

Neural Structure of Language

185:335

Prereqs: 01:185:201 Cognitive Science: A Multidisciplinary Introduction

Instructor: Ryan Rhodes (ryan.rhodes@rutgers.edu)

Office Hours: Wednesday 1-3pm, RuCCS A119

Course Site: <https://rutgers.instructure.com/courses/36994>

Course Materials

This course has no textbook. We will be reading scientific articles published in peer-reviewed journals, which will be available on canvas.

All relevant materials can be found on the course canvas site (see above).

Course Description

Language is a deceptively complex computational system. In this course, we will explore how linguistic structure is represented and processed in the brain, and how the computational machinery that generates language intersects with different cognitive capacities and brain structures. We will focus on a few major themes: neural evidence of linguistic structures and structure-building; major brain regions associated with language and competing models of their functions; and the underlying cognitive resources necessary for producing and comprehending language.

This course incorporates both lecture and discussion, and we will be reading and discussing primary scientific literature.

Course Learning Outcomes

This course has two primary goals. Reading and understanding primary scientific literature is challenging. A primary objective of this course is to develop the skill of reading scientific papers, extracting meaningful information, and integrating that new information with our prior knowledge. We will be viewing this literature with a critical lens to better understand scientific reasoning as it is applied to very difficult questions.

The other goal of this course is to develop a deep understanding of language and the brain, viewed through a framework informed by theoretical linguistics, cognitive psychology, and neuroscience. We will adopt a “levels of analysis” approach – common in cognitive science – to understand language as the output of a complex computational system.

Assignments

Reading Journal: 10%

You will be required to keep a journal, where you will make notes about the readings. Bring your journal to class and show me your entry for that week’s reading to receive credit.

The journal is important because it gives you well-structured notes to reference for discussion and reading responses. Please bring it to class!

Reading Responses: 30%

Each week there will be a paper on the week’s reading (500-1000 words). These must be submitted to Canvas. The purpose of the response is to get you thinking about the readings, connecting the new material to other readings and discussion, and offering your own thoughts.

There will be 13 reading responses total. The highest 10 will be counted towards your final grade.

Responses will be graded according to the following rubric:

| Great 3 | Proficient 2 | Developing 1 | Unsatisfactory 0 |
|--|--|---|--|
| The response is well-developed. It indicates that the material was read and understood. It expands on, elaborates, or offers a unique insight on the material. | The response is adequate. There is evidence that the material was read and understood. Elaboration or unique insights may be less developed. | The response is not adequate. There may be little evidence that the material was read or understood. There is no elaboration. | The response was not submitted properly to Canvas by the deadline. |

Critical Review Paper: 30%

As a midterm assignment, you will write a critical review of a scientific article. This will be a longer paper in which you will evaluate the scientific merit of a paper according to guidelines for journal reviewers.

I want you to think critically about the paper – does it have a well-articulated model that predicts the experimental outcomes? Are the tools used appropriately for what is being measured? Are there any unstated assumptions in the author’s explanations or discussion? Is the writing clear?

Final Exam: 30%

The final exam will be cumulative, covering material from the readings, lectures, and our discussions. The format of the final exam will be mixed, consisting of both short answer and essay questions.

Your reading journal will serve as a valuable resource while studying for the final exam. Please utilize it! Keep up with the readings and use your journal to make notes about each study as we read/discuss them.

Schedule

| Week | Reading | Journal | Assignment Due |
|----------------|--|---------|-----------------------|
| 1 | Embick & Poeppel (2015) | No | Response 1 |
| 2 | Friederici (2002) Kaan & Swaab (2002) Hagoort (2014) | No | Response 2 |
| 3 | Ding et al. (2016) | Yes | Response 3 |
| 4 | Nelson et al. (2017) | Yes | Response 4 |
| 5 | Fiebach, Schlesewsky, & Friederici (2001) | Yes | Response 5 |
| 6 | Epstein, Hestvik, Shafer, & Schwartz (2013) | Yes | Response 6 |
| 7 | Musso et al. (2003) | Yes | Response 7 |
| 8 | Petersson, Folia, & Hagoort (2012) | Yes | Response 8 |
| 9 | Ullman (2015) | No | Critical Review Paper |
| 10 | Jaeger et al. (1996) | Yes | Response 9 |
| 11 | Walenski, Mostofsky, & Ullman (2007) | Yes | Response 10 |
| 12 | Fedorenko, Gibson, & Rohde (2007) | Yes | Response 11 |
| 13 | Fedorenko & Varley (2016) | No | Response 12 |
| 14 | Jonas & Kording (2017) | Yes | Response 13 |
| Finals Week | | | Final Exam |

Class Policies

Attendance

This is a discussion-based class, so it is very important that you come every week. You'll show me your reading journal entry on class day – if you don't show up, you won't get credit for your journal!

If you have to miss class for any reason, please email me or come to office hours to find out what you missed.

Collaboration

Collaboration is at the heart of good science! I encourage you to collaborate with each other - but every student must always turn in their own work. Your work must be written solely by you!

Academic Integrity

Cheating or plagiarism of any kind will not be tolerated. University policies on academic dishonesty are draconian – please don't put me in a position where I have to enforce them. If you are not familiar with Rutgers's academic integrity policies, you can find them here: <http://academicintegrity.rutgers.edu/academic-integrity-policy/>.

Student Resources

Accommodation of Disabilities

I am very happy to offer any kind of accommodation you may need. Please let me know if you have any special needs by coordinating with me and ODS:

<https://ods.rutgers.edu/students/registering-for-services>

Student wellbeing

Your mental health, comfort, and wellbeing are important! Please be aware and if needed avail yourselves of the counseling, psychiatric services, and crisis intervention resources Rutgers makes available for students.

Mental health services: <http://health.rutgers.edu/medical-counseling-services/counseling/>
CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Crisis intervention: <http://health.rutgers.edu/medical-counseling-services/counseling/crisis-intervention/>

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Violence prevention and victim assistance: www.vpva.rutgers.edu/

Readings

- Ding, N., Melloni, L., Zhang, H., Tian, X., & Poeppel, D. (2016). Cortical tracking of hierarchical linguistic structures in connected speech. *Nature Neuroscience*, 19(1), 158–164. <http://doi.org/10.1038/nn.4186>
- Embick, D., & Poeppel, D. (2015). Towards a computational(ist) neurobiology of language: correlational, integrated and explanatory neurolinguistics. *Language, Cognition and Neuroscience*, 30(4), 357–366. <http://doi.org/10.1080/23273798.2014.980750>
- Epstein, B., Hestvik, A., Shafer, V. L., & Schwartz, R. G. (2013). ERPs reveal atypical processing of subject versus object Wh-questions in children with specific language impairment. *International Journal of Language & Communication Disorders / Royal College of Speech & Language Therapists*, 48(4), 351–65. <http://doi.org/10.1111/1460-6984.12009>
- Fedorenko, E., Gibson, E., & Rohde, D. (2007). The nature of working memory in linguistic, arithmetic and spatial integration processes. *Journal of Memory and Language*, 56(2), 246–269. <http://doi.org/10.1016/j.jml.2006.06.007>
- Fedorenko, E., & Varley, R. (2016). Language and thought are not the same thing: evidence from neuroimaging and neurological patients. *Annals of the New York Academy of Sciences*, 1369(1), 132–153. <http://doi.org/10.1111/nyas.13046>. Language
- Fiebach, C. J., Schleewsky, M., & Friederici, A. D. (2001). Syntactic working memory and the establishment of filler-gap dependencies: insights from ERPs and fMRI. *Journal of Psycholinguistic Research*, 30(3), 321–338. <http://doi.org/10.1023/A:1010447102554>
- Friederici, A. D. (2002). Towards a neural basis of auditory language processing. *Trends in Cognitive Science*, 6(2), 78–84.
- Hagoort, P. (2014). Nodes and networks in the neural architecture for language: Broca's region and beyond. *Current Opinion in Neurobiology*, 28, 136–141. <http://doi.org/10.1016/j.conb.2014.07.013>
- Jaeger, J. J., Lockwood, A. H., Kemmerer, D. L., Valin, R. D. Van, Murphy, B. W., Khalak, H. G., ... Kemmerer, D. L. (1996). A Positron Emission Tomographic Study of Regular and Irregular Verb Morphology in English. *Language*, 72(3), 451–497.
- Jonas, E., & Kording, K. P. (2017). Could a Neuroscientist Understand a Microprocessor? *PLoS Computational Biology*, 13(1), 1–24. <http://doi.org/10.1371/journal.pcbi.1005268>
- Kaan, E., & Swaab, T. Y. (2002). The brain circuitry of syntactic comprehension. *Trends in Cognitive Sciences*, 6(8), 350–356.
- Musso, M., Moro, A., Glauche, V., Rijntjes, M., Reichenbach, J., Büchel, C., & Weiller, C. (2003). Broca's area and the language instinct. *Nature Neuroscience*, 6(7), 774–781.
- Nelson, M. J., El, I., Giber, K., Yang, X., Cohen, L., Koopman, H., ... Dehaene, S. (2017). Neurophysiological dynamics of phrase-structure building during sentence processing. *Proceedings of the National Academy of Sciences*, 114(18), 1–10. <http://doi.org/10.1073/pnas.1701590114>
- Petersson, K. M., Folia, V., & Hagoort, P. (2012). What artificial grammar learning reveals about the neurobiology of syntax. *Brain and Language*, 120(2), 83–95. <http://doi.org/10.1016/j.bandl.2010.08.003>
- Ullman, M. T. (2015). The declarative/procedural model. In B. VanPatten & J. Williams

(Eds.), *Theories in Second Language Acquisition: An Introduction* (Second, pp. 135–160).
New York, NY: Routledge.

Walenski, M., Mostofsky, S. H., & Ullman, M. T. (2007). Speeded processing of grammar and tool knowledge in Tourette's syndrome. *Neuropsychologia*, 45(11), 2447–2460.
<http://doi.org/10.1016/j.neuropsychologia.2007.04.001>