

ARTICLE

Decreasing Neuroscience Anxiety in an Introductory Neuroscience Course: An Analysis Using Data from a Modified Science Anxiety Scale

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To determine whether participation in a neuroscience course reduced neuroscience anxiety, a modified version of the Science Anxiety Scale was administered to students at the beginning and end of an introductory course. Neuroscience anxiety scores were significantly reduced at the end of the course and correlated with higher final

grades. Reduced neuroscience anxiety did not correlate with reduced science anxiety, suggesting that neuroscience anxiety is a distinct subtype of anxiety.

Key words: introductory neuroscience; neuroscience anxiety; teaching

Anxiety about general science (Desy et al., 2009), chemistry (McCarthy and Widanski, 2009), biology (Okebukola and Jegede, 1989) and physics courses (Udo et al., 2001) is prevalent among college students. "Neuroscience anxiety" is an emerging subtype of science anxiety that broadly includes student fear and anxiety about topics or coursework in the field of neuroscience.

Anxiety about science courses contributes to poor academic performance, avoidance of courses (Eddy, 2000; McCarthy and Widanski, 2009), and limits the possibility that students will develop an appreciation for scientific disciplines (McCarthy and Widanski, 2009). Perhaps more detrimental, high or prolonged levels of stress or anxiety can impair learning and memory at the neurobiological level (McEwen and Sapolsky, 1995).

Student anxiety may have implications for academic departments responsible with increasing student retention and graduation rates. Fear of science courses has been associated with declining enrollment (McCarthy and Widanski, 2009) and avoidance of classes, thereby preventing students from making satisfactory degree progress (Onwuegbuzie and Wilson, 2003).

A review of the literature reveals that neuroscience anxiety has not been studied among college students; however, a related phenomenon has been documented among medical students. Józefowicz (1994) suggested that medical students experience "neurophobia"; defined as a fear of neural sciences and neurology. Neurophobia affects approximately one third of medical students (Hudson, 2006); however, neurophobia research has thus far been limited to assessment of topic difficulty rather than anxiety, and failed to include data from non-medical students (Flanagan et al., 2007; Youssef, 2009). Despite limited preliminary research, these findings suggest that this is an important area for continued study, particularly among college students.

Several lines of research suggest that participation in a science course can reduce science anxiety or neurophobia. One semester's exposure to science course content modestly reduced general science anxiety, even without a specific teaching intervention (Udo et al., 2001). Cooperative learning with indirect teacher interaction (Okebukola, 1986) and concept mapping (Okebukola and Jegede, 1989) significantly reduced general science

anxiety. Increasing the length of neurology training from four to thirteen weeks reduced neurophobia among medical students (Ridsdale et al., 2007).

Gender and ethnicity are important factors in science anxiety; however, their role in neuroscience anxiety is unknown. Mallow and colleagues were among the first to formally describe science anxiety and have consistently reported that women and members of underrepresented groups in the sciences (e.g., members of ethnic minority groups) were most detrimentally affected by science anxiety (Greenburg and Mallow, 1982; Mallow, 1994). Empirical research on the relationship between ethnicity and science anxiety is limited, but individuals from ethnic minority groups experienced increased math anxiety (Hembree, 1990) and greater prevalence of test anxiety (Anderson and Mayes, 2010). Browlow, Jacobi, and Rogers (2000) suggested that several factors discouraged individuals from pursuing study in science including science teachers who held gender stereotypes and tacitly or explicitly influenced anxiety, and the scarcity of female scientists and science professors to serve as positive role models.

In their guidelines for undergraduate psychology programs, the American Psychological Association recommends that all undergraduate students demonstrate knowledge and understanding in the domain of biological bases of behavior and mental processes (American Psychological Association, 2007). To meet this goal, neuroscience courses taught from a psychological perspective are now offered by most undergraduate institutions (Cleland, 2002). The number and variety of undergraduate neuroscience courses have increased in the past two decades and the number of neuroscience programs and departments has doubled (Cleland, 2002). As further evidence of significant student interest in the discipline, the largest professional neuroscience organization, the Society for Neuroscience, reported over 10,000 student members in 2009 (Society for Neuroscience, 2009). As interest in neuroscience continues to grow, it will be increasingly helpful for teachers to anticipate neuroscience anxiety in their classes.

Altogether, anxiety about science courses is prevalent and contributes to negative outcomes, particularly for

female and minority students. Reducing this anxiety increases the likelihood of positive outcomes for students. We anticipate that neuroscience anxiety will become an increasingly important area of study in light of recent increases in neuroscience course offerings and student interest in the discipline. Based on previous research about related types of anxiety, such as neurophobia and science anxiety, we hypothesized that (1) neuroscience anxiety will be significantly reduced after participation in an introductory course; (2) reduced neuroscience anxiety will be correlated with positive student outcomes (in the form of higher final grades); and (3) neuroscience anxiety is unique subtype of anxiety and distinct from general anxiety, science anxiety and non-science anxiety experienced by students.

METHODS

To determine whether neuroscience anxiety was significantly reduced after participation, anxiety levels were measured at the beginning (pretest) and end (posttest) of an introductory neuroscience course using a modified version of the Science Anxiety Scale (SAS) during the fall 2009 and fall 2010 semesters. The SAS, originally developed by Fraser, Nash, and Fisher (1983), was based on Zuckerman's (1960) Affect Adjective Checklist. The original version of the SAS instructed participants to select words from a list that described how they felt about "science." The modified version instructed participants to select words that described how they felt about "neuroscience." This self-report measure included 21 key words embedded within 60 adjectives arranged in alphabetical order. Eleven of the key words that were associated with the experience of neuroscience anxiety were scored with one point if they were chosen and zero if they were not chosen. Ten words that were associated with enjoyment and comfort with neuroscience were scored with zero points if chosen and one point if not chosen. The remaining 39 adjectives were not scored. A total neuroscience anxiety score was calculated for each student by summing the scores of the 21 key words. Consistent with previous research by Okebukola and Jegede (1989) that reported good internal consistency for modified versions of the SAS (modified by reference to "genetics" or "ecology" in the directions), the internal consistency of the scale in the present study was .80 for scores of key words from the SAS given at the beginning of the semester in the fall 2009 cohort. Repeated measures ANOVAs were used to assess neuroscience anxiety reduction from pretest to posttest measurement.

To determine whether reduced anxiety was associated with positive outcomes (higher final grade), the Pearson product-moment correlation coefficient was calculated using SAS difference scores (posttest to pretest) and final grades of participants.

To determine whether neuroscience anxiety is a unique subtype of anxiety and distinct from general anxiety, science anxiety and non-science anxiety, a subset of participants ($n=32$; those enrolled in the neuroscience course during the fall 2010 semester) completed the Science Anxiety Questionnaire (SAQ) at the beginning

(pretest) and end (posttest) of the introductory course. The SAQ was developed to assess general anxiety, science anxiety, and non-science anxiety based on Likert-type ratings of anxiety in response to 22 science and 22 non-science scenarios "with emphasis on analogous situations; e.g. studying for a physics exam vs. studying for a history exam" (Alvaro, 1978; Udo et al., 2004, p. 438). Based on responses to SAQ items, participants were classified as experiencing general anxiety (GA; "much" or "very much" to any item), science anxiety (SA; "much" or "very much" to one or more of the science items only), and non-science anxiety (NSA; "much" or "very much" to one or more non-science items only). Because this instrument produced classifications of anxiety "status," all SAQ data were analyzed using statistics appropriate for categorical data (e.g., McNemar's tests). The SAQ has been used in research for over 30 years, with acceptable reliability and convergent validity with physiological measures of stress and other self-report anxiety instruments (Udo et al., 2004). Repeated measures ANOVAs were used to assess significant general, science, and non-science anxiety reductions from pretest to posttest measurement. McNemar's tests were used to evaluate changes in the proportions of students meeting criteria for GA, SA, and NSA from the beginning to the end of the semester. All analyses were conducted using SPSS software (v.19).

Seventy-nine students, enrolled in an introductory neuroscience course during the fall 2009 ($n=46$) or 2010 ($n=33$) semester at a southwestern, public university, completed SAS and SAQ (fall 2010 cohort only) surveys anonymously on-line at the beginning and end of the semester. Participants who completed only the SAS pretest ($n=33$, $M[SD]=11.5[3.1]$) or posttest ($n=20$, $M[SD]=9.5[3.0]$) were excluded from analysis. Five students (3.5% of the class) officially withdrew from the course during the fall 2009 semester, and six students (8.6% of the class) during the fall 2010 semester. Of the participants, 82.3% were female, 67.1% were Caucasian, 77.2% were psychology majors, and 44.3% were in their third year of undergraduate education. Participants ranged from 18 to 38 years of age ($M[SD]=21.2[3.4]$ years). The university's Institutional Review Board approved all research.

An introductory course was chosen to limit the confounding variable of experience that students might have had with previous neuroscience courses. Students were enrolled in sections of the same course taught by the same full-time female faculty member (MB) and supported by a graduate teaching assistant. The course met twice a week for 75 minutes in a lecture format. Interactive activities were included at several points throughout the semester (e.g., sheep brain dissection demonstrations, cell model building, small group review and problem solving activities, video presentations with discussions, invited guest lecturers, group and final project presentations). The instructor addressed the topic of neuroscience anxiety at the beginning of the course and invited students to participate in the study to determine whether changes in neuroscience anxiety occurred after participation in the course.

RESULTS

Hypothesis 1: Neuroscience anxiety will be significantly reduced after participation in an introductory course.

Neuroscience anxiety was assessed using the modified SAS. First, SAS difference scores were calculated for each student by subtracting the pretest SAS score from the posttest SAS score. There was no significant difference in SAS difference scores between the fall 2009 and fall 2010 semesters, and data from both semesters was combined for all subsequent analysis.

There was a significant reduction in SAS neuroscience anxiety scores from the beginning to the end of the semester ($F [1, 78]=42.90, p<.001$, partial $\epsilon^2=0.36$, large effect size; Table 1). Interpretation of effect size is according to criteria proposed by Cohen: 0.01=small effect, 0.06=moderate effect, 0.14=large effect (1988, pp. 284-7). These criteria for effect size interpretation are used throughout subsequent analyses. There was a significant reduction of neuroscience anxiety scores among female ($F [1, 65]=41.54, p<.001$, partial $\epsilon^2=0.39$, large effect size), Caucasian ($F [1, 52]=27.50, p<.001$, partial $\epsilon^2=.346$, large effect size), and Hispanic ($F=8.442, p=.017$, partial $\epsilon^2=.484$, large effect size) students. Significantly reduced SAS neuroscience anxiety scores were also found among students in the second ($F [1, 20]=28.54, p<.001$, partial $\epsilon^2=.588$, large effect size) and third ($F=28.68, p<.001$, partial $\epsilon^2=.458$, large effect size) years of college. Both psychology majors ($F [1, 60]=36.39, p<.001$, partial $\epsilon^2=.378$, large effect size) and "other" majors ($F [1, 17]=6.54, p=.020$, partial $\epsilon^2=.278$, large effect size) had significantly reduced SAS neuroscience scores at the end of the semester.

Hypothesis 2: Reduced neuroscience anxiety will be correlated with positive student outcomes (higher final grade).

Correlations were examined between SAS neuroscience anxiety difference scores and final grades in the neuroscience course. Final grades from two students were excluded from correlation analysis due to lack of participation in the class (less than 20% of course work completed during the semester). There was a small, negative correlation between SAS reduction and final grade ($r =-.19, n=77, p=.046$), with higher final grades in the class associated with greater reductions in SAS score. A larger non-significant correlation between SAS reduction and final grade was found among males ($r =-.37, n=14, p=.097$) than females ($r =-.09, n=63, p=.242$). The correlation between final grade and SAS reduction was significantly greater for males than females ($z=11.6, p<.05$). A large, negative correlation between SAS reduction and final grade was found among Hispanic students ($r =-.67, n=10, p=.016$), indicating that higher final grades were strongly correlated with larger reductions in neuroscience anxiety in this group. A significant negative correlation between SAS reduction and final grade was found among psychology majors ($r =-.27, n=61, p=.019$) but not among collapsed "other" majors.

Hypothesis 3: Neuroscience anxiety is unique subtype of anxiety and distinct from general anxiety, science anxiety and non-science anxiety experienced by students.

There was no significant correlation between reductions in SAS neuroscience anxiety score and reductions in SA ($r =.09, p=.312$) or NSA ($r =-.18, p=.163$), although SA and NSA were significantly reduced among Caucasian and second year students (see Table 1)

General anxiety (GA), non-science anxiety (NSA), and science anxiety (SA) were assessed using the SAQ. Approximately 80% of students in the fall 2010 cohort met criteria for GA (i.e., responding "much" or "very much" to any of the 44 SAQ questions) at the beginning of the semester, while nearly 72% still met criteria for general anxiety at the end of the semester (Table 2). McNemar's test revealed a significant tendency for female students who reported GA at the beginning of the semester to report no GA at the end of the semester ($p=.021$), however no other demographic group experienced significant changes in GA.

The majority of students (73.1%) who experienced GA also experienced non-science anxiety (NSA) at the beginning of the semester (i.e., responded "much" or "very much" to any of the 22 SAQ non-science scenarios; see Table 2). The percent of GA students experiencing NSA decreased significantly at the end of the semester (McNemar's test, $p=.007$). More specifically, the number of female (McNemar's test, $p=.022$), Caucasian ($p=.012$), second year students ($p=.031$), and students majoring in psychology ($p=.012$) who experienced NSA decreased significantly at the end of the semester.

NSA scores were calculated for each student by summing their responses to the 22 non-science scenarios on the SAQ as follows; "not at all" =1, "a little"=2, "a fair amount" =3, "much" =4, "very much" =5. Caucasian ($F [1, 21]=5.56, p=.028$, partial $\epsilon^2=0.209$, large effect size) and second-year students ($F [1, 12]=5.32, p=.04$, partial $\epsilon^2=0.307$, large effect size) experienced significant reductions in NSA scores at the end of the semester.

Using McNemar's test, a significant tendency was found for students to change from reporting non-science anxiety at the beginning of the semester, to reporting no non-science anxiety at the end of the semester ($p=.007$). That is, these students met criteria for NSA at the beginning of the semester, but failed to meet criteria at the end of the semester. Significantly more female (McNemar's test, $p=.022$), Caucasian ($p=.012$), and second-year ($p=.031$) students, along with psychology majors ($p=.012$), who previously met criteria for NSA, failed to do so at the end of the semester.

DISCUSSION

Neuroscience anxiety is significantly reduced after participation in an introductory course in neuroscience.

As hypothesized, neuroscience anxiety was significantly reduced after students participated in a one-semester introductory neuroscience course. In general, all demographic groups exhibited reductions in neuroscience

	Neuroscience Anxiety			Science Anxiety (SA)			Non-Science Anxiety (NSA)	
	n	Pretest M(SD)	Posttest M(SD)	n	Pretest M(SD)	Posttest M(SD)	Pretest M(SD)	Posttest M(SD)
All Students	79	11.3(3.4)	9.2(2.7)*	32	49.4(16.3)	45.2(14.9)	45.2(13.3)	42.8(11.4)
Female	65	11.6(3.3)	9.2(2.3)*	25	50.2(16.3)	46.0(14.6)	45.6(14.2)	43.6(10.8)
Male	14	10.1(3.7)	9.1(4.2)	7	46.6(17.0)	42.4(17.1)	43.9(10.3)	39.9(14.0)
Caucasian	53	10.9(3.0)	9.2(2.4)*	22	48.2(17.1)	41.8(12.0)*	41.7(11.7)	41.6(9.0)*
African American	4	12.5(5.2)	10.5(4.5)	3	57.0(8.9)	55.3(16.0)	48.3(10.1)	50.3(14.6)
Native American	9	10.9(5.0)	9.3(3.6)	2	55.0(18.4)	48.0(25.5)	51.0(7.1)	36.0(12.7)
Hispanic	10	12.8(3.2)	9.5(2.0)*	4	53.0(14.7)	58.5(20.4)	48.0(24.0)	46.8(21.3)
Other Ethnicity	3	13.0(1.0)	7.0(4.4)	1	26.0(-)	31.0(-)	23.0(-)	44.0(-)
Psychology Major	61	11.7(3.0)	9.5(2.6)*	22	48.6(17.2)	44.6(13.8)	42.8(12.9)	41.9(10.7)
Other Major	18	9.9(4.4)	8.2(2.9)*	10	51.0(14.5)	46.4(17.9)	50.5(13.3)	44.7(13.3)
First year	3	10.0(2.7)	8.0(3.0)	0	-	-	-	-
Second year	21	12.0(2.3)	9.3(1.8)*	13	47.9(16.4)	42.5(13.6)*	46.1(15.1)	42.2(12.3)*
Third year	35	11.5(3.8)	9.5(2.8)*	10	56.8(14.7)	55.5(16.3)	49.0(12.1)	46.5(13.9)
Fourth year	16	10.3(4.1)	8.7(2.4)	7	43.3(15.8)	37.3(9.0)	40.3(9.9)	38.0(5.4)
More than 4 years	4	12.0(2.2)	9.5(6.1)	2	43.0(24.0)	39.0(11.3)	37.5(20.5)	44.5(0.7)

Table 1. Neuroscience, science and non-science anxiety scores by gender, ethnicity, major, and year in college across two time points.

* $p < .05$, repeated measures ANOVA; significant reduction from pretest.

Note: Neuroscience anxiety scores from the SAS; science and non-science anxiety scores from the SAQ. SA and NSA scores represent severity of anxiety.

	Pretest			Posttest		
	GA % of all students (n)	NSA % of GA students (n)	SA % of GA students (n)	GA % of all students (n)	NSA % of GA students (n)	SA % of GA students (n)
All Students (N=32)	81.3 (26)	73.1 (19)	92.3 (24)	71.9 (23)	34.8 (8)*	82.6 (19)
Female (N=25)	88.0 (22)	72.7 (16)	90.9 (20)	76.0 (19)*	36.8 (7)*	84.2 (16)
Male (N=7)	57.1 (4)	75.0 (3)	100.0 (4)	57.1 (4)	25.0 (1)	75.0 (3)
Caucasian (N=22)	81.8 (18)	72.2 (13)	88.9 (16)	68.2 (15)	26.7 (4)*	80.0 (12)
African American (N=3)	100.0 (3)	100.0 (3)	100.0 (3)	100.0 (3)	66.7 (2)	100.0 (3)
Native American (N=2)	50.0 (1)	100.0 (1)	100.0 (1)	50.0 (1)	-	100.0 (1)
Hispanic (N=4)	100.0 (4)	50.0 (2)	100.0 (4)	75.0 (3)	33.3 (1)	100.0 (3)
Other Ethnicity (N=1)	-	-	-	100.0 (1)	100.0 (1)	-
Psychology Major (N=22)	81.8 (18)	66.7 (12)	88.9 (16)	68.2 (15)	20.0 (3)*	86.7 (13)
Other Major (N=10)	80.0 (8)	87.5 (7)	100.0 (8)	80.0 (8)	62.5 (5)	75.0 (6)
Second year (N=13)	84.6 (11)	72.7 (8)	90.9 (10)	69.2 (9)	22.2 (2)*	88.9 (8)
Third year (N=10)	90.0 (9)	66.7 (6)	100.0 (9)	70.0 (7)	57.1 (4)	100.0 (7)
Fourth year (N=7)	71.4 (5)	80.0 (4)	80.0 (4)	71.4 (5)	20.0 (1)	80.0 (4)
More than 4 years (N=2)	50.0 (1)	100.0 (1)	100.0 (1)	100.0 (2)	50.0 (1)	-

Table 2. Percent General Anxiety, Non-Science Anxiety, and Science Anxiety Distribution at Pretest and Posttest as determined by the Science Anxiety Questionnaire.

* $p < .05$, McNemar's Test. Indicates significant reduction in proportion of students in this category at posttest.

Note: SAQ administered to fall 2010 cohort only. GA: General Anxiety, students answered any of the 44 SAQ questions "much" or "very much"; NSA: Non-Science Anxiety, students answered any of the 22 SAQ non-science anxiety questions "much" or "very much"; SA: Science Anxiety, students answered any of the 22 SAQ science anxiety questions "much" or "very much."

anxiety during the course, with significant reductions among female, Caucasian, Hispanic, second- and third-year students, regardless of major (psychology or collapsed "other" category, including biology, art, business, engineering, and several other majors in the social sciences). Overall, 75% ($n=59$) of students experienced decreases in SAS neuroscience scores (ranging from -12 to -1 points), 15% ($n=12$) had no change, and only 10% ($n=8$) experienced increases (ranging from +1 to +4 points). This study presents the first measurement of neuroscience-specific anxiety among students, and demonstrates that neuroscience anxiety decreases after

participation in an introductory course.

In physics courses, Udo et al. (2001) suggested that participation in the courses themselves, and particularly in those with interactive components, was beneficial in reducing anxiety. Okebukola and Jegede (1989) attributed reduced anxiety in biology courses to improved understanding of biology content. Although not directly tested in this study, participation and improved understanding of the content during the course likely contributed to reduced neuroscience anxiety.

The results of this study suggest that female students experienced reduced neuroscience anxiety, in the absence

of reduced science anxiety or non-science anxiety, although significantly fewer female students met criteria for GA or NSA at the end of the course. Previous research suggests that female college students have higher levels of science anxiety, but findings are inconsistent. Mallow (1994) reported higher levels of science-associated anxiety in female college students, however Brownlow et al. (2000) found no significant difference in science anxiety between male and female students. Neither of these studies assessed changes in science-related anxiety after participation in the science course. However, our results suggest that females can have reduced neuroscience anxiety following participation in a class, regardless of changes in science anxiety.

Although not directly tested, the use of interactive teaching may be important in reducing neuroscience anxiety. During the course, interactive teaching strategies included assignments to create physical models of neurons, dissect sheep brains, and discuss neuroscience topics in groups. Previous research suggests that positive role modeling and interactive teaching are important factors in reducing anxiety in math and science classes (Okebukola, 1986; Okebukola and Jegede, 1989; Udo et al., 2001). Interestingly, in a physics course, science anxiety was selectively reduced among female students in a class taught by female professor who employed interactive teaching strategies (Udo et al., 2001). The role of the female faculty member may have contributed to selective reductions in neuroscience anxiety among female students in the present study.

Research further suggests that ethnicity is an important factor in science anxiety in college students. Greenburg and Mallow (1982) and Mallow (1994) suggested that minority groups experience increased levels of science anxiety. While Caucasian students experienced reductions in severity of non-science, science, and neuroscience anxiety, it is important to note that Hispanic students selectively experienced reductions in neuroscience anxiety in the present study. Selective reductions in neuroscience anxiety among Hispanic students occurred in the absence of reductions in GA, SA or NSA. One semester of participation in the neuroscience course appears to be an effective way of selectively reducing neuroscience anxiety for both Hispanic and Caucasian students, although caution should be used in interpreting the results of this small sample size ($n=10$ Hispanic students).

Many studies have investigated the role of stereotype threat in academic performance among women and members of ethnic minority groups (Steele et al., 2002). Stereotype threat can undermine academic performance though underachievement consistent with widely held stereotypes (e.g. the belief that women and members of ethnic minority groups perform poorly in the sciences). In the case of stereotype threat, poor performance occurs even when other background factors, such as academic preparation or socioeconomic status, are controlled. Anxiety about performance in situations invoking stereotype threat mediates academic performance among groups subject to stereotype threat (Osborne, 2001; Steele et al., 2002). The role of stereotype threat in neuroscience

anxiety and academic performance remains to be investigated.

Reduced neuroscience anxiety is correlated with positive student outcomes.

In the present study, reduced neuroscience anxiety was associated with positive outcomes for students in the form of higher final grades. In particular, Hispanic and male students, along with psychology majors, benefited most from reduced neuroscience anxiety. In particular, the strong negative correlation between final grade and SAS reduction among Hispanic students ($r = -.673$, $p = .016$) was notable. Among students in this demographic group, reduction in SAS score ranged from 0 to -12 points and the mean final grade was $85.8 \pm 10.1\%$. Among this demographic group in particular, reducing neuroscience anxiety may be a critical component for student success in neuroscience classes.

Neuroscience anxiety is a unique subtype of anxiety and distinct from general anxiety and non-science anxiety experienced by students.

Neuroscience anxiety was reduced in the absence of reductions in science and non-science anxiety. There was no correlation between neuroscience anxiety score reductions and SA or NSA score reductions. Together with the results of correlation analyses indicating that changes in neuroscience anxiety were not correlated with changes in science anxiety, we suggest that neuroscience anxiety reduction is distinct from changes in general anxiety or science anxiety experienced by students, and may be a novel subtype of anxiety.

Although GA and SA were prevalent (over 80% of students met criteria for GA at the beginning of the course; 92% of those also met criteria for SA), the proportion of students experiencing GA was only reduced among female students. The proportion of students who experienced SA did not decrease during the study, and the severity of SA was selectively reduced among Caucasian and second-year students only. In contrast, 75% of students experienced reduced neuroscience anxiety and the cohort as a whole, as well as female, Caucasian, Hispanic, psychology major, other major, second- and third-year students all experienced reduced neuroscience anxiety.

Limitations

In the future, this research should be extended to address the likely influence of teaching style and/or classroom management techniques on neuroscience anxiety. Furthermore, the generalizability of these findings is limited. Future research should also examine reductions in neuroscience anxiety across multiple sections and instructors.

Although not directly tested, benefits of reduced neuroscience anxiety could be enhanced with additional interventions. For instance, studies that reported reduced anxiety in other math or science disciplines have employed various teaching strategies as interventions to actively reduce anxiety. Students reported that reassurance from teachers that the students could successfully complete

assignments, positive attitudes from teachers, teachers' improvement of students' perceived worth of the topic, and encouragement from teachers were all helpful in reducing anxiety. Students also reported that open book/open note tests and working with a partner in class were helpful in reducing anxiety (for reviews, see Onwuegbuzie and Wilson, 2003). Although several interactive strategies were used in the present course (e.g., creating physical models of neurons, dissecting sheep brains, discussing neuroscience topics in groups and completing group assignments), the inclusion of additional interventions could further reduce neuroscience anxiety among college students.

SAQ data collection was limited to approximately 40% of the present sample due to practical considerations of data collection, which resulted in small sample sizes for some studied demographic groups. Cautious interpretation of this data is advised. Furthermore, it will be important to continue to validate neuroscience anxiety by comparing it to other indices of student anxiety.

Conclusion

In conclusion, this study demonstrates that neuroscience anxiety is significantly reduced after participation in a one-semester introductory neuroscience course. Secondly, reduced neuroscience anxiety is associated with positive student outcomes. Finally, neuroscience anxiety may be a unique subtype of anxiety experienced by students.

Reducing neuroscience anxiety by participating in an introductory neuroscience course could lead to increased student enrollment and minimize avoidance of additional neuroscience courses. It might also be beneficial to include neuroscience content in introductory psychology or biology courses requiring student participation. Future studies employing interventions to reduce neuroscience anxiety are recommended as more neuroscience courses are offered nationwide and larger numbers of students take neuroscience courses to meet degree program requirements.

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ADDITIONAL MATERIALS

Modified Science Anxiety Survey (after Fraser et al., 1983)

The words below could describe how you feel about neuroscience. Read through the list of words and select those which describe how you generally feel about neuroscience. You may select as many or as few as you wish.

1. Absorbed
2. **Afraid**
3. Aimless
4. Ambitious
5. Annoyed
6. *Aware*
7. Bored
8. *Calm*
9. Careless
10. Cautious
11. Challenged
12. Cheated
13. *Cheerful*
14. Comfortable
15. Confused
16. *Contented*
17. Creative
18. Curious
19. Dedicated
20. **Desperate**
21. Disappointed
22. Efficient
23. Entertained
24. Excited
25. **Fearful**
26. Fortunate
27. **Frightened**
28. *Happy*
29. Hopeless
30. Impatient
31. Incapable
32. Inspired
33. Interested
34. *Joyful*
35. Lazy
36. *Loving*
37. Miserable
38. Misplaced
39. **Nervous**
40. Organized
41. Overloaded
42. **Panicky**
43. *Pleasant*
44. Pleased
45. Productive
46. Pushed
47. Refreshed
48. Regretful
49. Rewarded
50. Satisfied
51. *Secure*
52. Serious
53. **Shaky**
54. *Steady*
55. **Tense**
56. **Terrified**
57. *Thoughtful*
58. **Upset**
59. Weary
60. **Worried**

Note: Eleven of the key words associated with the experience of neuroscience anxiety (in **bold**) were scored with one point if they were chosen and zero if they were not chosen. Ten words that were associated with enjoyment and comfort with neuroscience (in *italics*) were scored with zero points if chosen and one point if they were not chosen.

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