BABEL: Bio-inspired Architecture for Brain Embodied Language – Berlin part

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Abstract:
Previous research in behavioural and cognitive neuroscience demonstrates a close link between the brain systems for language, action and perception. These parallel developments in behavioural and computational neuroscience, as well as in cognitive robotics and in neuromorphic engineering constitute a timely opportunity to synergistically integrate the interdisciplinary methods and approaches from these fields with the aim of furthering the scientific and technological progress in language processing in natural and artificial cognitive systems. The project proposes the interdisciplinary integration of new brain imaging experiments, of neuro-anatomical computational and neuromorphic studies, and of humanoid robotics experiments in order to characterise the brain mechanisms supporting language learning in an embodied and pragmatic (situated) context, and to design and test novel brain-inspired neural technologies for action and language learning experiments with interactive intelligent systems such as humanoid robots. This integrative approach is supported by the establishment of a highly interdisciplinary project team with an international track record in behavioural neuroscience of language (Pulvermüller), computational neuroscience (Wennekers, Garagnani, Tomasello), neuromorphic engineering (Furber) and cognitive and neuro-robotics (Cangelosi).

Background publications:

Garagnani M, Pulvermüller F (2013) Neuronal correlates of decisions to speak and act: Spontaneous emergence and dynamic topographies in a computational model of frontal and temporal areas. Brain Lang 127:75–85 Available at: http://www.ncbi.nlm.nih.gov/pubmed/23489583.

Pulvermüller F (2013) How neurons make meaning: Brain mechanisms for embodied and abstract-symbolic semantics. Trends Cogn Sci 17:458–470 Available at: http://www.ncbi.nlm.nih.gov/pubmed/23932069 [Accessed March 29, 2014].

Pulvermüller F, Garagnani M (2014) From sensorimotor learning to memory cells in prefrontal and temporal association cortex: A neurocomputational study of disembodiment. Cortex 57:1–21.

Pulvermüller F, Garagnani M, Wennekers T (2014) Thinking in circuits: toward neurobiological explanation in cognitive neuroscience. Biol Cybern 108:573–593.

Key publications:

Garagnani M, Lucchese G, Tomasello R, Wennekers T, Pulvermüller F (2017) A Spiking Neurocomputational Model of High-Frequency Oscillatory Brain Responses to Words and Pseudowords. Front Comput Neurosci 10:1–19 Available at: http://journal.frontiersin.org/article/10.3389/fncom.2016.00145/full.

Garagnani M, Pulvermüller F (2016) Conceptual grounding of language in action and perception: A neurocomputational model of the emergence of category specificity and semantic hubs. Eur J Neurosci 43:721–737 Available at: http://doi.wiley.com/10.1111/ejn.13145.

Garagnani M, Wennekers T, Pulvermüller F (2008) A neuroanatomically grounded Hebbian-learning model of attention-language interactions in the human brain. Eur J Neurosci 27:492–513 Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2258460&tool=pmcentrez&rendertype=abstract [Accessed April 1, 2014].

Kiefer M, Pulvermüller F (2012) Conceptual representations in mind and brain: Theoretical developments, current evidence and future directions. Cortex 48:805–825 Available at: http://www.ncbi.nlm.nih.gov/pubmed/21621764 [Accessed July 10, 2014].

Pulvermüller F, Fadiga L (2010) Active perception: sensorimotor circuits as a cortical basis for language. Nat Rev Neurosci 11:351–360 Available at: http://dx.doi.org/10.1038/nrn2811.

Schomers MR, Garagnani M, Pulvermu F (2017) Neurocomputational Consequences of Evolutionary Connectivity Changes in Perisylvian Language Cortex. J Neurosci 37:3045–3055.

Tomasello R, Garagnani M, Wennekers T, Pulvermüller F (2017) Brain connections of words, perceptions and actions: A neurobiological model of spatio-temporal semantic activation in the human cortex. Neuropsychologia 98, 111-129.

Wennekers T, Garagnani M, Pulvermüller F (2006) Language models based on Hebbian cell assemblies. J Physiol Paris 100:16–30 Available at: http://www.ncbi.nlm.nih.gov/pubmed/17081735 [Accessed April 9, 2014].