האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University of Jerusalem

Syllabus

Numerical Cognition - 34939

Last update 03-11-2021

HU Credits: 2

Degree/Cycle: 2nd degree (Master)

Responsible Department: Education

Academic year: 0

Semester: 1st Semester

Teaching Languages: Hebrew

Campus: Mt. Scopus

Course/Module Coordinator: Sarit Ashkenazi

Coordinator Email: sarit.ashkenazi@mail.huji.ac.il

Coordinator Office Hours: Sunday, 14- 16

Teaching Staff:

Dr. Sarit Ashkenazi

Course/Module description:

During the course will study key issues in the field of number processing and calculation capabilities. These will be examined in the context of developmental and acquired difficulties. In addition, we will learn a variety of cognitive paradigms with an emphasis on neuropsychology research on numerical processing.

Course/Module aims:

During the course will study key issues in the field of number processing and calculation capabilities. These will be examined in the context of developmental and acquired difficulties. In addition, we will learn a variety of cognitive paradigms with an emphasis on neuropsychology research on numerical processing.
The course deals with numerical processing. We will talk about the following issues: cognitive processes involved in processing numbers, basic numerical processing, arithmetic, numerical estimation, and an exact calculation. In addition we will deal with the development of numerical representations. Then, we will talk about cognitive effects that related to numerical processing such as the size congruity effect, the numerical distance effect, subitizing. Last, we will talk about imaging methods such as ERP, fMRI and TMS.

Learning outcomes - On successful completion of this module, students should be able to:

1. Understanding the development of numerical concepts, from childhood to adulthood.
2. Understanding what is basic numerical processing, learning indications that numerical processing abilities are presents from infancy.
3. Understanding the dissociation in the adult brain between districts numerical calculation processes.
4. Understanding that solving arithmetical problems is supported by basic magnitude understanding and general attention and working memory capabilities.

Attendance requirements(%):

80

Teaching arrangement and method of instruction: Frontal

Course/Module Content:

1. *Models of numerical processing: Triple code model of number processing.*
2. *Core system for numerical processing.*
3. *Introduction to neuropsychological methods.*
4. *Basic numerical processing: the numerical distance and size effects.*
5. *Enumeration abilities.*
6. *Arithmetical processing: approximation and exact calculations.*
7. *The development of arithmetical abilities: typical and atypical development.*
8. *The development of basic numerical processing abilities.*
9. *Domain general vs. domain specific demanded.*
10. *The involvement of working memory in arithmetical processing.*
11. *The involvement of verbal abilities in arithmetical processing.*
12. *Training of numerical abilities.*

Required Reading:

Gallistel, C. R., & Gelman, R. (2000). Non-verbal numerical cognition: from reals to integers. Trends in Cognitive Sciences, 4(2), 59-65. doi: 10.1016/s1364-6613(99)01424-2

Arsalidou, M., & Taylor, M. J. (2011). Is 2+2&eq;4? Meta-analyses of brain areas needed for numbers and calculations. Neuroimage, 54(3), 2382-2393. doi: S1053-8119(10)01301-7 [pii]10.1016/j.neuroimage.2010.10.009

Wood, G., Ischebeck, A., Koppelstaetter, F., Gotwald, T., & Kaufmann, L. (2009). Developmental trajectories of magnitude processing and interference control: an FMRI study. Cereb Cortex, 19(11), 2755-2765.

Demeyere, N., Rotshtein, P., & Humphreys, G. W. (2012). The Neuroanatomy of Visual Enumeration: Differentiating Necessary Neural Correlates for Subitizing versus Counting in a Neuropsychological Voxel-based Morphometry Study. Journal of Cognitive Neuroscience, 24(4), 948-964. doi: 10.1162/jocn_a_00188

De Smedt, B., Holloway, I. D., & Ansari, D. (2011). Effects of problem size and arithmetic operation on brain activation during calculation in children with varying levels of arithmetical fluency. Neuroimage, 57(3), 771-781.

Lemaire, P., & Siegler, R. S. (1995). Four aspects of strategic change: contributions to children's learning of multiplication. J Exp Psychol Gen, 124(1), 83-97.

Menon, V. (2010). Developmental cognitive neuroscience of arithmetic: implications for learning and education. ZDM, 42(6), 515-525.

Cohen Kadosh, R., Lammertyn, J., & Izard, V. (2008). Are numbers special? An overview of chronometric, neuroimaging, developmental and comparative studies of magnitude representation. Prog Neurobiol, 84(2), 132-147.

Zago, L., & Tzourio-Mazoyer, N. (2002). Distinguishing visuospatial working memory and complexmental calculation areas within the parietal lobes. Neurosci Lett, 331(1), 45-49

Zago, L., Petit, L., Turbelin, M-R, Andersson, F., Vigneau, M., & Tzourio-Mazoyer, N. (2008). How verbal and spatial manipulation networks contribute to calculation: An fMRI study. Neuropsychologia, 46(9), 2403-2414. doi: 10.1016/j.neuropsychologia.2008.03.001

Siegler, R. S., & Ramani, G. B. (2009). Playing linear number board games—but not circular ones—improves low-income preschoolers' numerical understanding. Journal of educational psychology, 101(3), 545-560. doi: 10.1037/a0014239

Additional Reading Material:

Dehaene, S. (1992). Varieties of numerical abilities. Cognition, 44(1–2), 1-42. doi: 10.1016/0010-0277(92)90049-n

Dehaene, S. (1995). Towards an anatomical and functional model of number processing. Mathematical Cognition, 1(1), 83.

Dehaene, S., Piazza, M., Pinel, P., & Cohen, L. (2003). Three parietal circuits for number processing. Cogn Neuropsychol, 20(3), 487-506.

Feigenson, L., Dehaene, S., & Spelke, E. (2004). Core systems of number. Trends in Cognitive Sciences, 8(7), 307-314.

Rubinsten, O., Henik, A., Berger, A., & Shahar-Shalev, S. (2002). The Development of Internal Representations of Magnitude and Their Association with Arabic Numerals. Journal of Experimental Child Psychology, 81(1), 74-92. doi: 10.1006/jecp.2001.2645

Revkin, S. K., Piazza, M., Izard, V., Cohen, L., & Dehaene, S. (2008). Does subitizing reflect numerical estimation? Psychol Sci, 19(6), 607-614. doi: PSCI2130 [pii]

Piazza, M., Fumarola, A., Chinello, A., & Melcher, D. (2011). Subitizing reflects visuo-spatial object individuation capacity. Cognition, 121(1), 147-153. doi: S0010-0277(11)00132-6 [pii]

Stanescu-Cosson, R., Pinel, P., van De Moortele, P. F., Le Bihan, D., Cohen, L., & Dehaene, S. (2000). Understanding dissociations in dyscalculia: a brain imaging study of the impact of number size on the cerebral networks for exact and

approximate calculation. Brain, 123 (Pt 11), 2240-2255

Geary, D. C. (2004). Mathematics and learning disabilities. J Learn Disabil, 37(1), 4-15.

Rivera, S. M., Reiss, A. L., Eckert, M. A., & Menon, V. (2005). Developmental changes in mental arithmetic: evidence for increased functional specialization in the left inferior parietal cortex. Cereb Cortex, 15(11), 1779-1790.

Cantlon, J. F., Brannon, E. M., Carter, E. J., & Pelphrey, K. A. (2006). Functional imaging of numerical processing in adults and 4-y-old children. PLoS Biol, 4(5), e125.

Cantlon, J. F., Libertus, M. E., Pinel, P., Dehaene, S., Brannon, E. M., & Pelphrey, K. A. (2009). The neural development of an abstract concept of number. J Cogn Neurosci, 21(11), 2217-2229. doi: 10.1162/jocn.2008.21159

Bull, R., Espy, K. A., & Wiebe, S. A. (2008). Short-Term Memory, Working Memory, and Executive Functioning in Preschoolers: Longitudinal Predictors of Mathematical Achievement at Age 7 Years. Developmental Neuropsychology, 33(3), 205-228. doi: 10.1080/87565640801982312

De Smedt, B., & Boets, B. (2010). Phonological processing and arithmetic fact retrieval: Evidence from developmental dyslexia. Neuropsychologia, 48, 3973-3981.

De Smedt, B., Taylor, J., Archibald, L., & Ansari, D. (2010). How is phonological processing related to individual differences in children's aritmetic skills. Developmental Science, 13, 508-520.

Prado, J., Mutreja, R., Zhang, H., Mehta, R., Desroches, A. S., Minas, J. E., & Booth, J. R. (2011). Distinct representations of subtraction and multiplication in the neural systems for numerosity and language. Hum Brain Mapp. doi: 10.1002/hbm.21159

Ischebeck, A., Zamarian, L., Siedentopf, C., Koppelstätter, F., Benke, T., Felber, S., & Delazer, M. (2006). How specifically do we learn? Imaging the learning of multiplication and subtraction. Neuroimage, 30(4), 1365-1375. doi: 10.1016/j.neuroimage.2005.11.016

Course/Module evaluation:

End of year written/oral examination 60 %
Presentation 30 %
Participation in Tutorials 10 %
Project work 0 %
Assignments 0 %
Reports 0 %
Research project 0 %
Quizzes 0 %
Other 0 %

Additional information:

In the case that on campus test will not be possible, online test using the model, will replace the on campus test.