Language and the Brain

Lecture series at the *Berlin School of Mind and Brain*
Summer term 2021
Lecturer: Friedemann Pulvermüller

Course code: 32851 (Humboldt Universität zu Berlin), 16857 (Freie Universität Berlin)

Time: Summer term 2021, Mondays 12:15-13:45; start: 19 April 2021

Venue: The lectures and tutorials will be offered via videoconference using Zoom at
https://hu-berlin.zoom.us/j/62948458406?pwd=UG9GdjdqR09LZDB6c3V5VDZUUnNBQT09

Language has been investigated from a range of perspectives. Linguists have described it as a formal system focusing on levels that range from phonology to syntax, semantics and pragmatics. Both linguists and psychologists worked on models focusing on the time course of linguistic processing, so that these psycholinguistic models could be tested in behavioral experiments. Most recently, neuro- and cognitive scientists have attempted to spell out the brain mechanisms of language in terms of neuronal structure and function. These efforts are founded in neuroscience data about the brain loci that activate when specific linguistic operations occur, the time course of their activation and the effects of specific lesions.

The lecture series will provide a broad introduction into these linguistic, psycholinguistic and neurolinguistics research streams and highlight a range of cutting-edge behavioral and neuroscience findings addressing a broad range of linguistic issues, including, for example, the recognition of words, the parsing of sentences, the computation of the meaning and of the communicative function of utterances. Language development and language disorders caused by disease of the brain will also be in the focus. To accommodate language processing, psycho- and neurolinguists make use of theoretical and computational models. The modeling approaches discussed range from theoretical models of the language system to language processing to (neuro-)computationally implemented models. The experimental approaches under discussion will range from behavioral (reaction time studies, eye tracking) to neuroimaging methods (EEG, MEG, fMRI, NIRS) and neuropsychological ones (patient studies, TMS, tDCS).

Complementing the lecture series, a tutorial will be offered by Johanna Knechtges, a student of linguistics at the FU Berlin, and Marika Constant, a PhD student at the Berlin School of Mind and Brain. The tutorial will deepen the lecture contents, in part by discussing specific relevant articles with theoretical and experimental focus. Together with the lectures, the tutorial will familiarize students with current research (questions) in the field of language and the brain.

This lecture series is open to students at the Berlin School of Mind and Brain as well as for students of linguistics and cognitive neuroscience at HU, FU and TU Berlin.

Readings (course preparation):

Fromkin, V., Rodman, R., & Hyams, N. (2013). An introduction to language. Wadsworth: Cengage Learning.

Hickok, G., & Small, S. L. (Eds.). (2016). *Neurobiology of Language*. Amsterdam: Elsevier.

Pulvermüller, F., & Fadiga, L. (2016). Brain language mechanisms built on action and perception. In G. Hickok & S. L. Small (Eds.), *Neurobiology of language* (pp. 311-324). Amsterdam: Elsevier.

Pulvermuller, F. (2018). Neural reuse of action perception circuits for language, concepts and communication. *Progress in Neurobiology*, 160, 1-44. doi: 10.1016/j.pneurobio.2017.07.001

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Please note: References highlighted by an asterisk (*) are required readings and form, together with the content of the lectures, the basis of the final exam. Additional recommendations for readings are given for interested participants.

01. When Do We Understand? – Questions and Methods In Psycho- and Neurolinguistics 19.04

* Marslen-Wilson, W. D. (1987). Functional Parallelism in Spoken Word-Recognition. Cognition, 25(1-2), 71-102.

Harley, T. A. (2013). The psychology of language (4 ed.). Hove, UK: Psychology Press, Taylor & Francis Group. Chapters 6 and 9 (word recognition).

(basic methods: Müller, H. M. (2013). Psycholinguistik - Neurolinguistik: Die Verarbeitung von Sprache im Gehirn. Stuttgart: UTB, Fink. Chapter 8, 10, and 11.)

02. From Brain Structure to Linguistic Function 26.04

*Pulvermuller, F. (2002). *The neuroscience of language: on brain circuits of words and serial order* (pp. 9–32). Cambridge University Press, Chapters 2 and 3.

Schomers, M. R., Garagnani, M., & Pulvermüller, F. (2017). Neurocomputational consequences of evolutionary connectivity changes in perisylvian language cortex. *Journal of Neuroscience*, 2693-16. doi:10.1523/JNEUROSCI.2693-16.2017

(in depth: Pulvermüller, F. (2018). Neural reuse of action perception circuits for language, concepts and communication. *Progress in Neurobiology, 160*, 1-44: Sections 1 & 2.)

03. Phonetics and phonology 03.05.

*Fromkin, V., Rodman, R., & Hyams, N. (2013). An introduction to language. Wadsworth: Cengage Learning (pp. 189–223).

Galantucci, B., Fowler, C. A., & Turvey, M. T. (2006). The motor theory of speech perception reviewed. *Psychonomic bulletin & review*, *13*(3), 361-377.

(in depth: Pulvermüller, F. (2018). Neural reuse of action perception circuits for language, concepts and communication. *Progress in Neurobiology, 160*, 1-44, Section 3.1.)

04. When Do We Understand? – Neurophysiological Perspectives 10.05.

* Friederici, A. D. (2002). Towards a neural basis of auditory sentence processing. Trends in Cognitive Sciences, 6(2), 78-84.

Johnsrude, I. S., & Hauk, O. (2011). Neuroimaging. In N. Braisby (Ed.), Cognitive Psychology (pp. 430-467). Oxford: Oxford University Press.

(additional reading: Pulvermüller, F., Shtyrov, Y., & Hauk, O. (2009). Understanding in an instant: neurophysiological evidence for mechanistic language circuits in the brain. Brain and Language, 110(2), 81-94.)

05. Lexical and Semantic Word Categories 17.05.

* Vigliocco, G., Vinson, D. P., Druks, J., Barber, H., & Cappa, S. F. (2011). Nouns and verbs in the brain: A review of behavioural, electrophysiological, neuropsychological and imaging studies. Neurosci Biobehav Rev, 35 (3), 407-426.

Moseley, R. L., & Pulvermüller, F. (2014). Nouns, verbs, objects, actions, and abstractions: Local fMRI activity indexes semantics, not lexical categories. *Brain and Language, 132*, 28-42. doi:10.1016/j.bandl.2014.03.001

06.   Q&A Session I   31.05

Please send your questions until 18.5.2021!

07.   Meaning in mind and brain   07.06.

* Pulvermüller, F. (2013). How neurons make meaning: Brain mechanisms for embodied and abstract-symbolic semantics. *Trends in Cognitive Sciences, 17*(9), 458-470. doi:10.1016/j.tics.2013.06.004

Grisoni, L., Tomasello, R., & Pulvermüller, F. (2021). Correlated Brain Indexes of Semantic Prediction and Prediction Error: Brain Localization and Category Specificity. Cereb Cortex, 31(3), 1553-1568. doi: 10.1093/cercor/bhaa308

(in depth: Pulvermüller, F. (2018). Neural reuse of action perception circuits for language, concepts and communication. *Progress in Neurobiology, 160*, 1-44, Section 3.2.)

08.   Speech Acts and Communication   14.06

*Tomasello, R., Kim, C., Dreyer, F. R., Grisoni, L., & Pulvermüller, F. (2019). Neurophysiological evidence for rapid processing of verbal and gestural information in understanding communicative actions. *Scientific Reports, 9*(1), 16285. doi:10.1038/s41598-019-52158-w

Hagoort, P., & Levinson, S. C. (2014). Neuropragmatics. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 667-674). Boston, MA: MIT Press.

09.   Language Breakdown and Therapy   21.06.

*Blumstein, S. E. (2016). Psycholinguistic approaches to the study of syndromes and symptoms of aphasia. In G. Hickok & S. L. Small (Eds.), *Neurobiology of language* (pp. 923-933). Amsterdam: Elsevier.

Pulvermüller, F., Mohr, B., & Taub, E. (2016). Constraint-induced aphasia therapy: A neuroscience-centered translational method. In G. Hickok & S. L. Small (Eds.), *Neurobiology of language* (pp. 1025-1034). Amsterdam: Elsevier.

10.   Brain Constrained Neural Language Modelling   28.06.

* Pulvermüller, F., Tomasello, R., Henningsen-Schomers, M. R., & Wennekers, T. (2021). Biological constraints on neural network models of cognitive function. submitted.

Tomasello, R., Wennekers, T., Garagnani, M., & Pulvermüller, F. (2019). Visual cortex recruitment during language processing in blind individuals is explained by Hebbian learning. Sci Rep, 9(1), 3579.

11.   Q&A Session II   05.07.

Please send your questions until 29.6.2021!

12.   Final exam   12.07.