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## Factors Impacting Student Success in a Graduate Neuroscience Course

### Abstract

The purpose of this study was to investigate the perceived factors that occupational and physical therapy graduate students believed led to success in a clinical neuroscience course. A cross-sectional survey design was utilized from a convenience sample of Occupational Therapy Doctorate (OTD) and Doctor of Physical Therapy (DPT) students. There were 76 (42%) responses collected, comprised of 62 (82%) OTD students and 14 (18%) DPT students. Descriptive statistics were used to analyze all survey results. Results indicated that success in a graduate neuroscience course may be supported with prior science coursework. Success in a graduate neuroscience course may be supported with additional resources such as a tutor, visuals, and other supplementary materials. Occupational therapy programs may consider supporting a neuroscience course with additional resources in order to facilitate student success.

### Keywords

Neuroscience education, academic performance, occupational therapy and physical therapy graduate education, student supports

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## Factors Impacting Student Success in a Graduate Neuroscience Course

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### ABSTRACT

The purpose of this study was to investigate the perceived factors that occupational and physical therapy graduate students believed led to success in a clinical neuroscience course. A cross-sectional survey design was utilized from a convenience sample of Occupational Therapy Doctorate (OTD) and Doctor of Physical Therapy (DPT) students. There were 76 (42%) responses collected, comprised of 62 (82%) OTD students and 14 (18%) DPT students. Descriptive statistics were used to analyze all survey results. Results indicated that success in a graduate neuroscience course may be supported with prior science coursework. Success in a graduate neuroscience course may be supported with additional resources such as a tutor, visuals, and other supplementary materials. Occupational therapy programs may consider supporting a neuroscience course with additional resources in order to facilitate student success.

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### Introduction

Occupational therapists (OT) and physical therapists (PT) use neuroscience knowledge as the basis for understanding the nervous system, sensory processing, movement, pain, and clinical diagnoses that impact the nervous system (Lundy-Ekman, 2013). Neurological disorders are among the world's largest causes of disability (Feigin et al., 2019). Common neurological disorders that OTs and PTs treat include acquired brain injuries, cerebral vascular accidents, infectious neurological disorders, and degenerative neurological disorders such as multiple sclerosis, Parkinson's disease, and dementia (Feigin et al., 2019). These conditions impact occupational function in a variety of ways and are encountered across practice settings (Nicholson et al., 2020). Neurological disorders negatively impact an individual's physical and psychological health and wellbeing, occupational performance, and participation and cause negative impacts on the individual's quality of life (Feigin et al., 2019; Nicholson et al., 2020). Therapists use neuroscience knowledge to successfully apply advanced neurorehabilitation techniques

in practice (Ross et al., 2016). Curricular standards for OT and PT programs require foundational science courses such as neuroscience to be included in graduate programs (Accreditation Council for Occupational Therapy Education, 2018; Commission on Accreditation in Physical Therapy Education, 2017).

When students have difficulty understanding basic neuroscience concepts, this may present as a lack of confidence when working with clients with neurological disorders (Zinchuk et al., 2010). It is essential for rehabilitative professionals to be competent and confident addressing the needs of clients with a variety of neurological diagnoses across settings (Feigin et al., 2019; Rao, 2012). Neuroscience coursework is often identified as challenging content for students to master due to its abstract nature and the complexity of the subject matter (Myers et al., 2013; Shelley et al., 2018; Zinchuk et al., 2010). Medical students have reported negative perceptions and beliefs towards neuroscience education including feelings of intimidation, anxiety, and dislike towards the subject matter (Shelley et al., 2018). These negative feelings towards neuroscience can lead to difficulty applying basic science knowledge learned in neuroscience courses in clinical scenarios (Shelley et al., 2018). A poor understanding of foundational neuroscience knowledge can have a negative impact on the student's performance in other classes or clinical experiences when working with neurological disorders and neurological symptom manifestation (Merlin et al., 2014).

Successful OT and PT students must draw upon knowledge learned in prerequisite courses in graduate school. Neuroscience and the study of brain functioning is a blend of basic biology, chemistry, and psychology which often requires previous knowledge and coursework (Schneider et al., 2013). Program requirements are outlined in order to identify candidates who meet the minimum standards and will most likely succeed in their educational program and the profession as a whole (Bowyer et al., 2018; Lysaght et al., 2009; Nuciforo et al., 2014; Thew & Harkness, 2017). The PT literature supported the grade point average (GPA) earned in science classes as a positive predictive factor of student success within a PT program (Fell et al., 2015; Nuciforo et al., 2014). In the OT literature, the science GPA has not been well researched and previous science background was not found to be predictive of success (Lysaght et al., 2009; Thew & Harkness, 2017).

Student academic success in a graduate OT or PT program is important both for the students to do well in subsequent coursework and for the program as a whole. Students reported having academic difficulty in their first semester of graduate school due to difficulties adjusting to the pace, volume, and rigor of course work found in their programs (Dunn et al., 2019; Noonan et al., 2012). Neuroscience classes are often offered at the beginning of the therapy curriculum. These factors compounded with the difficult subject matter make neuroscience coursework challenging for many OT and PT students. Increased critical thinking skills, collaboration, professional role identification, and facilitating respect between the professions are all benefits reported from OT and PT student shared learning experiences (Bondoc & Wall, 2015). The purpose of this study was to investigate the perceived factors that OT and PT graduate students believed led to success in a clinical neuroscience course.

## Methods

### Development of the Survey

A cross-sectional survey design was used to investigate the influences of student success in a graduate clinical neuroscience course. Authors who had experience with survey design developed the survey. A small group of eight OT and PT students pilot tested the survey to ensure clarity and understanding of the questions and the survey was modified based on feedback received. Two questions were modified based on pilot testing. The 11-question survey inquired about students' previous academic history including undergraduate field of study and GPA. The survey also inquired about overall performance in the offered graduate clinical neuroscience course, as well as the supports utilized, study habits, and resources. The questions were multiple choice and free response format was also provided. The survey had three open-ended questions asking about study resources, struggles that they had encountered in the course, and perceived beneficial resources. To ensure the face/content validity of the survey instrument, an OT faculty member who is considered an expert in teaching neuroscience, reviewed and provided recommendations for the revision.

A letter of informed consent was sent with the email link to the survey, and participants were asked to provide their consent to continue to the survey link. Participants had the option to opt out of individual questions. Thus, there was no risk in participating in this research. Approval for this research was received from the university's Institutional Review Board. A copy of the survey can be found in the Appendix.

### Participants

A convenience sample for this survey was obtained from a southern private university that offers an Occupational Therapy Doctorate (OTD) and a Doctor of Physical Therapy (DPT) program. The sample was obtained from both OT and PT students that had taken the class at the same time and had the same experience with the instructor and course content. Within both the OTD and DPT programs, clinical neuroscience was offered in the fall semester of the first year. The course is taught to the PT and OT students simultaneously in a face to face format and the student learning objectives are assessed through tests and case-based written assignments.

### Survey Administration

The web-based survey was administered through the university's email system to all students in the OTD and DPT programs that completed the clinical neuroscience course. The survey was sent to 179 students: 91 OT students and 88 PT students across three cohorts. The survey was sent on two separate occasions, March 26, 2020 and April 16, 2020 to encourage a higher response rate. During the study data collection period, all courses were held virtually due to the COVID 19 pandemic. The clinical neuroscience course was held in person prior to COVID 19. A link to the Qualtrics survey was included in the email with informed consent. Participation to complete the survey was voluntary and the option not to respond to individual questions was provided.

## Data Analysis

This was a survey based descriptive study that used a convenience sample. No sample size calculation or power calculations were performed prior to undertaking the study. Raw survey data were extracted from the Qualtrics site at the end of the survey period. All responses in the survey were participant self-report. Descriptive statistics were used to analyze all survey results. A Mann Whitney U test was applied to the unpaired mean grade score data. Statistical significance was set to  $< 0.05$ . Free responses were reviewed by authors independently and organized into concepts of similar or same responses. Similar concepts were compared by the authors, discussed and revised until agreement was achieved to identify categories.

## Results

The survey was sent out to a total of 179 students and 76 (42%) responded, comprised of 62 (82%) OTD students and 14 (18%) DPT students. Participant demographics are found in Table 1.

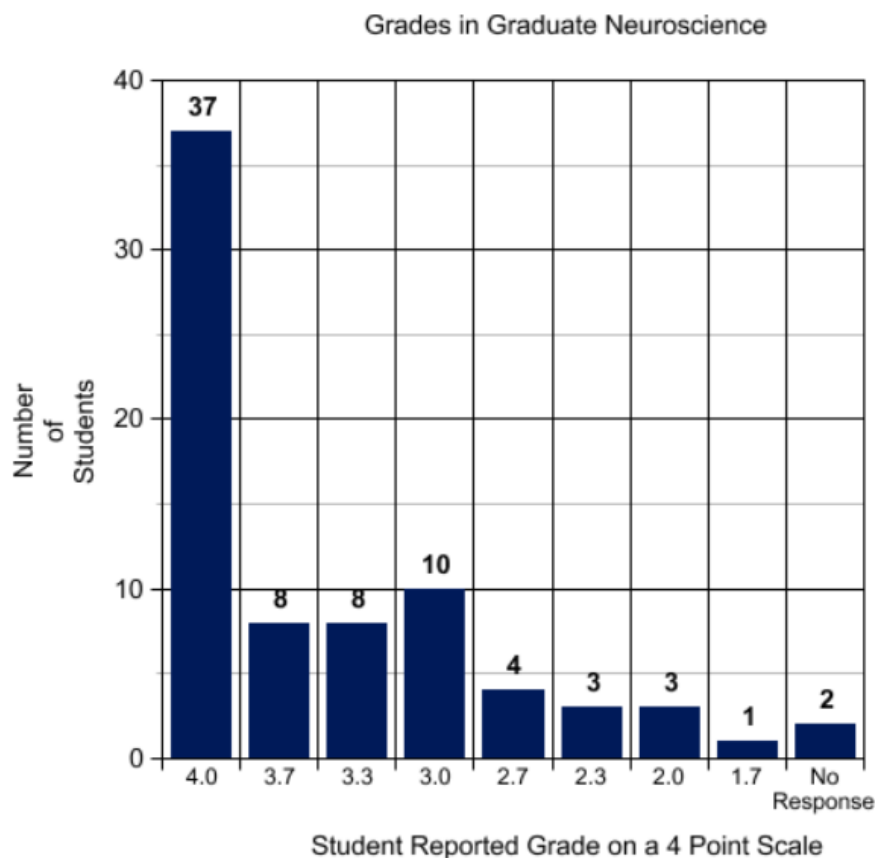
**Table 1**

<i>Previous Undergraduate Educational Background</i>		
<b>Program Enrollment</b>	<b>Percentage</b>	<b>Total Number of Responses</b>
Occupational Therapy	82%	62
Physical Therapy	18%	14
<b>Undergraduate Degree</b>		
Exercise Science	30%	23
Psychology	17%	13
Health Science	13%	10
Allied Health & Public Health	12%	9
Biology	8%	6
Other	15%	11
No Response	5%	4
<b>Number of Undergraduate Science Courses Taken Prior to Graduate School</b>		
3-5 courses	30%	23
6-10 courses	36%	27
11-15 courses	16%	12
16-20 courses	7%	5
Over 20 courses	10%	8
No Response	1%	1
<b>Undergraduate Cumulative Grade Point Average</b>		
3.0 – 3.3	30%	23
3.4 – 3.7	53%	40
3.8 – 4.0	10%	8
No Response	7%	5
<b>Undergraduate Prerequisite Grade Point Average</b>		
3.0 – 3.3	17%	13
3.4 – 3.7	39%	30
3.8 – 4.0	12%	9
No Response	32%	24
<b>Total</b>	<b>100%</b>	<b>76</b>

Students reported their final grade in the graduate neuroscience course on a four-point scale. Forty-five (59%) students reported their grade in graduate neuroscience as 4.0 - 3.7, 22 (29%) as 3.3 - 2.7, 7 (9%) as 2.3 - 1.7 and 2 (3%) did not respond. Specific grade breakdown is in Figure 1.

**Figure 1**

*Grades in Graduate Neuroscience*



Forty-eight (63%) students indicated understanding course content to be a struggle, 34 (45%) indicated struggles with time management with other courses, 27 (36%) students indicated having difficulty finding supplementary resources to understand course content, and 16 (21%) indicated *other*. Students were asked about other study strategies used in the graduate neuroscience course as shown in Table 2.

**Table 2**

*Student Reported Study Methods in Graduate Neuroscience*

<b>Hours a Week Spent Studying</b>	<b>Percentage</b>	<b>Total Number of Responses</b>
0-2 hours	4%	3
3-4 hours	36%	27
5-7 hours	33%	25
Over 8 hours	26%	20
No Response	1%	1
<b>Total</b>	<b>100%</b>	<b>76</b>
<b>Tutor Use</b>		
Once a week	36%	27
2-3 times a week	24%	18
Once before exams	13%	10
Did not use tutors	10%	8
<i>Other</i>	16%	12
No Response	1%	1
<b>Total</b>	<b>100%</b>	<b>76</b>
<b>Study Strategies</b>		
Utilization of guiding questions	89%	68
Use of tutor	82%	62
Studying with a friend or small group	72%	55
Rewriting class notes	45%	34
Use of concept maps	17%	17
<i>Other</i>	16%	12
Private tutor	1%	1
No Response	1%	1

When the mean reported grade in the graduate neuroscience course was compared between the OTD and DPT students there was a statistically significant difference present. A Mann Whitney U test was applied to the unpaired 2 sample data. The z-score is -1.78604. The *p*-value is .037. The result is statistically significant at  $p < .05$ . Mean OTD grade in graduate neuroscience was 88.65 ( $sd=6.73$ ) and mean DPT grade was 93.21 ( $sd=5.66$ ) as represented in Table 3. These results should be interpreted with caution due to the small sample size of the DPT students.

**Table 3**

*Mean Grade in Graduate Neuroscience*

	<b>Occupational Therapy Students</b>	<b>Physical Therapy Students</b>
Mean	88.65	93.21
Standard Deviation	6.73	5.66
Total	60	14



### **Free Text Responses Regarding the Graduate Neuroscience Course**

Students were asked about specific struggles they experienced in the graduate neuroscience course in an open-ended question. The students indicated challenges identifying important information from the lecture content, study techniques for an essay style exam, and accessing tutoring appointments.

When asked about studying strategies used in the graduate neuroscience course, the *other* free text responses in this question included students relistening to recorded lectures, using videos found online, and studying the PowerPoint lecture material. The students also provided responses regarding what they believed would be beneficial for future student success in the neuroscience course. Online videos that supplemented the lectures, more 3-D models, and providing case examples of neurological deficits seen by clinicians would enhance student performance.

### **Discussion**

The purpose of this study was to investigate the perceived factors that OT and PT graduate students believed led to success in a clinical neuroscience course. Eighty-two percent of students in this study identified tutoring as a student support in the graduate clinical neuroscience course. This is consistent with a study by Owens et al. (2014) who examined DPT student perceptions regarding tutoring and found 75% (n=12) of students utilized tutoring during their first semester of their DPT program. Peer tutoring provided many benefits to students that included a supportive environment for learning; a different point of view, clarification, and additional feedback on concepts covered in lecture; motivation to learn difficult concepts; enhanced understanding of the learning process; and development of study habits (Agius et al., 2018; Dioso-Henson, 2012; Grillo & Leist, 2013; Stigmar, 2016). A study with DPT students in a graduate anatomy course found that students perceived weekly peer tutoring sessions improved their grades on quizzes and written practical exams (Youdas et al., 2008).

Over sixty percent of the students in this study indicated that understanding course content was a struggle. Neurophobia is described as a student's negative perception and beliefs associated with neurological education (Shelley et al., 2018; Zinchuk et al., 2010). According to Zinchuk et al. (2010) insufficient teaching and poor integration of foundational neuroscience into clinical knowledge often influences students' perception of neuroscience content. There are multiple ways to bridge the gap in understanding and enhance students' confidence while learning the course material such as providing supplementary material. Thirty six percent of students in this study indicated difficulty finding appropriate supplementary resources to understand course content. Students also indicated a need for additional supplementary videos that were reflective of the course content in the free text responses. Dynamic visual displays such as videos are intended to aid learners in processing complex information into long term memory for later use and application, aiding in the learning process as a whole (Mayer, 2013). Videos can provide students the opportunity to work at their own desired pace and timeframe (Berg et al., 2014; Emanuel, 2020; Giles et al., 2018). Students indicated

several perceived benefits of using videos as supplemental materials such as being able to review videos multiple times, pausing to take notes, and speeding them up or down (Berg et al., 2014; Emanuel, 2020; Giles et al., 2018; Miner & Stefanik, 2018).

While students reported benefits of videos to their learning, students indicated they felt videos were to be used as a supplement to course material to enhance understanding rather than a replacement of a face-to-face lecture (Berg et al., 2014). O’Keeffe et al. (2017) found that 90% of undergraduate neuroscience students felt that it was beneficial to have traditional lectures in spite of advances in technology and e-learning. While students in the aforementioned studies confirmed the value of videos to supplement their knowledge, they did not see videos as a replacement for lecture instruction. This supports the use of traditional lecture to provide course content and the use of dynamic visual displays to enhance learning and highlight specific topics covered in the course.

In this study, the DPT science prerequisites for admission included 10 undergraduate science courses while the OTD prerequisite requirements for admission included three undergraduate science courses. Undergraduate science courses are defined as biology, genetics, natural science, chemistry, physics, and exercise science courses. This indicated that DPT students may have had a better basic science background and easier transition into graduate neuroscience as reflected in the difference in mean graduate neuroscience grade. The unpaired t-test indicated a statistically significant ( $p < 0.05$ ) difference in mean final grade in graduate neuroscience when comparing OTD and DPT students. Results from our study should be interpreted with caution due to the limited number of DPT students in this sample. However, this may have highlighted differences in prerequisite admission factors for OTD and DPT programs to be addressed in further studies. Admission requirements and prerequisite courses are not standardized and vary for every OT and PT graduate program in the United States (Bowyer et al., 2018; Lysaght et al., 2009; Nuciforo et al., 2014; Thew & Harkness, 2017). Physical therapy graduate admission committees may have placed a greater emphasis on applicants with a high science prerequisite GPA, and admit these applicants into their graduate programs (Nuciforo et al., 2014). Meanwhile, OT graduate programs tend to have emphasized diversity of applicants, noncognitive admission factors such as letters of recommendation and interviews, and cumulative undergraduate GPA (Bowyer et al., 2018; Lysaght et al., 2009; Thew & Harkness, 2017). Occupational therapy graduate programs may have a reduced number of prerequisite courses to increase and diversify the applicant pool (Lysaght et al., 2009; Thew & Harkness, 2017). This leads to a diverse cohort of students with diverse problem-solving skills to serve in a variety of practice areas as OT practitioners (Lysaght et al., 2009).

### **Limitations**

Limitations of this study included self-report bias and lack of generalizability. Students were asked to voluntarily submit their answers to the survey. The survey results represented the top grades in the class; the majority of responses were from students who received an A or B in the graduate neuroscience course. Students may not have accurately reported their grade and this is a major limitation. Thus, this study did not

represent the students who received a lesser grade in the course who did not complete the survey. Students that received a grade of C or lower, most likely had a different set of challenges and perceptions regarding the graduate neuroscience course. The study was limited in its generalizability due to taking place at a single, private university and a small sample size for the PT students. Another bias is the fact that one author also served as a peer tutor for the graduate neuroscience course and the other authors were faculty at the university. To mitigate bias all results were anonymous with no identifying information collected. Finally, because the survey was conducted when the course was interrupted by COVID-19 and switched from in person to online learning, the students' perception could have changed if the class was either conducted only in person or online.

### **Future Research**

It would be worthwhile to determine how different teaching strategies such as team-based learning or project-based learning impact the graduate neuroscience grade. Additionally, it would be interesting to compare the student perceived factors by age group to determine if younger students have different perceptions than older students. It would also be important to quantify neurophobia and its impact on learning. Finally, comparing student perceptions of barriers and supports of learning neuroscience content through online delivery and in person delivery would be informative for curricular development.

### **Implications for Occupational Therapy Education**

Educators should have an awareness that the majority of graduate therapy students in this study struggled with neuroscience course content. Supporting students with supplementary materials and tutoring that complement course content can benefit the students' understanding and application of the learned materials. Videos provided as supplementary material can provide a more robust educational experience for students and allow educators to create supplementary materials for their course with a personal touch (Sandrone & Schneider, 2020). Miner and Stefanik (2018) indicated that educators perceived numerous advantages to the use of videos as a supplement to course materials validating the time and effort to be allocated to the development of these resources. Thompson et al. (2011) suggested that additional course materials allow students to be more engaged in the learning process through self-directed learning opportunities promoting a greater understanding of difficult neuroscience concepts.

Tutors may assist in the students' understanding of the neuroscience course content along with providing other benefits to the student (Agius et al., 2018; Dioso-Henson, 2012; Grillo & Leist, 2013; Stigmar, 2016). Tutors can streamline course content and provide structure, motivation, and accountability for students as they navigate difficult course content (Owens et al., 2014). Tutoring may also benefit students with different learning styles than what is presented in the course (Owens et al., 2014).

Additionally, OT educators may consider adding more science prerequisite courses to ensure OT students are prepared to take on the required science courses in the curriculum. If OT students are learning concurrently with PT students, it is important to recognize the difference in prerequisite preparation for a graduate neuroscience course and provide appropriate scaffolding techniques.

### Conclusion

Success in a neuroscience course may be supported with additional resources such as a tutor, visuals and other supplementary materials. Occupational therapy programs may consider implementing a neuroscience course that provides additional resources in order to facilitate success.

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## Appendix

1. What program are you in at the university?
  - a. Occupational Therapy
  - b. Physical Therapy
  - c. Prefer not to answer
  
2. What was your undergraduate degree?
  - a. Fill in the blankIf you prefer not to answer, indicate N/A in the space below
  
3. How many science classes did you take in your undergraduate degree? Science classes are defined those specific to: biology, genetics, natural science, chemistry, physics, and exercise science.
  - a. 3-5 classes
  - b. 6-10 classes
  - c. 11-15 classes
  - d. 16-20 classes
  - e. Over 20 classes
  - f. Prefer not to answer
  
4. What was your overall undergraduate GPA on a 4-point scale?
  - a. Fill in the blankIf you prefer not to answer, indicate N/A in the space below
  
5. What was your pre-requisite GPA on a 4-point scale?
  - a. Fill in the blankIf you prefer not to answer, indicate N/A in the space below
  
6. What was your overall grade in Clinical Neuroscience at the university?
  - a. A+
  - b. A
  - c. A-
  - d. B+
  - e. B
  - f. B-
  - g. C+
  - h. C
  - i. C-
  - j. Prefer not to answer

7. What specific struggles did you have in Clinical Neuroscience? (choose all that apply)
  - a. Understanding the course content
  - b. Time management with other courses
  - c. Finding supplementary resources to understand course content
  - d. Pulling out important information from lecture content
  - e. Other (fill in the blank)
  - f. Prefer not to answer
  
8. How did you study for Clinical Neuroscience class? (choose all that apply)
  - a. Study the guiding questions
  - b. Rewrite class notes
  - c. Study with a friend or small group
  - d. Make a concept map
  - e. Go see the Neuro graduate assistant/tutor
  - f. Working with a private tutor
  - g. Other (fill in the blank)
  - h. Prefer not to answer
  
9. How many hours a week did you spend studying for the Clinical Neuroscience class?
  - a. 0-2 hours
  - b. 3-4 hours
  - c. 5-7 hours
  - d. Over 8 hours
  - e. Prefer not to answer
  
10. How often did you use tutoring offered by the university during the semester?
  - a. Once a week
  - b. 2-3 times a week
  - c. 1 session before the exams
  - d. Did not use the tutor
  - e. Other (fill in the blank)
  - f. Prefer not to answer
  
11. What additional resources would be beneficial for student success in the Clinical Neuroscience course?
  - a. Fill in the blankIf you prefer not to answer, indicate N/A in the space below