2021 43rd Annual International Conference of the
IEEE Engineering in Medicine & Biology Society (EMBC)
Oct 31 - Nov 4, 2021. Virtual Conference

Sensory Gating Measurements Through a Novel Vibration System

Jean-Paul B. Badjo and Fow-Sen Choa, *IEEE*

***Abstract*— This work demonstrated using vibrational motors to provide the double-click stimulus signal via the peripheral nerve system to measure the sensory gating (SG) effect. The system is portable and benefits from doing SG monitoring without adding workloads to the visual or auditory system.**

***Clinical Relevance*— Portable medical devices are beneficial to the populace because they enable individuals to monitor brain disorders or define mechanisms for treatment quantitatively as they can convey information from diagnosis. These devices are critical in the healthcare sector, which is currently undergoing gradual digitalization, emphasizing prevention rather than cure and moving towards patient-centered care and personalized medicine.**

I. INTRODUCTION

Sensory gating (SG) refers to the ability of the neurological process to remove unnecessary or redundant stimuli during information processing to prevent higher-level cortical neural network layers from being flooded with irrelevant information [1]. It represents the quantitative measures of a person's mental strength. In terms of clinical applications, SG effect has been successfully used to quantitatively measure the abnormality of a wide range of disorders including schizophrenia, bipolar, autism spectrum disorders, attention-deficit /hyperactivity disorders, Parkinson's disease, cocaine abuse, and depression. However, all existing SG measurement are done in laboratories making it less convenient to be used for real time health or treatment monitoring. To accomplish portable personal health monitoring functions like commercial smart watches, new measurement modality must be developed. In this research we try to accomplish SG measurement by using the touch sense in the peripheral nerve system rather than the classic visual or auditory based systems. The system can be portable and operated in the field without adding further visual and auditory load to the user. We consider a few potentials related to events that represent sensory gating: Pre-attentional filtering of sensory information (P50), attention activation and the process of allocation (N100), neutral face, object, or word's processing (N170), and processes tasked with evaluating or categorizing stimulus (P300) [2].

II. METHODS

As shown in Fig. 1, Arduino microcontroller and other vibrational motors are used to develop and program a vibrational system. The vibrational system is designed to repeat subject vibration sequences as the recording of the electroencephalogram (EEG) data is done: no vibration (0-2s), vibration (2-2.01), no vibration (2.01-2.51), vibration (2.51-2.52), and no vibration (2.52-10.52). Using an emotiv epoc flex, the EEG of the subject is recorded, with the sequence being repeated 30 times. The human sensory system takes 10 seconds to reset after receiving a stimulus. The data obtained is then averaged. Two subjects are examined.

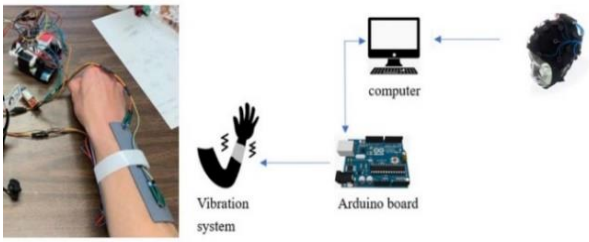

Figure 1. EEG event related potentials are synchronously collected with programmed double-clicked vibrational sequences.

III. RESULTS

Using vibration stimuli, in Fig. 2, we obtained very reasonable SG measurement results, compatible with results using auditory stimuli, from both subjects examined. SG effects were evident in the P50, N100, N170, and P300 described by reducing ERP amplitude peaks of second stimuli (S2). For the first subject, the S2/S1 ratio of the P50 potential was 0.23. The ratio was 0.76 for the second subject. The obtained ratio tends to be low if the gating inhibition of the subject is normal and strong.

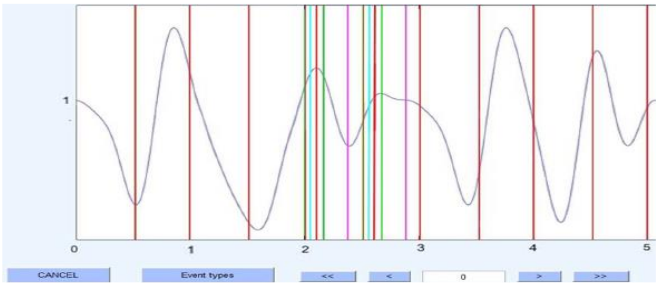

Figure 2. Measured ERP signals from subject 1: 5 seconds of the 10.52 seconds processed recording (30 times average). V-axis full scale: 10 microvolts. The blue/green lines regions are correspondig to the activation double clicks.

IV. DISCUSSION & CONCLUSION

This work demonstrated that sensory gating effects can go through the peripheral nerve system similar to classical auditory sensory experiments. In the future, it will be possible to track the sensory gating and EEG, 24 hours a day.

REFERENCES

[1] Cromwell H. C., Mears R. P., Wan L., and Boutros N N, "Sensory Gating: A Translational Effort From Basic to Clinical", Clin EEG Neurosci. 2008 April ; 39(2): 69-72.

[2] Introductory guide to EEG & BCI for Entertainment, Available at: neurosky.com/wp-content/uploads/2016/06/Intro-Guide-EEG-BCI.pdf

* This research was supported by NSF grant ECCS-1631820

J. B. Badjo and F-S Choa are with the University of Maryland Baltimore County, 1000 Hilltop Cir, Baltimore, MD 21250 USA; e-mail: bad5@umbc.edu and choa@umbc.edu