ECRONICON OPEN ACCESS

EC PSYCHOLOGY AND PSYCHIATRY
Editorial

Rain Man Unmasked: An 'Escape' of Language from the Left Hemisphere Unlocks Working Memory for Numbers

Michal Klichowski*

Faculty of Educational Studies, Adam Mickiewicz University in Poznan, Poznan, Poland

***Corresponding Author:** Michal Klichowski, Faculty of Educational Studies, Adam Mickiewicz University in Poznan, Poznan, Poland.

Received: August 09, 2017; **Published:** September 04, 2017

Representations of numbers are closely related to representations of language [1-5]. However, the dynamics of the relation between numbers and language remain unclear [6]. For example, some researchers assume that language is indispensable to processing precise numerical values, others that symbolic numbers larger than 4 are represented through language, and yet others that all numbers are processed in language brain regions [7-15]. On the other hand, there is also evidence that representations of numbers can be right lateralized; therefore, they must be independent from language [16-20].

In a recent study with my colleague [21] we found that the relation between language and numbers is even more complex. As figure 1 shows, our main findings indicate that numbers can in a sense block access to linguistic concepts. More precisely, when working memory is substantially engaged in number processing (even a few seconds before) there is a functional reorganization of language skills in the form of their weakened laterality.

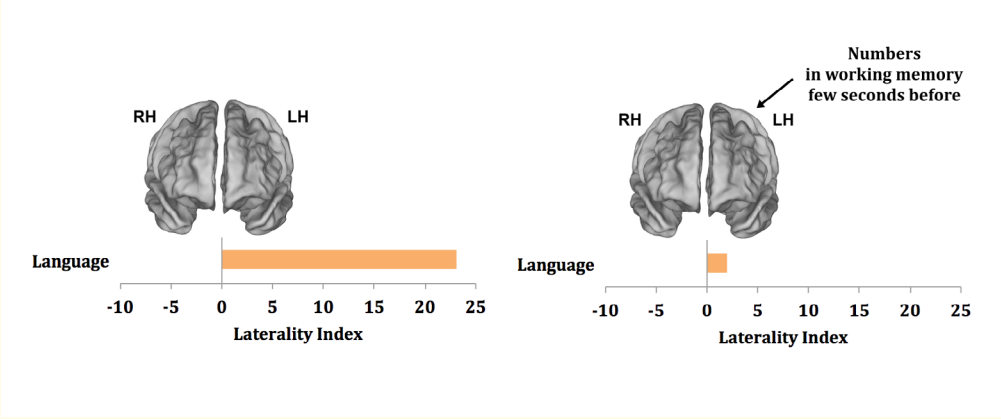

Figure 1: *Lateralization of language and number processing. A study by Klichowski and Kroliczak shows that after a substantial engagement of working memory by numbers, there is a functional reorganization (weakened laterality) of language processing. LH – left hemisphere, RH – right hemisphere.*

Our results [21] are hard to explain because numerous studies show that a general phenomenon is left-hemispheric dominance for language [22-32]. Therefore, it looks like that the engagement of working memory by numbers can lead to a "temporary escape of language" from the left hemisphere. Thus, numbers can in a sense block the "smooth" processing of language. This finding sheds a new light

on abilities of mathematical savants, like Raymond Babbitt from *Rain Man*, with exceptional counting skills but poor language command [33-34]. Mathematical savants' language is not "smooth" and rather limited to single word utterances [35]. This is probably why all resources of their working memory (located in the left hemisphere [36]) can be devoted to such exceptional counting. Nevertheless, it is only a hypothesis and thorough research on this problem and further debates are still necessary.

Bibliography

1. Blanco-Elorrieta E and Pylkkanen L. "Composition of complex numbers: delineating the computational role of the left anterior temporal lobe". *NeuroImage* 124 (2016): 194-203.

2. Houde O and Tzourio-Mazoyer N. "Neural foundations of logical and mathematical cognition". *Nature Reviews Neuroscience* 4 (2003): 507-514.

3. Iversen W., *et al*. "The influence of an external symbol system on number parity representation, or what's odd about 6?" *Psychonomic Bulletin and Review* 13.4 (2006): 730-736.

4. Lyons IM., *et al*. "Qualitatively different coding of symbolic and nonsymbolic numbers in the human brain". *Human Brain Mapping* 36.2 (2015): 475-488.

5. Nieder A. "Counting on neurons: the neurobiology of numerical competence". *Nature Reviews Neuroscience* 6.3 (2005): 177-190.

6. Castro A., *et al*. "How do incorrect results change the processing of arithmetic information? Evidence from a divided visual field experiment". *Laterality* 19.3 (2014): 340-353.

7. Agren M and van de Weijer J. "Number problems in monolingual and bilingual French-speaking children". *Language, Interaction and Acquisition* 4.1 (2013): 25-50.

8. Dehaene S., *et al*. "Three parietal circuits for number processing". *Cognitive Neuropsychology* 20.3 (2003): 487-506.

9. Macizo P., *et al*. "Is there cross-language modulation when bilinguals process number words?" *Applied Psycholinguistics* 31.4 (2010): 651-669.

10. Prior A., *et al*. "Number word structure in first and second language influences arithmetic skills". *Frontiers in Psychology* 6 (2015): 266.

11. Purpura DJ and Reid EE. "Mathematics and language: individual and group differences in mathematical language skills in young children". *Early Childhood Research Quarterly* 36 (2016): 259-268.

12. Semenza C., *et al*. "Is math lateralised on the same side as language? Right hemisphere aphasia and mathematical abilities". *Neuroscience Letters* 406.3 (2006): 285-288.

13. Spelke ES and Tsivkin S. "Language and number: a bilingual training study". *Cognition* 78 (2001): 45-88.

14. Van Rinsveld A., *et al*. "The relation between language and arithmetic in bilinguals: insights from different stages of language acquisition". *Frontiers in Psychology* 6 (2015): 265.

15. Zhang X. "Linking language, visual-spatial, and executive function skills to number competence in very young Chinese children". *Early Childhood Research Quarterly* 36 (2016): 178-189.

16. Bulthe J., *et al*. "Format-dependent representations of symbolic and non-symbolic numbers in the human cortex as revealed by multivoxel pattern analyses". *NeuroImage* 87 (2014): 311-322.

17. Butterworth B., *et al*. "Numerical thought with and without words: evidence from indigenous Australian children". *Proceedings of the National Academy of Sciences, USA* 105.35 (2008): 13179-13184.

18. Carreiras M., *et al*. "Numbers are not like words: different pathways for literacy and numeracy". *NeuroImage* 118 (2015): 79-89.

19. Gelman R and Butterworth B. "Number and language: how are they related?" *Trends in Cognitive Sciences* 9.1 (2005): 6-10.

20. Gobel S., *et al*. "The mental number line and the human angular gyrus". *NeuroImage* 14.6 (2001): 1278-1289.

21. Klichowski M and Kroliczak G. "Numbers and functional lateralization: a visual half-field and dichotic listening study in proficient bilinguals". *Neuropsychologia* 100 (2017): 93-109.

22. Bless JJ., *et al*. "Laterality across languages: results from a global dichotic listening study using a smartphone application". *Laterality: Asymmetries of Body, Brain and Cognition* 20.4 (2015): 434-452.

23. Hull R and Vaid J. "Bilingual language lateralization: a meta-analytic tale of two hemispheres". *Neuropsychologia* 45.9 (2007): 1987-2008.

24. Peng G and Wang WS-Y. "Hemisphere lateralization is influenced by bilingual status and composition of words". *Neuropsychologia* 49.7 (2011): 1981-1986.

25. Klichowski M and Przybyla T. "Does cyberspace increase young children's numerical performance? A brief overview from the perspective of cognitive neuroscience". In: H. Krauze-Sikorska and M. Klichowski (Eds.), Swiat malego dziecka. Przestrzen instytucji, cyberprzestrzen i inne przestrzenie dzieciństwa, Poznan: AMU Press (2017).

26. Krefta M., *et al*. "Co-lateralized bilingual mechanisms for reading in single and dual language contexts: evidence from visual half-field processing of action words in proficient bilinguals". *Frontiers in Psychology* 6 (2015): 1159.

27. Kroliczak G. "Praxis in left-handers". *Kultura i Edukacja* 99.6 (2013): 5-31.

28. Kroliczak G and Frey SH. "A common network in the left cerebral hemisphere represents planning of tool use pantomimes and familiar intransitive gestures at the hand-independent level". *Cerebral Cortex* 19.10 (2009): 2396-2410.

29. Kroliczak G., *et al*. "Atypical lateralization of language predicts cerebral asymmetries in parietal gesture representations". *Neuropsychologia* 49.7 (2011): 1698-1702.

30. Kroliczak G., *et al*. "Specialization of the left supramarginal gyrus for hand-independent praxis representation is not related to hand dominance". *Neuropsychologia* 93 (2016): 501-512.

31. Kubiak A and Kroliczak G. "Left extrastriate body area is sensitive to the meaning of symbolic gesture: evidence from fMRI repetition suppression". *Scientific Reports* 6 (2016): 31064.

32. Przybylski L and Kroliczak G. "Planning functional grasps of simple tools invokes the hand-independent praxis representation network: an fMRI study". *Journal of the International Neuropsychological Society* 23.2 (2017): 108-120.

33. Corrigan NM., *et al*. "Toward a better understanding of the savant brain". *Comprehensive Psychiatry* 53.6 (2012): 706-717.

34. Pring L and Hermelin B. "Numbers and letters: exploring an autistic savant's unpractised ability". *Neurocase* 8.4 (2002): 330-337.

35. Bor D., *et al*. "Savant memory for digits in a case of synaesthesia and Asperger syndrome is related to hyperactivity in the lateral prefrontal cortex". *Neurocase* 13.5 (2008): 311-319.

36. Baddeley AD., *et al*. "Working memory and executive control [and discussion]". *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 351.1346 (1996): 1397-1404.

Volume 5 Issue 2 September 2017