Verification of the neural noise hypothesis of dyslexia

Good reading skills are very important for success in the modern world. Why reading can be so difficult for so many children who are otherwise of normal intelligence remains still a mystery. Despite the fact that reading difficulties are present in every language and do not remit with age or time, the exact neurobiological mechanisms of reading ability and disability remain unknown. The current project aims at verifying "neural noise hypothesis of dyslexia", which suggest that reading disorder is a consequence of deficits in neurotransmission. Glutamate, the main excitatory neurotransmitter in the human brain, is supposed to have elevated concentration in dyslexic individuals, which may contribute to impaired reading through excessive excitatory activity (hyperexcitability) resulting in heightened noise and instability in information processing. Heightened noise affects encoding of sensory information and produces impairments in multisensory integration and phonological awareness, key components of reading development. The proposed project aims at providing a direct test of the neural noise hypothesis by adopting an interdisciplinary approach of studding hyperexcitability and neural noise, cognitive skills and behavior in typical and dyslexic readers.

Since previous studies examining glutamate concentration in dyslexia during rest are inconclusive, here for the first time we will test neurotransmitter concentration during reading (using the so called functional magnetic resonance spectroscopy (fMRS) in 120 youth participants with and without dyslexia. According to the neural noise hypothesis, heightened glutamate should characterize dyslexic readers. We will explore whether this effect is related to stimulation (rest, reading words or viewing false font strings) or region specific (we expect group differences only in the reading brain network). To increase signal to noise ratio we will employ high-field fMRS at 7T scanner. Additionally, in each subject we will measure neural noise from EEG power spectrum during rest and natural speech processing. This method has been proven useful for studying the effects of neural noise in other disorders associated with increased noise. Finally, we plan to relate neurotransmitter concentration to measures of neural noise from EEG and cognitive performance (phonological awareness, lexical access and multisensory integration, assumed to be affected by neural noise) to discern whether the observed effects in neurotransmitter levels are linked to neural noise and its effects on cognitive performance.

The findings will point to new directions for research on brain-behavior pathways in human studies of reading disability. Such knowledge can help educators facilitate reading in children who might otherwise struggle. This line of research has the potential to offer the basis for creating evidence-based educational interventions and treatment, both pharmacological and physiological, bridging the gap between neuroscience and education. The proposed research has also the potential to advance cognitive neuroscience beyond the area of reading research by establishing links between specific neurotransmitters, hyperexcitability, neural noise and cognitive abilities.