EEG demonstration: recording evoked potentials beyond the laboratory

Ángel de la Torre[1, 2]

[1] Department of Signal Theory, Telematics and Communications, University of Granada, Granada, Spain
[2] Research Centre for Information and Communications Technologies, University of Granada, Granada, Spain
* *Contact:* atv@ugr.es

Keywords: biopotential, instrumentation amplifier, common mode noise, auditory evoked potentials.

Abstract. Our research team focuses on developing methods that enable the acquisition of auditory evoked potentials (AEPs) without the need for expensive infrastructures such as shielded booths or costly recording systems. The goal is to promote the utilization of evoked potentials in clinical, research, education and/or dissemination contexts, ultimately leading to a deeper knowledge and understanding of audiology within our society.

Acquiring auditory evoked potentials poses important technical challenges due the low amplitude of the biopotential signals and the presence of noise. To achieve high-quality AEPs, various methods are employed to mitigate the effect of the noise, such as using a low-noise instrumentation amplifier, increasing the number of stimuli, minimizing external interference, and reducing the internal myogenic activity. Averaging (or deconvolution) of responses involving a high number of stimuli improves the quality of the responses, yielding a 3 dB improvement with each doubling of stimuli, but this increases the duration of the exploration. In practical terms, the EEG noise primarily arises from electric interference of the power supply network, and is characterized by the presence of harmonics of 50 (or 60) Hz. This interference is essentially common-mode noise, and in an ideal scenario, an instrumentation differential amplifier with a high CMRR (common-mode rejection ratio) would eliminate it. However, due to imbalances in electrode impedances, the common-mode noise gets amplified through the differential gain of the amplifier. This is why AEP acquisition is usually conducted in shielded booths to minimize interference, and it is recommended to maintain balanced electrode impedances to reduce the amplification of common-mode noise.

We have developed a method for acquiring biopotentials, with dedicated hardware for recording both the signal of interest (usually contaminated by the common-mode noise) and an estimation of the common-mode noise. Both signals are then processed, resulting in biopotentials significantly less affected by the common-mode noise. In addition to the specific hardware, the acquisition system includes some inexpensive elements that can be acquired in the context of consumer electronics. As a result, AEPs can be recorded with a reasonable quality, within a practical exploration timeframe and with accessible infrastructure (in terms of instrumentation or shielded room requirements).

In the demonstration, we showcase the proposed biopotential recording system and conduct an analysis of the noise that affects the EEG, including myogenic noise and interference from the electric power line. Our focus is on attenuating the common-mode noise that contaminates the recorded signal. In the demonstration, we examine the effect of the common-mode noise on the recorded AEPs (estimated via deconvolution), and we show how the proposed methods enable the acquisition of AEPs outside of a laboratory setting (i.e., without expensive infrastructures) and within a reasonable recording time.

2023 International Workshop on Advances in Audiology
University of Salamanca, Salamanca, Spain, 25-27 May 2023