An Experimentation Framework Towards Longitudinal Analysis of EEG/ERP data to Assess Brain Plasticity

R.N Rajapakse[#1], A.J. Rubasinghe[*2],

[#]*University of Colombo School of Computing, Colombo, Sri Lanka*

[1] r.n.r@ieee.org

[*]*Vindana Reproductive Health Centre, Colombo, Sri Lanka*

[2] amilajr1@gmail.com

***Keywords*— Neuroplasticity, EEG (Electroencephalography), ERP (Event related Potentials), EEG profile**

Whilst there are many studies at present conducting research on brain related activities, many of its functions still remain a mystery. Neuroplasticity is one such area specifically in relation to its effects and changes in brain disorders. Devising an experimentation framework towards longitudinal assessment of brain plasticity related to learning and rehabilitation via electrophysiological markers based "EEG profiles" is the main research aim of this study.

Literature states that pertaining to human subjects, the efficacy of the mechanisms of brain plasticity changes over a lifetime, where it does so from variable starting points with variable slopes depending on complex interactions between genetic and environmental factors. Thus if one were to assess the variation of brain plasticity pertaining to a human subject, it should be done predominately in a case by case basis. We present the concept of "EEG Profiles" which are aimed at encapsulating various electrophysiological markers of EEG (Electroencephalography)/ ERP (Event Related Potentials) data, where such a profile is created for each subject aimed at longitudinal analysis of plastic changes in the brain. The following parameters will be included in a profile;

1. Experiment centric averaged ERP component parameters
2. Oscillatory dynamics/ spatial characteristics of EEG data related parameters

Whilst in most previous studies which use EEG/ERP as electrophysiological input they have focused on using only one of the above mentioned paradigms in their research, we believe that one can obtain a more comprehensive account of the underlying cognitive processes via combining them. Thus in this study which expects to analyse intrinsic processes of the brain, we consider this approach will be the best way forward. Once the profile is established, then the requirement would be to complete the parameters for a period sufficient for a longitudinal analysis of this nature. Since the aim of the research is to study inherent processes with regard to the functioning of the brain, the experiments should be devised in a manner that captures neural oscillations pertaining to the same. The following experimentation designs are proposed:

- **Experimentation design 01: Multiple cognitive processing strategies**

Experiment designs with multiple cognitive processing strategies are planned to be conducted where the participants will be required to perform cognitive tasks which are novel to them (As opposed to tasks familiar to them which then will be mainly based on memory retrieval). In the proposed experiments the ERP eliciting stimulus' are planned to be ones where the participants will be required to use new cognitive skills, hence opening the possibility to a link with plastic changes in the brain.

- **Experimentation design 02: Selective alternation of ERP components**

Previous studies have stated that selective alternation of a single ERP component via auditory/visual stimuli constitutes a form of synaptic plasticity. We believe that such alternations of specific components in ERP waveforms can be studied more effectively via the aforesaid EEG profile. Further it should be noted that these studies lay as evidence that auditory/ visual stimulus' alone can be used to induce long-lasting effects on neuronal responses in cerebral cortex. Profiling these responses in a subject by subject basis would be thus, a suited method to validate whether these aforementioned effects are truly plastic changes in the brain.

These tasks and its variations are planned to be conducted on the same subjects over a period of time observing the same parameters noted by the earlier experiments (as captured by the EEG profile). The temporal ordering of the aforementioned observations will then be studied using longitudinal data analysis techniques. Well known techniques of analysing EEG data will be used in this study, where the oscillatory dynamics are planned to be studied via MATLAB and the ERP based analysis by using ERPLAB/EEGLAB tools.

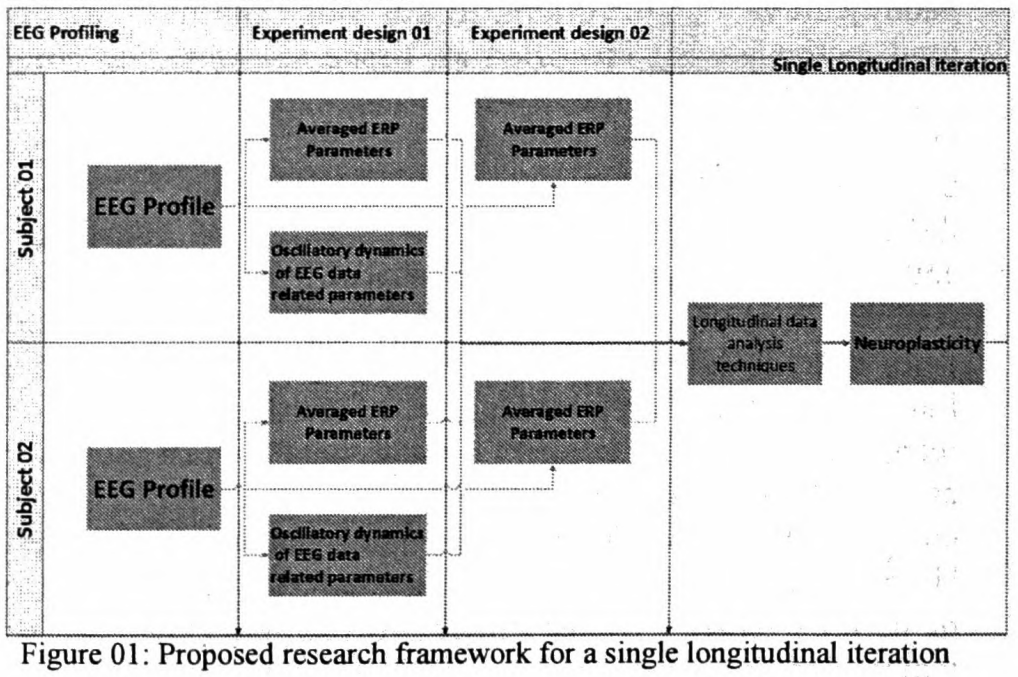

Figure 01: Proposed research framework for a single longitudinal iteration

In the rehabilitation process from a brain disorder if the treatment is effective, it is fair to assume that plastic changes would take place in the brain. Thus, it can be reasoned that if the above framework is effective, it could lead to new ways of assessing rehabilitative methods for brain disorders.