly, reports of higher perceived costs of neuroscience coursework among students at Regional Universities may reflect lower-levels of resources available at these schools (Ramos et al., 2011), which may lead students to feel that they cannot access the support they need to do well in their courses. Turning to gender differences, motivation patterns between males and females might result from norms regarding gender roles that may still persist today. In accordance with this perspective, it is possible that females feel greater pressure to meet the expectations of others and attribute higher value to their neuroscience coursework, in order to overcome traditional gender expectations that influence society's view of women's competence in STEM. This could also contribute to the higher levels of anxiety reported by female students in the present study, which indeed parallels previous reports (Bandalos et al., 1995; Zalta and Chambless 2012; Núñez-Peña et al., 2016). At present, though, all of these possible mechanisms are speculative and more work is needed to fully understand the pathways linking gender and school type with differences in motivation and anxiety.

### **Psychosocial Factors That Correlate With Academic Performance**

A final goal of this study was to identify psychosocial factors that associate with academic performance. Correlation analyses showed that higher expectancy motivation was associated with higher GPA, while higher default motivation,

perceived costs, test-anxiety and trait-anxiety, were all associated with lower GPA. These results also suggest possible targets for intervention to improve academic performance. For example, it is possible that by emphasizing to students that they have been given the skills and knowledge necessary to do well in their courses (i.e., increasing expectancy motivations), neuroscience educators might be able to help students improve their academic performance (Dweck 1986; Justiz and Rendon 1989; Gettinger 2002; Dweck 2002). Further, providing mentoring and feedback throughout the semester, incorporating in-class activities that promote successful learning strategies, and including several methods of learning assessment into the grading plan (i.e., low-and high stakes assignments) (Komarraju et al., 2009), could be utilized in the classroom to increase student confidence and shift motivation. Indeed, anxiety presents another target for intervention. Extensive evidence shows that anxiety hinders academic performance (Culler and Holahan 1980; Chamorro-Premuzic and Furnham 2003); this makes sense given prior literature that suggests that negative emotions (such as anxiety) may influence attention, motivation and memory (Tyng et al., 2017), and that emotion regulation improves performance among disadvantaged students (Rozeck et al., 2019). To reduce anxiety and negative emotions, neuroscience educators can establish clear objectives and expectations for their courses (Tan 2008). Further, by making connections between complex neuroscience concepts and salient emotional experiences via the use of analogies, student learning can be enhanced (Pekrun 1992; Donnelly and McDaniel 1993; Tan 2008). Both of these strategies could be incorporated into the classroom to possibly reduce anxiety and improve academic performance, which will particularly aid vulnerable student populations. Together with implementing classroom-level strategies, diversifying faculty and developing mentoring programs for first-generation students are institution-level changes that could be employed to further support underrepresented students, such as first-generation students.

### Limitations and Opportunities for Future Research

While informative, the present results should be interpreted in light of some important limitations. First, the study followed a quasi-experimental design, making it impossible to determine the direction of causality. In order to fully unpack the processes contributing to motivational and anxiety differences among neuroscience students, further experimental and intervention studies are warranted. Another limitation is the use of self-reported cumulative GPA as an indicator of academic performance. Despite the well-established association between GPA and academic performance, self-reported GPA might be suspect to reporting bias due to memory constraints or inflated estimates (Gramzow et al., 2003). Moreover, while cumulative GPA may be influenced by years in college (e.g., number of credit hours a student has taken and level of courses enrolled), for the present analysis, data from students at all different stages were combined. There are also generalizability limitations due to the study population

and potential selection biases. For example, greater participation by females potentially skewed the data toward their particular experiences. Further, the participant pool represents only a small sample of all neuroscience undergraduates; while we contacted 168 different schools, there was student participation from only 69 of them. The emphasis on neuroscience undergraduates limits the interpretation of our findings to a particular setting; nonetheless, results from previous studies cited herein suggest that the present findings might also be relevant to students in other fields. Finally, our demographics assessment did not ask about ethnicity/race of the student or the ethnicity/race distribution at their school, which might also influence the college experience of the individual.

Although there are limitations to the present study, results suggest possible teaching and advising strategies that could be targets for intervention that could aid student academic performance among neuroscience majors across different school types, genders, and generations in college. The present findings represent an important step toward understanding the make-up of and opportunities for providing support to one of the fastest growing groups of college students, neuroscience majors.

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