Abstract

Research on mental disorders and cognitive phenomena of the brain has attracted the attention of researchers in recent years. Providing computational models for simulating mental disorders and cognitive phenomena is considered as one of the successful research approaches which has been proposed by neuroscientists and neuroengineers. Artificial neural networks, inspired by the biological structure and cognitive functions of the human brain, have been developed as one of the foundations of cognitive computational modeling. Analyzing the dynamics of complex interactions between the internal components of these networks using chaos theory opens new doors for understanding the unexplored aspects of mental disorders and cognitive phenomena.

In this research, using artificial neural networks and chaotic analysis of network components, we present a novel model for Alzheimer's disease and attention deficit disorder (ADD). We also introduce new models for cognitive phenomena including neuronal synchronization, synaptic synchronization, and synaptic plasticity. Brain trauma injuries are also simulated using artificial neural networks.

The results of the research show that neuronal synchronization appears in the lower layers of the brain during the learning process, but as the level of the layers increases, synchronization disappears. The simulations also demonstrate a new phenomenon called synaptic synchronization which makes it possible to illustrate the dynamics of the synaptic plasticity in the brain. The new model for ADD which is associated with intermittent behavior in chaotic systems, provides a wide variety of macroscopic, mesoscopic and microscopic analysis of the disease, as well as drug intervention effects. Simulating the brain trauma injuries makes it possible to individually investigate memory formation and memory recall steps while illustrating the effect of chaotic and non-chaotic synapses in learning process separately.