

# PROPOSAL FOR SELF-DESIGNED MAJOR: COGNITIVE SCIENCE

## Laurie O'Neill '22

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Cognitive Science is an interdisciplinary, yet stand-alone field which investigates the cognitive processes, thought, and consciousness of all possible minds (human, animal, machine, etc.) through the study of psychology, neuroscience, philosophy, computer science, anthropology and linguistics. Therefore, given its scope, this self-designed major pulls together courses from many different departments within Muhlenberg, as well as occasionally from other LVAIC institutions.

This major cannot be fulfilled through any other major at Muhlenberg both due to the subject's intellectual breadth and the fact that it, as a subject, has distinct and different goals from that of, for instance, psychology or neuroscience. As a matter of fact, the field of neuroscience, even with the unusually broad view of Muhlenberg's Neuroscience Department, is narrower than the range of cognitive science. Even further stated, neuroscience is still a biological science at its core, focused on the study of the nervous system with an emphasis on biology and chemistry. Psychology on the other hand, is not solely focused on the cognitive aspects of the mind, and often takes a more clinical route in its analysis. Cognitive Science, although sharing some common ground with neuroscience and psychology, has a distinct purpose in its dedication to the study of cognitive processes and consciousness, usually preferring an emphasis on a more computational and fundamentally abstract approach.

Apart from this very "purist" standpoint on Cognitive Science, a self-designed major would allow me to explore the computational, anthropological and linguistic approaches to the study of the mind without fetter, in a way that would be impossible were I to attempt to fit them into my schedule with a different major.

After Muhlenberg, my ambition is to attend graduate school with the goal of eventually earning a PhD in Cognitive Science and becoming a research scientist. My proposed major of Cognitive Science would ideally help me to flourish in these endeavors. Cognitive science is also new and fast-growing field, and it is my hope to get as close to this new "ground floor" as possible, so that I may be able to be a part of the pioneering research that lies ahead.

### GOALS OF THE MAJOR:

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(These are similar to those listed for the Cognitive Science major at Occidental College.)

- To investigate the nature of consciousness, thought, cognition, language, perception, and memory through a variety of methodologies such as philosophical reflection, psychological experiments, the modeling of intelligence with machines, and the investigation of the biological basis of cognition.
- To understand the benefits and drawbacks of the various methodologies used to investigate the aforementioned issues.
- To understand the complex similarities and differences between human, animal, and (theoretically) mechanical minds.
- To understand the arguments put forward by philosophers, neuroscientists, computer scientists, psychologists, anthropologists, and linguists regarding the nature of minds and cognition.
- To develop the ability to formulate one's own academic research regarding the nature of minds and cognition.
- To acquire the skills needed for further study in the field of cognitive science (i.e. graduate school/research).

## REQUIREMENTS:

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**The proposed Cognitive Science major consists of the following CORE courses (No Backups):**

1. Introduction To Cognitive Science (COGS 007) *Offered at Lehigh University*
2. Mind and Brain (NSC 201)
3. Cognitive Processes (PSY 217)
4. Symbolic Logic (PHL 211)
5. Research Methods In Psychology (PSY 104)
6. Thesis I (975) & Thesis II (976) for the CUE Requirement

**It also consists of ONE of the Philosophy Courses below:**

1. Philosophy of Mind (PHL 328/338)
2. Phenomenology (PHL 229)
3. Philosophy of Science (PHL 237)
4. Neuroethics (PHL 249)
5. The Fabric of Reality (PHL 332)

**It also consists of ONE of the Anthropology or Linguistics Courses below:**

1. Psychology of Language (PSY 412)
2. Philosophy of Language (PHL 327/337)
3. Introduction To Linguistics (COG/ANT/MLL 140) *Offered at Lehigh University*
4. Human Evolution and Prehistory (ANTH 012) *Offered at Lehigh University*
5. Human Evolution (ATH 211)

**It also consists of ONE of the Computer Science Courses below:**

1. Artificial Intelligence Theory and Practice (COGS/CSE 327) *Offered at Lehigh University*
2. Artificial Intelligence (CSI 326)
3. Artificial Intelligence (CSCI 260) *Offered at Moravian College*
4. Software Engineering (CSI 210)
5. Programming Languages (CSI 310)

**It also consists of ONE of these Psychology or Neuroscience Courses below:**

1. Sensation and Perception (PSY 214)

2. Learning & Behavior (PSY 212)
3. States of Consciousness (NSC 301)
4. Brain and Behavior (NSC 310)
5. Embodied Cognition (NSC 387)

**Lastly, it also requires these Prerequisites (not part of the major):**

1. Introductory Psychology (PSY 101)
2. Computer Science I: Introduction To Game Programming (CSI 102)
3. Computer Science II (CSI 111)
4. Data Structures & Algorithms (CSI 220)\*
5. Calculus I (MTH 121)
6. Psychological Statistics (PSY 103)

[\*Only a prerequisite if I take option 2, 3, or 5 on the Computer Science Course List, but my preference is the course at Lehigh.]

## **CORE COURSE DESCRIPTIONS:**

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### **Introduction To Cognitive Science (COGS 007) Offered at Lehigh University**

What is a mind? How is the mind related to the brain? Could we make an artificial mind? Issues concerning knowledge representation and intelligence in minds and computers as investigated by psychologists, philosophers, linguists, neuroscientists, and researchers in artificial intelligence.

**Credit:** 1.0

**Rationale:** Equivalent to Occidental College's "Introduction To Cognitive Science" (COGS 101). Offered at Lehigh University through the LVAIC.

**Offered:** Every Spring

### **Mind and Brain (NSC 201)**

The major trajectory of this course is to evaluate the project of neuroscience, and in so doing, assess the possibility that the mind is manifested in and caused by the brain. We will consider neural arguments about various states of mind, including dreaming, language, selfhood, agency, attention, and intention from a variety of disciplinary and interdisciplinary perspectives. Class discussions will center on working definitions of consciousness, experimental approaches to consciousness and self-knowledge, and dysregulations of mind. A laboratory will explore systems of consciousness from a physiological and phenomenological perspective. Three class hours and one and one-half laboratory hours per week. Meets general academic requirement SC.

**Credit:** 1.0

**Rationale:** Equivalent to Occidental College's "Introduction To Neuroscience" (COGS 104).

**Offered:** Every Fall

### **Cognitive Processes (PSY 217)**

The study of human mental processes, including perception, attention, memory, problem solving, language, conceptual representation, and visual imagery. All students participate in classroom demonstrations and in cognitive research. Recommended for teacher education candidates.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology

**Rationale:** Equivalent to Occidental College's "Cognitive Psychology" (COGS/PSYC 306).

**Offered:** Every Spring.

### **Formal Logic (PHL 211)**

The formal analysis and assessment of deductive arguments using modern symbolic logic, including propositional and predicate logic. Meets general academic requirement RG.

**Credit(s):** 1.0

**Rationale:** Equivalent to Occidental College's "Formal Logic" (PHIL 225).

**Offered:** Every Spring

### **Research Methods In Psychology (PSY 104)**

Exploration of the methodological issues and strategies most germane to research in psychology. Topics include types of research designs, ethics, measurement, library resources, and a review of data analysis procedures. Scientific writing and oral presentations of research results will be emphasized. Four hours lecture/lab. Meets general academic requirement W.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology and PSY 103 Psychological Statistics or permission of instructor.

**Rationale:** Near equivalent to Occidental College's "Empirical Methods of Cognitive Science" (COGS 201), although it is not specific to Cognitive Science, all of the methodologies in this course apply to Cognitive Science.

**Offered:** Every Semester

### **Thesis I (975)**

In interdisciplinary thesis in Cognitive Science supervised primarily by Dr. Alexandra Frazer with Thesis Advisory members from at least two other departments (Neuroscience, Philosophy, Computer Science, et cetera). Successful completion of both semesters of the thesis program fulfills the required CUE.

Junior/Senior standing.

**Credit(s):** 1.0

**Prerequisite(s):** Permission of instructor.

**Rationale:** Fulfilling the CUE for the Cognitive Science Major. This was suggested by Dr. Alexandra Frazer.

**Offered:** Senior Year (Fall 2022)

## **Thesis II (976)**

This course is the second semester of the senior thesis sequence. Successful completion of both semesters of the thesis program fulfills the required Culminating Undergraduate Experience.

**Credit(s):** 1.0

**Prerequisite(s):** 975 - Thesis I and permission of instructor.

**Rationale:** Fulfilling the CUE for the Cognitive Science Major. This was suggested by Dr. Alexandra Frazer.

**Offered:** Senior Year (Spring 2022)

## **PHILOSOPHY COURSE DESCRIPTIONS:**

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### **Philosophy of Mind (PHL 328/338)**

This course is a survey of the fundamental issues, controversies, and methods in contemporary philosophy of mind. Topics will include the relation between the mental and the physical, the problem of consciousness, perception, intentionality, mental causation, and the self. The course will also examine various methods for studying the mind, such as phenomenology, conceptual analysis, and natural scientific approaches. Meets general academic requirement HU (and W when offered as 338).

**Credit(s):** 1.0

**Prerequisite(s):** Any previous course in philosophy or NSC 201 Mind & Brain.

**Rationale:** Equivalent to Occidental College's "Philosophy of Mind" (PHIL 360).

**Offered:** Every Spring

### **Phenomenology (PHL 229)**

In the twentieth century phenomenology emerged as a new and powerful philosophical program. At its core lay the impulse to reveal the reality that gets obscured by one-dimensional activity and "everyday" thinking. The thinkers who carry out this project reveal both similarities in method and provocative variation in results. For example, some phenomenologists ground reality in the first-person experience of time, whereas others privilege the spatial experience of persons in being with others. We will examine historical and contemporary variations of phenomenology and read figures such as Edmund Husserl, Maurice Merleau-Ponty, Alia Al-Saji, Lewis Gordon, and Elizabeth Grosz. Meets general academic requirement HU.

**Credit(s):** 1.0

**Rationale:** Not equivalent to anything offered at Occidental College, but is an important topic in Cognitive Science since the advent of the field.

**Taken:** Fall 2019

### **Philosophy of Science (PHL 237)**

An examination of the goals, methods, and assumptions of modern science. What distinguishes scientific explanations from non-scientific ones? How are scientific theories discovered and confirmed? What criteria of adequacy are used to decide between competing scientific theories? Are all sciences reducible to physics? Has physics proven that the world does not exist independently of our consciousness? Does science give us objective knowledge of the world? Is science a religion?

**Credit(s):** 1.0

**Rationale:** Equivalent to Occidental College's "Philosophy of Science" (PHIL 365). Can be used to meet a "Philosophy Course" requirement as in Occidental's program.

**Offered:** Every Fall

### **Neuroethics (PHL 249)**

Advances in neuroscience, biochemistry, and genetics have brought a new set of ethical questions to the fore. We now have the ability to not only monitor brain functioning in real time (through such devices as PET scanners and MRIs) but also to alter the structure of the brain (through drugs, surgery, implants, genetic engineering, etc.). But the brain is the seat of the mind; it directly affects how we think, feel, and act. Any change in brain structure can have a profound effect on the self. In this course we will examine the ethical implications of the new brain scanning and brain altering technologies. How should they be used? How should they be regulated? For example: If we could identify people with brain structures that are highly correlated with violent behavior, should we force them to undergo treatment? If brain scanning can reliably tell when people are lying, should that evidence be used in court? If brain-altering procedures can erase memories, increase intelligence, or alter personalities, when, if ever, should they be used? Meets general academic requirements HU and W.

**Credit(s):** 1.0

**Rationale:** Although not like anything offered at Occidental College, to understand the ethics of neurotechnology in society is important for a Cognitive Scientist, as a portion of those in their field often work alongside neuroscientists, computer scientists, and engineers to understand the underpinning of intelligence and cognitive abilities with the intention to change or augment them within human beings and animals.

**Offered:** Every Fall

### **The Fabric of Reality (PHL 333)**

An inquiry into the ultimate nature of reality and our relationship to it. What sorts of things exist? Does the world consist solely of material objects or does it also contain immaterial objects such as God, souls, or numbers? What is the relationship between the mind and the body? Do humans have free will? Can humans survive the death of their bodies? Do our best theories reveal the truth about reality or do they merely reveal the ideological biases of the dominant group? Topics may include realism vs. anti-realism; nature of space and time; persons, minds, and free will; the problem of universals; and the existence of God. Meets general academic requirements W.

**Credit(s):** 1.0

**Rationale:** Near Equivalent to Occidental's "Theory of Knowledge" (PHIL 375).

**Offered:** Every Fall

## **ANTHROPOLOGY & LINGUISTICS COURSE DESCRIPTIONS:**

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### **Psychology of Language (PSY 412)**

This course considers the psychological processes involved in language acquisition, production, and comprehension. Specific topics include sign language, bilingualism, disorders of language, language in non-humans, language and society, and the relation of language and thought.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 104 Research Methods in Psychology and PSY 217 Cognitive Processes.

**Rationale:** Equivalent to Occidental College's "Psycholinguistics" (LING 350/PSYC 351).

**Offered:** Every Fall

**Note:** Dr. Frazer, who teaches the course, is willing to waive the "Research Methods In Psychology" prerequisite so that I may be able to take both classes at the same time or one before the other.

### **Introduction To Linguistics (COG/ANTH/MLL 140) Offered at Lehigh University**

Relationship between language and mind; formal properties of language; language and society; how languages change over time.

**Credit(s):** 1.0

**Rationale:** Equivalent to Occidental College's "Introduction To Linguistics" (LING 301). Offered at Lehigh University through the LVAIC.

**Offered:** Every Fall

### **Philosophy of Language (PHL 327/337)**

In this course, we shall reflect on the nature of language, communication, and meaning. We shall use the pragmatist Peirce, and the founder of linguistics, Ferdinand de Saussure, as our guides, and will look briefly at the influential ideas of Chomsky. We then engage in an extended examination of contemporary challenges in linguistics and the philosophy of language, focusing largely on the philosophy of Wittgenstein. We also incorporate contemporary empirical scientific research on language in our philosophical reflections.

**Credit(s):** 1.0

**Prerequisite(s):** Any previous course in philosophy. Meets general academic requirement W when offered as 337.

**Rationale:** Equivalent to Occidental College's "Philosophy of Language" (PHIL 370), but here is used to meet a Linguistics/Anthropology Requirement instead of a Philosophy one.

**Offered:** Every Spring

### **Human Evolution and Prehistory (ANTH 012) Offered at Lehigh University**

Introductory biological anthropology and prehistory. Adaptive functions of human culture and its relation to biological evolution. Mechanisms of evolution, non-human primate morphology and behavior, hominid fossil record, cultural beginnings, and survey of world prehistory.

**Credit(s):** 1.0

**Rationale:** Although not equivalent to anything offered at Occidental College, human evolution and the discipline of biological anthropology is important to Cognitive Science, as it is seen by Cognitive Scientists as a way to study the development of human cognitive abilities through found tools, skeletal structures, and early societies. Biological Anthropology also contains the subdiscipline of Cognitive Anthropology.

**Offered:** Every Semester

**Note:** Although I took the course "Archaeology and Prehistory" here at Muhlenberg in Spring 2019, it was focused on archeological methods instead of on biological anthropology. The class "Human Evolution and Prehistory" at Lehigh is nearly identical in material and content to Muhlenberg's "Human Evolution," regardless of the title's inclusion of the word "Prehistory."

### **Human Evolution (ATH 211)**

This course introduces students to the scientific concepts, principles, methods, and research pertaining to human biological evolution. The course begins with a discussion of evolutionary theory and then applies evolutionary theory to examine: (1) contemporary human biological diversity, (2) the biological and behavioral similarities and differences among human and nonhuman primates, and (3) the fossil evidence for human evolution. Meets general academic requirement SC.

**Credit(s):** 1.0

**Rationale:** Although not equivalent to anything offered at Occidental College, human evolution and the discipline of biological anthropology is important to Cognitive Science, as it is seen by Cognitive Scientists as a way to study the development of human cognitive abilities through found tools, skeletal structures, and early societies. Biological Anthropology also contains the subdiscipline of Cognitive Anthropology.

**Offered:** Usually in the Spring.

**Note:** I took Dr. Carter's course in "Archaeology and Prehistory" in Spring 2019, and he teaches that class. He told us that he offers it regularly, usually as something of a "prequel" to the course that we were already in, and he encouraged us to take it in the near future. Unfortunately, Dr. Carter will likely be on sabbatical in 2020-2021, but he said that it might be taught by another professor during that time.

## **COMPUTER SCIENCE COURSE DESCRIPTIONS:**

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### **Artificial Intelligence Theory and Practice (COGS/CSE 327) Offered at Lehigh University**

Introduction to the field of artificial intelligence: Problem solving, knowledge representation, reasoning, planning and machine learning. Use of AI systems or languages. Advanced topics such as natural language processing, vision, robotics, and uncertainty.

**Credit(s):** 1.0

**Prerequisites:** (CSE 001 and CSE 002) **or** CSE 017 - *Equivalent to Muhlenberg's CSI 100 classes & CSI 111 or CSI 220*

**Rationale:** Near equivalent to Occidental College's "Computational Approaches To Cognition" (COGS 242). It is very important to note that artificial intelligence is integral to Cognitive Science as a field and is almost always a requirement for serious study of CogSci, especially for those intending to go on to

graduate study. Because the artificial intelligence course at Muhlenberg is only offered every two years and demands that one has met all of the prerequisites by that exact time, it is more practical to substitute Lehigh's course here, which is offered much more often. Offered at Lehigh University through the LVAIC.

**Note:** According to Dr. Malt, the director of Cognitive Science at Lehigh, they will soon be offering another Artificial Intelligence class for Cognitive Science majors that does not require as many prerequisites, which will likely alternate with the class listed here. I believe that either class would be worth taking. They are also likely to change the numbering of this class.

**Offered:** Every Spring

### **Artificial Intelligence (CSI 326)**

An introduction and survey of the opportunities and challenges in solving problems often thought to require human intelligence. Topics may include intelligent agents, searching, learning, planning, natural language processing, machine vision, and robotics.

**Credit(s):** 1.0.

**Prerequisite(s):** CSI 220 Data Structures & Algorithms and MTH 121 Calculus I.

**Rationale:** See "Artificial Intelligence Theory and Practice." The reason for listing this class so many times at different colleges is that, as mentioned before, it cannot be overstated how important Artificial Intelligence is to the field of Cognitive Science.

**Offered:** Every Two Years, Next Class In Spring 2020

### **Artificial Intelligence (CSCI 260) Offered at Moravian College**

Topics and methods for emulating natural intelligence using computer-based systems. Topics include learning, planning, natural-language processing, machine vision, neural networks, genetic algorithms.

**Credit(s):** 1.0

**Prerequisite(s):** CSCI 120 - *Equivalent to Muhlenberg's CSI 220*

**Rationale:** See "Artificial Intelligence Theory and Practice." The reason for listing this class so many times at different colleges is that, as mentioned before, it cannot be overstated how important Artificial Intelligence is to the field of Cognitive Science. Offered at Moravian College through the LVAIC.

**Offered:** Every few years, but will likely be offered during the 2020/21 year according to Prof. Coleman, who teaches the class currently. He also says that it will likely be offered more and more due to the addition of a new faculty member who specializes in neuroscience and AI.

### **Software Engineering (CSI 210)**

A project-based study of the theory, practice, processes, and tools used to design, build, and maintain large software systems. Topics include requirements analysis, system architecture, design, testing, maintenance, and project maintenance, as well as professional practice, risks, intellectual property, and social impact of computing. Meets general academic requirement SC and W.

**Credit(s):** 1.0

**Prerequisite(s):** CSI 111 Computer Science II.

**Rationale:** Software Engineering is vital to the creation of artificially intelligent systems, an extremely important part of Cognitive Science.

**Offered:** Every Fall

### **Programming Languages (CSI 310)**

A study of the principles that govern the design and implementation of contemporary programming languages. Topics include lexical properties, compilers, interpreters, data structures, control structures, parameter passage, and run-time environments. Procedural, functional, object oriented, and logic programming languages will be considered.

**Credit(s):** 1.0

**Prerequisite(s):** CSI 220 Data Structures & Algorithms.

**Rationale:** Understanding the rules that govern programming languages can help one to better understand how humans “communicate” objectives to machines. Such could help with an understanding of AI and hypothetical computer “cognition.”

**Offered:** Every Two Years, Next Class In Fall 2020

## **PSYCHOLOGY & NEUROSCIENCE COURSE DESCRIPTIONS:**

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### **States of Consciousness (NSC 301/302)**

Critically examines the recent attempts by neuroscience to resolve the neural correlates of various states of consciousness. Our class conversations will broadly center on the philosophical and physiological traditions that guide this work. We will closely study the putative neural underpinnings of several states of consciousness, including sleep/dreaming, pain, meditation, ecstasy, and coma; in parallel, we will discuss how the resolution of neural function shapes and is shaped by social structures and cultural meanings. Meets general academic requirement W when offered as 302.

**Credit(s):** 1.0

**Prerequisite(s):** NSC 201 Mind & Brain.

**Rationale:** Not equivalent to anything offered at Occidental College, but is an important topic in discussing the nature of human, animal, and potentially machine consciousness. Also has something of an anthropological/sociological aspect in that it talks about the cultural aspects revolving around various states of human conscious experience.

**Offered:** Every Two Years, Next Class In Fall 2020

### **Learning and Behavior (PSY 212)**

An investigation of how our behavior is changed by experience. Topics will include the nature-nurture issue, conditioned reflexes, operant conditioning, observational learning, reinforcement schedules, punishment, and the stimulus-control of behavior.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology.

**Rationale:** Although not like anything offered at Occidental College, but understanding how animals and humans learn is an important topic in Cognitive Science, as well as the nature vs. nurture debate.

**Offered:** Every Semester

### **Sensation and Perception (PSY 214)**

Exploration of the human sensory systems and perception. The course is focused on investigating the relationship between our conscious experience of the world and the anatomy and physiology of the sensory systems. We start with very basic sensory coding and work up to looking at individual differences and the influence of learning and development on perception. There is an emphasis on classroom demonstrations and laboratory experiences. All students run a perception experiment. Meets general academic requirement SC.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology.

**Rationale:** Equivalent to one of Occidental College's potential Cognitive Science electives, "Perception" (PSYC 302) and is an important topic in Cognitive Science.

**Offered:** Every Semester

### **Brain & Behavior (NSC 310)**

An examination of the biological basis of behavior in humans and other animals. Topics discussed will include neuroanatomy; sensory and motor systems; psychopharmacology and drug abuse; motivated behaviors; learning and memory; and neurological and psychological disorders. Research methods of behavioral neuroscience will be introduced through class discussions, relevant primary literature, and laboratory investigations. Three class hours and three laboratory hours per week.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology

**Rationale:** Near equivalent to Occidental's elective "Animal Behavior."

**Offered:** Every Semester

### **Embodied Cognition (NSC 387)**

This course will provide you with an introduction to embodied cognition in human and non-human animals. More traditional approaches begin with the activity of the brain, assuming that cognition depends on algorithmic processes involving symbolic neural representations. Embodied approaches argue that we will misunderstand brain functioning if we fail to begin with the fact that the brain is located inside a body which is, in turn, embedded in a richly structured environment. Specifically, both an animal's specific morphology as well as its particular environment niche are seen as constitutive of the animal's mental life in non-trivial ways. This leads to a profound reconceptualization of the role of the brain in cognition. In addition to attending and participating in lectures and class discussions, you will read original source materials (e.g., book chapters and journal articles) and take part in experimental demonstrations and labs. Although you will be expected to build simple robots no background knowledge of engineering will be assumed, and knowledge of programming is not required.

**Credit(s):** 1.0

**Rationale:** Not equivalent to anything offered Occidental College, but represents an emerging perspective in Cognitive Science that is gaining in popularity.

**Offered:** Spring 2020 (will likely repeat after that for the next Spring if all goes as planned).

**Note:** This is a fairly new class still in the process of being developed, so it is subject to change. I am in contact with Dr. de Wit, who teaches the class and also work in his lab.

## PREREQUISITE COURSE DESCRIPTIONS:

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### **Introductory Psychology (PSY 101)**

An introduction to the science of psychology. Students will investigate theories, topics, and applications in the field of psychology across biological, cognitive, social, developmental, and clinical areas. Students learn to identify ways in which the science of psychology affects everyday lives and gain knowledge in multiple areas of psychology that provide a foundation for future courses within the major and across campus. The course will highlight connections among different areas of psychology and identify ways in which different perspectives contribute to a fuller understanding of human behavior.

Meets general academic requirement SL.

**Credit(s):** 1.0

**Taken:** Spring 2019

### **Computer Science I: Introduction To Game Programming (CSI 102)**

An introduction to Computer Science through the programming of games. Emphasis is given to the creation of arcade style games incorporating animation, user interaction, and sound effects. Students learn to use game development, audio, and image manipulation software in designing and constructing their games. The course is intended for those with no prior experience in computer science but with a desire to hone problem solving and computing skills with a focus on game programming.

Meets general academic requirement RG.

**Credit(s):** 1.0

**Taken:** Spring 2019

### **Computer Science II (CSI 111)**

Reviews basic programming language features and introduces advanced features such as inheritance, interfaces, exceptions, and recursion. Explores fundamental data structures and algorithms, including vectors, linked lists, stacks, and queues as well as algorithms for searching and sorting. Students will study, design, and develop programs with multiple files, classes, and objects.

Meets general academic requirement RG.

**Credit(s):** 1.0

**Prerequisite(s):** Any Computer Science I course with a grade of C- or above.

**Taken:** Fall 2019

### **Data Structures & Algorithms (CSI 220)**

A study of data structures and algorithms, their practical applications, and key techniques for designing, analyzing, and reasoning about them. Topics include lists, hash tables, trees, and graphs. Students will study, design, and develop programs that use, implement, and extend classic and novel data structures and algorithms.

Meets general academic requirement SC.

**Credit(s):** 1.0

**Prerequisite(s):** CSI 111 Computer Science II

**Offered:** Nearly every semester, I will take it Spring 2020

### **Calculus I (MTH 121)**

Differentiation of algebraic and transcendental functions, application of the derivative to related rates, max-min problems, L'Hôpital's Rule, and graphing. Introduction to integration, the Fundamental Theorem of Calculus.

Meets general academic requirement RG.

**Credit(s):** 1.0

**Prerequisite(s):** 3.5 years of high school mathematics.

**Taken:** Fall 2019

### **Psychological Statistics (PSY 103)**

Introduction to the role of statistical analyses in testing hypotheses in psychology. Students will learn both descriptive and inferential uses of statistics as they apply to a variety of research designs commonly used in psychology. This course also emphasizes scientific writing and the use of SPSS to conduct statistical analyses.

**Credit(s):** 1.0

**Prerequisite(s):** PSY 101 Introductory Psychology and MTH 119 Statistical Analysis or MTH 121 Calculus I.

**Offered:** Every semester

## **PARALLEL MAJOR AT OCCIDENTAL COLLEGE**

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Occidental College, a small, private liberal arts college of approximately 1,997 students in Los Angeles, California, offers a major in Cognitive Science. It is only one of many institutions to offer such a major, which is increasing in popularity across the country. Other small LACs offering Cognitive Science include Franklin & Marshall, Vassar College, Swarthmore College, Pomona College, and Hampshire College among others. Our neighboring research university, Lehigh University, also offers Cognitive Science as a major, which I have taken advantage of in placing some of their classes in this proposal. Yet I personally believe that Occidental stands above the rest of the LACs in providing a model for a Cognitive Science Major that could fit both Muhlenberg's strengths and constraints as an educational institution. The information below can be found on their website here: <https://www.oxy.edu/academics/areas-study/cognitive-science/courses-requirements>.

I also believe that it is important to note that apart from Occidental College, the design of Lehigh University's Cognitive Science Major had a very strong influence on the design of the major requirements set out in the proposal as well. Lehigh's Cognitive Science Major can be found on their website here: <http://catalog.lehigh.edu/coursesprogramsandcurricula/artsandsciences/cognitivescience/>.

**Note:** I wish to take a small portion of time here to explain some of the differences between Occidental's Cognitive Science Major and my own. First, there is simply the difference of classes. Both Muhlenberg and Occidental offer some amazing classes that fit into cognitive science extremely well, but simply do not match one another. For

instance, Muhlenberg has “Phenomenology” and “Embodied Cognition;” two amazing classes that are not found at Occidental but fit into the model of cognitive science extremely well. Another example would be Occidental’s “Computational Approaches to Cognition,” which is replaced (rather suitably) by a computer science requirement in my major and “Empirical Methods of Cognitive Science” which is replaced by “Research Methods In Psychology,” which strongly overlaps with the Occidental course, but does not match it entirely. I believe that these differences are okay to have, as no college can truly match the exact nature of a program at another school. Another thing is that I have left out the “additional electives” of Occidental’s major in favor of adding more categorical options. I have also combined the categories of Linguistics & Anthropology and Neuroscience & Psychology since they are often grouped together academically (especially within Cognitive Science) and tend to compliment one another.

Another issue about matching Occidental College is that on the Courses & Requirements page, they do not list the extra prerequisites needed for certain classes within the “Additional Electives” section, making their major appear smaller than mine. Also, their classes such as “Cognitive Psychology” and “Computational Approaches To Cognition” require the prerequisite of “Introduction To Cognitive Science,” which while in my major, cannot be used as a prerequisite to any of my psychology or computer science courses, thus requiring more courses to be taken prior to. My major as designed here is in full, actually 11 courses long (it would be ten courses if the CUE was not a thesis) but requires up to six courses worth of prerequisites which are not to be included in the major.

On the topic of my Computer Science electives: The main part of computer science vital to cognitive science is artificial intelligence in its various manifestations, whether that be machine learning, neural networks, genetic algorithms, cognitive robotics, et cetera. Although many other computer science classes such as “Programming Languages” and “Software Engineering” could generally suffice for the major requirement here (especially since both of those courses strongly contribute to AI in practice), it is of my opinion that AI itself should be something of a priority. I also hope to work with AI in graduate school, which makes taking a class on AI important to me.

Lastly, I would like to say that I am well aware that the maximum amount of LVAIC courses that can be included in a proposal is six, and here I have five options, only one of which is required.

## **Major Requirements**

“To major in Cognitive Science, students take a total of at least 48 units. Along with six required courses, students select at least one course each from the approved list of courses in Neuroscience, Linguistics, and Philosophy. Electives can be any course with a COGS designation, can be drawn from the approved lists of courses in Neuroscience, Linguistics, and Philosophy, or selected from the additional electives list.”

[All courses listed here are equal to 4 units at Occidental College; 48 units = 12 courses]

## **COURSEWORK**

Students are encouraged to take [COGS 201](#) as early as possible, as preparation for other courses in the major and as a framework to fulfill the second-stage writing requirement.

### **REQUIRED COURSES**

[COGS 101](#) Introduction to Cognitive Science

[COGS 201](#) Empirical Methods in Cognitive Science

[PHIL 225](#) Formal Logic

[COGS 242](#) Computational Approaches to Cognition

[COGS 306/PSYC 306](#) Cognitive Psychology

[COGS 490](#) Senior Seminar in Cognitive Science

### **Neuroscience**

Students must select either

[COGS 104](#) Introduction to Neuroscience

Or

[COGS 320](#) Cognitive Neuroscience

### **Linguistics**

Students must select one course from the list below:

[COGS 330](#) Linguistics for Cognitive Science

[LING 301](#) Introduction to Linguistics

[LING 350/PSYC 351](#) Psycholinguistics

### **Philosophy**

Students must select one course from the list below:

[COGS 308/PHIL 308](#) Historical and Philosophical Foundations of Cognitive Science

[PHIL 360](#) Philosophy of Mind

[PHIL 365](#) Philosophy of Science

[PHIL 370](#) Philosophy of Language

[PHIL 375](#) Theory of Knowledge

[PHIL 380](#) Wittgenstein

### **Additional Electives**

Students must select an additional 12 units of coursework to complete the major.

Electives can be any course with a COGS designation, can be drawn from the approved lists of courses in Neuroscience, Linguistics, and Philosophy, or selected from the additional electives list. A total of 4 units can be applied to the major from [COGS 290](#) and [COGS 395](#). All students are also encouraged to take statistics and computer science coursework.

<a href="#">BIO 240</a>	Vertebrate Physiology	4 units
<a href="#">BIO 268</a>	Biostatistics	4 units
<a href="#">BIO 320</a>	Developmental Biology	4 units
<a href="#">BIO 333</a>	Neurobiology	4 units
<a href="#">BIO 340</a>	Sensory Biology and Neurophysiology	4 units
<a href="#">BIO 373</a>	Computational Biology	4 units
<a href="#">BIO 378</a>	Animal Behavior	4 units
<a href="#">COMP 113</a>	Data Science	4 units
<a href="#">COMP 131</a>	Fundamentals of Computer Science	4 units
<a href="#">COMP 149</a>	Mathematical Foundations of Computer Science	4 units
<a href="#">COMP 347</a>	Machine Learning	4 units
<a href="#">COMP 353</a>	Information Theory	4 units
<a href="#">CSLC 246</a>	Cognitive Science and Culture: New Encounters with Ancient Rome	4 units
<a href="#">ECON 305</a>	Game Theory	4 units
<a href="#">ECON 340</a>	Behavioral Economics	4 units
<a href="#">KINE 301</a>	Human Anatomy II	4 units
<a href="#">KINE 304</a>	Human Physiology	4 units

<a href="#">KINE 310/PSYC 310</a>	Motor Learning and Control	4 units
<a href="#">LING 355</a>	Sociolinguistics	4 units
<a href="#">MATH 146/COMP 146</a>	Statistics	4 units
<a href="#">MATH 150</a>	Statistical Data Analysis	4 units
<a href="#">MATH 186</a>	Network Models	4 units
<a href="#">MATH 330</a>	Probability	4 units
<a href="#">MATH 350</a>	Mathematical Logic	4 units
<a href="#">MATH 352/COMP 352</a>	Computability and Complexity	4 units
<a href="#">MATH 354/PHIL 320</a>	Set Theory and Foundations of Mathematics	4 units
<a href="#">MATH 370</a>	Numerical Analysis	4 units
<a href="#">MATH 392</a>	Mathematical Models in Biology	4 units
<a href="#">PHIL 250</a>	Bioethics	4 units
<a href="#">PHIL 275</a>	Logic, Problem Solving, and Education	4 units
<a href="#">PHIL 305</a>	Topics in Modern Philosophy	4 units
<a href="#">PHIL 325</a>	Metalogic	4 units
<a href="#">PHIL 355</a>	Philosophy of Space and Time	4 units
<a href="#">PSYC 111/COGS 111</a>	The Origins of Knowledge	4 units
<a href="#">PSYC 201</a>	Statistics in Psychological Science	4 units

<a href="#">PSYC 302</a>	Perception	4 units
<a href="#">PSYC 322L</a>	Physiological Psychology Laboratory	2 units
<a href="#">PSYC 403</a>	Psychophysiology	4 units
<a href="#">PSYC 444</a>	Thinking and Reasoning	4 units

## SECOND-STAGE WRITING REQUIREMENT

Students will normally fulfill the second-stage writing requirement by passing both the Research Proposal and Scientific Research Paper assignments in [COGS 201](#): Empirical Methods in Cognitive Science with a grade of C or better. Students who do not successfully complete both assignments with a grade of C or better will be required to submit a writing portfolio to the Department Chair no later than the midterm of the following semester. This portfolio will be prepared in consultation with the [COGS 201](#) instructor.

## COMPREHENSIVE REQUIREMENT

In the senior year the student carries out a project or writes a thesis on a topic in Cognitive Science related to their prior coursework. The project or thesis is coordinated with the work of the Cognitive Science Senior Seminar. All majors take the Senior Seminar in the fall semester of the senior year. Those students intending to do an empirical project for their senior comprehensives or who intend to go on to graduate school in cognitive science or in a related field should discuss taking a statistics course and gaining research experience prior to their senior year with their adviser.

## HONORS

Honors in Cognitive Science may be awarded to graduating seniors who demonstrate excellence in their course work and distinction in their senior comprehensive project. To be eligible, students must have a 3.5 grade point average in the major and a 3.25 overall grade point average. In addition, the comprehensive project or thesis must be judged as a "pass with distinction."

## GAR CLASSES FULFILLED & UNFULFILLED

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1. First-Year Seminar:
  - a. Strange Neighbors [Complete Fall 2018]
2. Personal & Professional Development:
  - a. Foundations of Student Success [Complete Spring 2019]
3. Social Sciences:

- a. Introduction to Psychology [Complete Spring 2019]
- b. Archaeology & Prehistory [Complete Spring 2019]
4. Natural Sciences:
  - a. Introductory Chemistry [Complete Fall 2018]
  - b. Bio I: Organisms & Populations [Complete Fall 2018]
5. Reasoning:
  - a. Computer Science I: Introduction To Game Programming [Complete Spring 2019]
6. Humanities:
  - a. Buddhist Traditions [Complete Spring 2019]
  - b. Phenomenology [Complete Fall 2019]
  - c. Not Yet Completed
7. Art:
  - a. Not Yet Completed
8. Foreign Language:
  - a. Not Yet Completed
  - b. Not Yet Completed
9. Diversity & Global Engagement:
  - a. Archaeology & Prehistory [Complete Spring 2019]
  - b. Buddhist Traditions [Complete Spring 2019]
10. Integrated Learning:
  - a. Not Yet Completed
11. Writing:
  - a. Not Yet Completed
  - b. Not Yet Completed

**Note:** I might choose to fulfil some of my GARs with CLEP exams, most likely my foreign language requirement and/or one of my humanities requirements. This is not to make room for my major, but to give myself more space to take more classes that I am interested in regardless of the subject.

## **4-YEAR TENTATIVE PLAN**

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### **Fall 2018 (Complete)**

Bio I: Organisms & Populations [SC]

Introductory Chemistry [SC]

Strange Neighbors [FY]

### **Spring 2019 (Complete)**

Introduction To Psychology [SL/Prereq.]

Buddhist Traditions [DE/HU]

Introduction To Computer Science I: Game Programming [RG/Prereq.]

Archaeology & Prehistory [DE/SL]

Foundations Of Student Success [PPD]

**Fall 2019**

Brain and Behavior

Calculus I [Prereq.]

Computer Science II [Prereq.]

Phenomenology [HU]

**Spring 2020**

Calculus II

Data Structures and Algorithms [Prereq.]

Introduction To Cognitive Science

Symbolic Logic

**Fall 2020**

Psychology of Language

Mind & Brain

Psychological Statistics [Prereq.]

Foreign Language GAR [FL]

Independent Study/Research

**Spring 2021**

Cognitive Processes

Artificial Intelligence Theory and Practice

Research Methods In Psychology [W]

Foreign Language GAR [FL]

**Fall 2021**

Linear Algebra

Arts GAR [AR]

Integrated Learning GAR [IL]

Thesis I [CUE]

**Spring 2022**

Integrated Learning GAR [IL] (if necessary for a linked course) or Free Elective

Philosophy of Mind [W]

Humanities GAR [HU]

Thesis II [CUE]

**Note:** Some of these classes written here such as Calculus II and Linear Algebra are not part of my major, but are classes that I am certain that I would really like to take if possible. I have placed them here only as a means to visualize academic possibilities for myself.

### **SUMMARY:**

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To conclude, Muhlenberg (in conjunction with the LVAIC) has all of the courses necessary to allow for the Cognitive Science Major as it is outlined in this proposal. Nevertheless, I cannot fulfill my interest in Cognitive Science by declaring another major, because the Cognitive Science Major and its corresponding prerequisites require too many classes from different disciplines. Not only that, but Cognitive Science is a distinctive field of its own, requiring a direct focus upon human, animal, and machine cognition; something which is not the aim of any of the majors currently offered here at Muhlenberg. This major, which I would pursue for the next three years, is constructed not only to fulfill my interest in Cognitive Science, but to assist in my ultimate goal of eventually becoming a research scientist in this beautiful and fast-accelerating field.