

# HONORS AND SENIOR CAPSTONE REQUIREMENTS

## NEUROSCIENCE & COGNITIVE SCIENCE

**SCHOOL OF MIND, BRAIN AND BEHAVIOR**

### Senior Capstone for Non-Honors Students

Students who are not active in the Honors College may choose to complete a Senior Capstone project. The requirements for an NSCS Senior Capstone project are the same requirements as the Honors Prospectus and Thesis requirements listed in this document. The only difference is that students doing a Senior Capstone will enroll in NSCS 498 instead of NSCS 498H and will submit their prospectus and thesis to the NSCS Program only and not to the Honors College.

### Graduating with Honors in NSCS

1. You must meet the Honors College requirements which include:
  - completion of the required number of Honors units,
  - completion of a 6-unit Honors thesis during your final two semesters, and
  - a GPA of at least 3.5 at the time of graduation.

You are responsible for knowing and abiding by all Honors College and NSCS program requirements.

2. You must complete an Honors Thesis, the final version of which must be approved by your Faculty Advisor and the Honors College. The Honors Thesis is a research project of at least one-year duration for which there must be a prospectus, a thesis, and a formal presentation in the annual NSCS Poster Forum. The thesis project is expected to help you:
  - integrate your knowledge of neuroscience and cognitive science,
  - give you an opportunity to delve deeply into and think critically about a particular area of neuroscience and cognitive science by engaging in a sustained research project, and
  - develop an appreciation for and skill in research in the neuroscience or cognitive science field.

Your honors thesis should be a well-designed research project, guided by a faculty member, carried out by you, and typically written in the form of a manuscript such as would be submitted to a peer-reviewed journal appropriate for the area of your research. Excellent writing is expected.

If you wish to graduate with honors in two majors, you must write a thesis for each major; the theses may be related. For example, an extensive literature review on a topic may be approved for one major while completing a manuscript on your laboratory research project on the same topic could be approved for the second major. The expectation is that each thesis could stand on its own with very little overlap in content.

3. You are expected to present your work in a short presentation at the NSCS Poster Forum, which is held during the last week of regular classes in the Spring semester. This presentation will not receive a formal grade, but is required for graduation with Honors in NSCS.

## Graduate-level Courses

**Students graduating with honors in NSCS are highly encouraged to** enroll in a graduate level course (500 level) in neuroscience or cognitive science in order to obtain experience taking graduate courses. These courses usually offer a more critical and advanced approach to the topic area. If you are considering graduate school or a professional school, having done well in one or more courses at this level strongly indicates to the admissions committees that you are capable of handling graduate coursework.

The course or courses selected can be courses listed as 400/500-level, in which you would enroll in the 500-level version, or any courses listed between 500-599. You will need to obtain the instructor's permission for a 500-level course with no 400-level component.

**IMPORTANT:** According to the rules of the Honors College, you will receive Honors credit for the course **ONLY IF** you select the Honors credit option on the 500-level course petition. If you choose the graduate-credit option, you will not earn Honors credit. In addition, you must take the course(s) for a letter grade and must successfully complete the course in order to receive Honors credit.

## Thesis/Capstone Timeline

*The following timeline was created by the Honors College. NSCS-specific requirements have been incorporated. Students are responsible for checking the Honors College website for any updates to this timeline.*

<https://www.honors.arizona.edu/academic-requirements>

Completion of an Honors thesis requires preparation and planning. You will build up to your thesis throughout your years at UA by completing coursework, participating in research, engaging with faculty, and narrowing down your areas of academic and professional interest. By the end of your junior year, you should have a well-developed thesis plan that you can implement in your senior year.

Follow these basic steps when preparing for the Honors thesis:

### **Explore Your Thesis Topic**

Early in the junior year, you will begin narrowing down your focus for an Honors thesis. This may be done in several ways, including engaging in discussions with faculty. You can search the *Thesis and Dissertation database* to read former students' theses.

### **Identify a Faculty Advisor**

A Faculty Advisor is the person who will supervise your thesis and award your final grade for your thesis. NSCS students are free to work with any tenure-track faculty member on campus *as long as your thesis topic is in an area of neuroscience and/or cognitive science*. The NSCS Honors Faculty Advisor, Dr. Ulises Ricoy, can help you identify a Faculty Advisor if you have been unsuccessful in your attempts to identify one on your own.

Ideally, you will find a Faculty Advisor no later than the first semester of your junior year and conduct research in that advisor's laboratory in the second semester of junior year. The goal is to meet regularly with your advisor and develop a proposal over the course of the second semester of junior year. Students who do not follow this recommended timeline for identifying a Faculty Advisor risk missing the thesis submission deadline.

### **Submit the Honors Thesis Prospectus**

Students who are completing an Honors Thesis are required to submit an Honors Thesis Prospectus to the Honors College and to the NSCS Program by the end of semester prior to beginning the thesis. This process allows you to provide a description of your proposed thesis project and provides confirmation that a faculty member has agreed to advise your thesis. Guidelines for the prospectus are available on page 3.

### **Register for Thesis credit**

The thesis is a two-semester commitment that demands a minimum of six units of work, three units of NSCS 498H per semester, usually taken in the senior year. Students are not permitted to complete all six thesis units in a single semester. You will enroll in NSCS 498H by submitting a signed enrollment form (located on the NSCS website) to the NSCS program. You must enroll through NSCS. Do not enroll through your faculty mentor's department. Forms are due to the NSCS Program by the 14<sup>th</sup> day of the semester in which you are starting your thesis.

PLEASE NOTE: Each unit of lab credit officially requires 3 hours of work per week so enrolling for the required 3 units of honors thesis credits per semester means a minimum of 9 hours in the lab per week. This represents a minimum expectation, and often you will be expected to or need to spend more hours in the lab. You and your faculty member should discuss this up front to come to a clear, mutual understanding of the expectation for weekly lab work.

### **Engage in Your Thesis Project**

Working under the guidance of your Faculty Advisor, you will engage in a personalized research experience. Although the details of the project will vary from student to student, most will begin by writing a draft of the statement of purpose, the methodology/capstone design, and the literature review. This is generally followed by collecting data, completing data analysis, synthesizing and drawing conclusions, and revising the written version of the thesis. Your Faculty Advisor will award a grade in your first semester of thesis work based on the progress you have made up to that point. Remember to register for your next three units of thesis credit for your second semester.

### **Submit Your Thesis**

Prior to the end of the semester, you will submit your thesis to your Faculty Advisor in order to receive feedback, complete any revisions needed, and receive a final grade. Students completing an Honors Thesis must submit their final thesis to the Honors College and the NSCS program by the last day of classes before graduation. You are encouraged to plan ahead and allow yourself enough time to make any needed revisions. Once your thesis has been approved by your advisor, you will submit:

- your original signed thesis title page
- your original signed UA Library Distribution Rights form The Distribution Rights form allows the UA library to include your thesis in the *UA Thesis and Dissertation Database*. If you do not want your thesis included in the database, you should write your name on the form and write "do not release" across the page;
- an electronic copy of your thesis document to the Honors College AND to the NSCS program. All parts of the thesis, including the signed title page, the distribution rights form, the abstract and the actual

thesis, should be integrated into a single pdf file. Your thesis will be kept as part of the NSCS program archives and will also be used for program assessment.

Note that you can submit your thesis only after your degree check has been completed by the Honors College. Submission guidelines and forms can be found here: <https://www.honors.arizona.edu/thesis-submission>

## Thesis/Capstone Prospectus Guidelines

### **What is a prospectus?**

A prospectus is a short description of your proposed thesis. Your prospectus should clearly describe your thesis topic, the form your thesis will take, and how you will reach your thesis goals. For a laboratory-research-based thesis, focus on your governing questions or hypotheses, your research methods, and your theoretical or methodological framework. For a literature-review-based thesis, your prospectus should focus on the big-picture question and what specific question you seek to answer or frame.

*Important:* To undertake this research, you may be required to get permission from the Institutional Review Board (IRB) in order to ensure the protection of your subjects if your research involves experimentation, observation, or interviews with individuals or groups. Your Faculty Advisor should be prepared to guide you through the process of obtaining Human Subjects/IRB approval, which may include specific training. Sometimes it can take several months to get this permission, so plan accordingly.

### **What to include in your prospectus**

#### 1. Introduction and Specific Aims.

What is your thesis topic, and why is this topic of interest to you and to other scholars or researchers in the field? Why is the topic relevant and important? What specific question will your research or project seek to answer? You can provide detailed and specific information, as space permits, but you should always provide enough background information so that a scientist working outside your specific area of interest, or even a well-read lay reader, can understand the big picture.

You should reference some of the literature to show that you have begun to think seriously about why that question is important to answer and what key findings drive your work. If you will be working in a lab or on a literature review that is driven by work in a lab, you should describe current efforts in the lab you have chosen that specifically support your project. End this section with a list of the specific aims for your work.

#### 2. Methods.

If you will be writing a laboratory-research-based paper or doing empirical or observational research, which research methods and resources will you use? Provide enough detail so that a reader unfamiliar with the kind of work you will be doing can understand. If you will be doing a project or creative work, please describe in detail what your project work will involve, what the outcome or result will be, and how you will incorporate research-based analysis into your final product or artist statement. The goal of this section is to provide enough detail that you, and we, know how you plan to do your study.

Here's an example: "I will be using intracellular electrophysiology of glial cells in the ventral nerve cord of 3<sup>rd</sup> instar *Drosophila* to show how these cells respond to stimulation of interneurons. Interneurons will be engineered to express a channelrhodopsin so that they can be stimulated by light. I will record from the glial

cells, pulse the preparation with light, and examine in the glial cells the resulting response to neuronal activity. After recording, I will pulse the glial cells with hyperpolarizing current to fill them with a fluorescent dye, and after processing, will view them on the confocal microscope. I will then use Image J to measure branch length and number.” If there are concepts that might not be familiar to your reader but that are important to understand in order to understand your project, you should address them briefly. For example, in the methods outlined above, you might describe what a channelrhodopsin is. Figures are welcome, and may be drawn from published work as long as the legend and bibliography include the appropriate acknowledgement and reference.

If you are writing a literature review, you should include a list of references that you have consulted or plan to consult to begin your review. You and your Faculty Advisor can construct this list together. An annotated bibliography of key references would be an excellent idea.

3. Create a timeline for your work, agreed upon by you and your advisor. Also list any expected work products, such as presentations to your lab group, a poster, an abstract, and the like. Finally, note the expected frequency of meetings with your advisor.
4. Specify that you will present your research in the NSCS Honors Thesis Poster Forum (students graduating in the fall semester will need to present in the spring forum associated with the prior academic year) even though their work will not have been completed by that time. Your poster will be more of a work-in-progress report.
5. Last, specify briefly what you hope to learn or gain from the work you do to create an honors thesis.

## Thesis/Capstone Guidelines

Honors Theses are intended to be major student projects involving various types of original work. While the type of research can vary, a substantive and substantial written product is required for completion of your Honors Thesis. It is expected that you will obtain a depth of understanding within the thesis topic equivalent to a point between a large undergraduate research paper and a Master's thesis. The thesis should synthesize and build upon existing scholarship, as well as further the discipline's understanding of the subject in some way.

The thesis may take any form appropriate to your sub-discipline and approved by your Faculty Advisor (e.g. research paper, performance, video, artwork). The Honors College requires a written summary or abstract to accompany thesis work. There are no set requirements as to length, but most theses range between 40 and 60 pages, including illustrations and references. You should discuss the thesis length and other expectations with your thesis advisor prior to the start of your thesis. In addition, the University requires a minimum of 45 hours of work for each unit of credit awarded. (Remember, an Honors Thesis requires a minimum of six units divided over two or more semesters.) The content of an Honors Thesis may not significantly duplicate research you have previously produced or that you are concurrently conducting in other courses used to fulfill degree requirements at the University of Arizona.

You will work closely with a Faculty Advisor of your choosing when completing your Honors thesis. The Faculty Advisor will help you to develop a research plan, outline goals, and delineate which thesis components should be written during each of the two semesters (with the understanding that the effort put forth and the quality of work completed during each semester can receive a separate grade.) It is also the responsibility of the Faculty

Advisor to set a deadline for a draft of the thesis so you will have enough time to make any necessary changes to the final document. The Faculty Advisor may also guide you in the presentation of the final thesis during the NSCS Poster Forum.

**For a laboratory-research-based thesis**, the typical structure of the thesis should closely resemble the structure of a paper that would be submitted to a journal in the field of Neuroscience or Cognitive Science. You may refer to the *Journal of Undergraduate Neuroscience Education* (<https://www.funjournal.org/for-authors/>), where you might even consider publishing your work.

A laboratory-based thesis typically will include:

- An **Abstract**, which is a short summary of your thesis and includes a statement of the key question, the approach and significant results, and a conclusion.
- An **Introduction** that lays out the overall and specific question(s) addressed, describes why these questions are important, and provides the existing context for the question(s) in the form of a presentation of the key relevant literature; include results from your laboratory if appropriate. If figures are included from another person's work, note the source of the figure in the legend and be sure to include the reference in your bibliography.
- A **Methods** section that is detailed enough for other people to replicate the work, including the statistical analysis.
- A **Results** section that details the logic for and results of your studies. Figures are expected.
- A **Discussion** section in which you will interpret your data in the light of your results and in the context of previously published results in the literature. It will end with a statement of your conclusions and could include one or more summary figures.
- **Acknowledgments** that specify the names, affiliations, and contributions of others who were critical to your effort.
- A **Bibliography** listing your references. The Bibliography should include a list of every reference you cite. You do not need to list any references that are not cited in the main body of the thesis.

**For a literature-review-based thesis**, the typical structure of the thesis should closely resemble the structure of a review paper that would be submitted to a journal in the field of Neuroscience or Cognitive Science. You could also look at the *Journal of Undergraduate Neuroscience Education* (<https://www.funjournal.org/for-authors/>), where you might consider publishing your work. The level of the literature review is greater than that expected for an upper-division course, but it is not expected to be as comprehensive as a Master's thesis. Note the earlier discussion of page length.

The first step will be to identify a topic area with your Faculty Advisor, then do some reading with the intent of exploring the topic broadly so that you can fine-tune the topic area on which you want to focus. Your Faculty Advisor may help you identify relevant research articles or even review articles to give you an overview, or you may search on your own. You will research your specific topic in depth once you and your Faculty Advisor agree on the topic and a broad outline of the thesis. There is no set number of primary research articles or primary sources specified because this is a scholarly exploration, which you pursue until you and your Faculty Advisor believe that you have satisfactorily addressed the question you set out to examine. Your thesis may benefit from figures. You might end up making some schematic diagrams to illustrate a point or a relationship or to

make a summary of your findings. You also may include figures from papers you study that you think make particularly important points as long as you cite the source.

Your thesis will have several parts:

- An **Abstract**, which is a short summary of your thesis and includes a statement of the key question, the major findings of your review and your conclusion.
- An **Introduction** that lays out the overall and specific question(s) addressed, describes why these questions are important, and provides the existing context for the question(s) in the form of a presentation of the key relevant literature. This is an overview of that literature only.
- The **Body** of your thesis, in which you critically review, and compare and contrast the studies you have chosen.
- A **Discussion** section, in which you bring together your analysis and interpretation to address the question you raised at the outset.
- **Acknowledgments** that specify the names, affiliations, and contributions of others who were critical to your effort.
- A **Bibliography** listing your references. Every reference you refer to in the text needs to be listed in the Bibliography.

**For either type of thesis**, the format and style of the thesis should follow guidelines typical of journals in the field of Neuroscience or Cognitive Science. Your Faculty Advisor can help you in this area.

### **Thesis approval process**

You and your Faculty Advisor should agree on a process and timeline for finishing your thesis that will allow several iterations of review by your Faculty Advisor. Two to three weeks before the due date to the Honors College is typical. The rubric for evaluation of an NSCS thesis is below. You should submit your thesis in accord with the guidelines above (See “Thesis Timeline”) once your Faculty Advisor approves and signs your thesis.

## **NSCS Poster Forum**

NSCS Honors students and students completing a Senior Capstone are required to present their thesis/capstone work at the end of the spring semester because scientists are expected to be able to present and explain their work, both to colleagues and to the general public. If you are graduating in December, you will present whatever work you have completed at the time of the Spring Forum. For example, Fall 2018 graduates will present in the Spring 2018 Poster Forum.

You are expected to present a poster whether your thesis is a research-based or a literature review. Your poster should be created in accord with the standards of poster presentations at the Society for Neuroscience Meeting or the American Psychological Association Meeting. In special circumstances, a 15-minute presentation at the NSCS Poster Forum may be considered.

### **Typical poster format**

Work with your thesis/research mentor to design your poster. Follow your lab/mentor's usual protocol for printing posters. If your lab's dept does not have a poster printer, you may print at the main library or any other print shop that can do posters. Let us know if you need help finding a place. Usually the cost of printing is the responsibility of the lab or student; however, if the cost cannot be covered by your lab and is a problem for you, please let us know.

Posters have a basic format that includes introduction, background, methods, results, summary, and acknowledgements. For a poster oriented horizontally, the content is organized left to right, generally in columns. Posters for the NSCS poster forum will be up to 72" wide and 41" high. (The 41-inch dimension is constrained by the size of the large-format printers.)

Each of the sections has a role:

- Introduction: what's the big picture, why is it important – a short paragraph that is intended to set the stage, to make people understand why they should care
- Background and hypothesis/specific question: what are the key findings underlying your specific question, and what is the specific question you sought to answer in your experiments or in your review
- Methods: Whether you are doing bench studies or a literature review, you will have methods, but these should be very brief, only enough to convey what approaches you are taking. Consider schematic diagrams.
- Key findings
  - For experimental or field work, or even for design of equipment or software, you will present a series of figures tell viewers what you found. Very important here is to be sure that the logic is very clear. Use headings and number the figures to help with that. What you present here should help the viewer learn how you went about answering your question and what you found. Schematic diagrams are almost always helpful.
  - In some cases, what was done was development of a method. In that case, the poster focuses on the method.
  - For a literature review, you can, and should, use figures from the articles you analyzed (remembering to acknowledge their sources, of course) and/or use one or more schematics that you design to illustrate key findings or relationships
- Summary: this goes back to your original question. You might have a series of bullet points that list answers to your question, even if they are partial, or you might have a summary diagram, or you may have concluded that the extant studies don't allow you to answer the question so propose studies that need to be done.
- Acknowledgement and references

Key in making your poster is minimizing words, because nobody wants to stand at a poster and read lots of words. Rather approach this as if you were asked to give a talk about your topic. Use images and figures to get your ideas across. Make sure your images and text are big enough! If you have completed a literature review, you have to be really creative here because, unlike those doing bench or field work where figures are more or less generated in the course of doing the lab work, you have to assemble or make figures that convey the story, from what you asked to what you found. Whatever the source of data on your poster, think like a teacher. How do I convey these ideas?

## **The Poster Forum**

You should dress in business attire for the Poster Forum. This includes clothing articles such as suits, slacks, khakis, polos, button down shirts, dresses, skirts, blouses, etc. Plan to arrive at the Poster Forum 20-30 minutes prior to the event start time so that you have time to set up your poster.

An array of poster boards will be available at the Poster Forum. You will pin your poster onto your assigned board and be prepared to guide visitors through it. You should work with your advisor to create a presentation that is targeted to a scientifically literate audience, but not necessarily to people who intimately know the area in which you have been working. Plan to be able to guide your visitors through your poster in about 5 minutes. This means you need to focus on why the question you're asking is important, what specific question(s) you asked, very briefly how you did the study, and then explain the results and conclusions. People will ask if they want more detail. You can expect people attending the Forum to circulate around the posters, and if you have time, you can do the same.

## **Rubric for Evaluation of NSCS Honors Theses/Capstones**

### *Outstanding*

- Original idea. Could also be described as clear, clever, creative, exciting, interesting, thoughtful, engaging, surprising, persuasive
- Very well written and very well organized
- Shows mature and independent thinking
- Clearly states the problem and why it is important
- Displays strong understanding of the literature and does an excellent job reviewing it critically
- Argument is focused and logical
- Has an excellent research design
- Uses or develops new tools, methods, or approaches
- Data were acquired by the student from multiple sources or technical approaches
- Analysis is complete and convincing
- Conclusion ties the projects elements together and explores interesting issues and connections
- Merits authorship on a manuscript in a peer-reviewed journal in the discipline

### *Very good* (this is the level expected of most Honors thesis projects)

- Has some original ideas and insights, but is less clear, clever, creative, exciting, interesting, thoughtful, engaging, surprising, or persuasive than is an outstanding project. Could be described as solid
- Well written and well organized
- Carries out a significant step in a larger project
- Shows good understanding of critical elements of the literature
- Argument is strong
- Research is well executed
- Demonstrates technical competence
- Uses only one or a few approaches or gets data from a single source
- Analysis is solid
- Contributes solidly to the body of work in the lab

### *Acceptable*

- Workman-like presentation
- Demonstrates technical competence
- Shows the ability to participate in research
- Displays little creativity or thoughtfulness or insight
- Writing is pedestrian
- Structure and organization are weak
- Displays a minimal understanding of critical elements of the literature
- Underlying problem is understood only at a simple level
- Scope of the project is minimal
- Analysis is adequate but doesn't explore possibilities and connections
- Makes a small contribution to the work of the lab

### *Unacceptable*

- Is poorly written with spelling and grammatical errors
- Presentation is sloppy
- Plagiarizes or misuses literature sources
- Shows no clear understanding of the important literature
- Lacks careful thought
- Argument is unconvincing or invalid
- Data are flawed or misinterpreted
- Scope of project is too small or project is trivial
- Analysis is unsupported or exaggerated