Even though the comprehensive biological and behavioral functions of sleep largely remain unknown, much evidence supported that human sleep must be of sufficient duration and physiological continuity to ensure coherent levels of neurocognitive performance while we are waking. Insufficient sleep increases includes increased reaction times, lower accuracy, and higher variability, which leads to high risk of human-error related accidents, injuries or even fatal outcomes. However, in modern society, more and more people suffer from sleep deprivation because of the increasing social, academic or occupational demand. It’s important to study at the impact of sleep deprivation not only in performance impairment, but in neurocognitive function. Researchers have been exploring brain functional integration, which demonstrates the interaction of activated brain areas, to improve our understanding of how the brain processes information. Functional connectivity mapping is the most widely used methods to identify temporal correlation between spatially remote areas. However it only provides us a unidirectional connectivity. More researches about directed influence between regions are needed.

The objective of this research is to identify the brain effective and directed connectivity pattern associated with one emergent performance impairment, attentional lapsing, induced by sleep deprivation. 10 healthy young women, with an average age of 25-years-old, performed saccadic eye movement spatial-attention tasks under two conditions: rested wakefulness (RW) where participants had their usual sleep and (2) after undergoing sleep deprivation (SD) of 3 h/night for 7 nights (amounting to 21 h of sleep debt). During each experiment, eye-position was monitored, when human functional magnetic resonance imaging was performed simultaneously.

AVONA analysis showed significant difference of response latency between full-rested condition and sleep-deprived condition, but no significant changes of performance accuracy. A short window granger causality analysis was applied to fMRI time series data to identify effective lobe-wise influence among 10 brain lobe areas with consideration of temporal variation. Thereafter, subject-level and group level brain connectivity map was formulated with an average granger causality approach. At last, I linked the dynamic connectivity pattern with performance behavior and therefore determined the connectivity pattern as an indicator of the performance impairment.