Abstract

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Title of the thesis: Chromoneurodynamics, Ambiguity and Creative Cognition: A new approach of study in the realm of Statistical and Quantum Physics

Submitted by: Souparno Roy

Recently, physicists have become seriously interested in understanding primarily the functions of human brain giving special emphasis to cognitive domain. Rigorous tools of statistical physics have been applied and a lot of interesting reports have come up in the literature. A part of the present work is focused on the study of the effect of acoustic and photic stimuli on cognitive aspect of the brain. Both the stimulus (acoustic signals) and the stimulus induced bio-signals (complex Electroencephalograph or EEG waveforms) are analysed with non-linear chaos-based techniques like MFDFA and MFDXA. Utilizing the observed changes in autonomic nervous system (experimentally obtained from a time series of EEG signals) due to exposure to external stimulus and the changes in stimulus complexity with its cognitive correlates (usually mediated through emotion), unprecedented effects of visual and auditory information on the neurocognitive domain were identified.

Also, Sequences of symbols carrying information is a common trait found in nature, including heartbeats and genetic codes to human language. Human cognition, similarly, is exhibitive of and responsive to such complex dynamical structures. Music is an explicit example of this. How to quantify these informative symbolic sequences based on the occurrence and rank of repetitive patterns is an interesting and open question. The second part of the work deals with analysing the acoustic stimuli with statistical tools (Maxwell-Boltzmann and Bose-Einstein distributions) in an attempt to structurally assess the dynamic nature of the stimulus in relation to their arousal invoking potential. The effectiveness of the methods in characterizing acoustical information could prove to be a stepping stone to determine their contribution in affective response as well.

The third part of the work is focused on the aspect of the longstanding mind vs. brain problem. The human brain, are nothing more, and nothing less, than atoms joined together to form molecules, bounded into specialized cells which can communicate with each other. Many luminaries have pondered on the mysterious ways in which such congregation of matter can give rise to the bewildering world called mind. In recent times, Quantum theory has found an increasing application in explaining the functional nature of human cognition. The application of Quantum theory to human cognition is driven not only by deep resonations between basic notions of quantum theory and psychological conceptions and intuitions, and also by the potential of the theory to provide coherent and mathematically principled explanations for the challenges in cognitive research. In this part, an attempt was made to find non-classical traits in human cognitive domain and to develop a model possibly describing its dynamics in the light of Quantum Physics.

The approaches described in this thesis to understand neurocognitive domain, with acousticaland visual stimuli, from the perspective of hard-core physics are unique in global scenario and may help in casting new lights on the functioning of brain and cognition.

PROFESSOR DIPAK GHOSH
EMERITUS PROFESSOR
SIR C.V. RAMAN CENTRE
for PHYSICS and MUSIC
JADAVPUR UNIVERSITY

Dipak Ghosh 28/09/2022

Souparno Roy 28/09/2022
Full signature of the candidate

2. Ranjan Sengupta 28/09/2022
Full signature of the supervisors

SIR CV RAMAN CENTRE
for PHYSICS and MUSIC
Jadavpur University
Kolkata - 32. India