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Flexible Multi-Layer Semi-Dry Electrode for Measurement of Scalp EEG at Hairy Sites

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Abstract

The lack of suitable EEG electrodes for hairy sites is one of the main obstacles to daily wearable electroencephalogram (EEG) monitoring. Wet anodes require conductive gels, which will dry over the procurement time, making them shaky for long haul EEG checking. Additionally, the majority of dry electrodes' electrode–scalp impedances are insufficient for high-quality EEG collection at hairy locations. This study proposes a flexible multi-layer semi-dry electrode for EEG monitoring in light of the aforementioned issues. A reservoir layer, a foam layer, and a flexible electrode body layer make up the semi-dry electrode. The body layer of the electrode has a probe structure that lets the electrode work well at hairy locations. Electrolytes stored in the reservoir layer are continuously released through the foam layer to the electrode–scalp interface during long-term EEG monitoring, resulting in a lower contact impedance between the electrode and the scalp. The semi-dry electrode performed well in both static and dynamic EEG monitoring, where the temporal correlation with wet electrode signals at the hairy site could reach 94.25% and 90.65%, respectively, and specific evoked EEG signals could be collected. The experimental results showed that the average electrode–scalp impedance of the semi-dry electrode at a hairy site was only 23.89 7.44 K at 10 Hz, and it was less than 40 K over a long-term use of 5 The multi-layer, flexible semi-dry electrode is a promising option for daily, long-term monitoring of wearable EEGs at hairy locations on the scalp.

Keywords: EG • Semi-dry electrode • Flexible electrode • Multi-layer

Introduction

Any acute disruption to homeostasis following external or internal exposure is an example of an exposome factor that causes acutely stressed skin. As a result, a brief but powerful response is elicited by acute stress, which typically lasts between a few minutes and a few hours in humans and typically does not last more than a week. This response from the essential functions of the skin, such as pigmentation, the skin barrier, defenses (biochemical and immune/cellular), structure (extracellular matrix and skin appendages), neuroendocrine functions, and thermoregulation, aims to protect against the disturbance or quickly get rid of it and get back to homeostasis. In the current audit, focussing on grown-up skin, we depict individual exposome factors that get an intense pressure reaction and their comparing influence on the key skin capabilities [1].

Description

It demonstrates how the scalp lotion affected the severity of skin symptoms. At week zero, there were no skin symptoms that distinguished patients with atopic dermatitis from those with the other two diseases that were statistically significant. All 34 subjects showed significant improvement in dryness, scaling, erythema, and itchiness at the week 4 evaluation. Even at week 2, highly significant improvements in scaling, erythema, and itching were observed. At baseline (week 0), only 5 subjects had a score of 2 for scrubbing; by week 4, this number had dropped to 4. Patients with atopic dermatitis, seborrheic dermatitis, and pityriasis capitis all found the scalp lotion to be effective. Photographs of specific parts of the head that show how the symptoms have improved clinically. Scaling and erythema on all areas of the scalp were reduced at the conclusion of the study in patients with atopic dermatitis and seborrheic dermatitis.

Non-invasive EEG techniques were utilized in numerous previous studies to target human subjects, whereas invasive techniques, such as implant screws and pole-type electrodes, were utilized in animal studies. The invasiveness of the sensor placement greatly influences the signal quality and characteristics of these techniques. Garner stressed the importance of using the same conditions for animal research as for human research for successful translational research. Non-invasive EEG methods, on the other hand, are rare in basic animal research. A novel strategy employing a scalp EEG sensor system that is not invasive and focuses on laboratory mice would be a reliable and effective tool for translational research that could also be used with non-invasive human paradigms [2].

The goal of this study is to get around the issues with EEG-based decoding that have been brought up. Ecological validity, portability, and generalizability drive the current experimental paradigm and decoding work. Hence, we gained scalp EEG signals in a regular office setting utilizing a compact, easy to use, and remote EEG Enobio framework with 32 dry terminals. Noniconic views of everyday objects embedded in complex scenes of 23 distinct semantic categories from an open image database served as the experimental image stimuli. Similar to how real-world visual stimuli are experienced, each participant's image was unique and never repeated throughout the experiment. By averaging responses from images belonging to the same semantic category, we also developed generalized category representations and single-trial classifiers [3].

As a viable and industrially scalable dry contact electrode, we present a composite of electrically conductive carbon nanofibers distributed within a silicone elastomer matrix. The polydimethylsiloxane contained the carbon nanofibers at three distinct concentrations, all of which are above the threshold for electrical percolation. Electrical impedance decreases with increasing concentration of carbon nanofibers due to an increase in the number of conductive pathways. Even when some of the pathways are severed during deformation, the increased number of conductive pathways ought to make it possible to transmit the EEG signal. This is especially important because dry

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EEG electrodes may be susceptible to some degree of flexion during active movements but must typically be slightly compressed in order to maintain contact with the scalp. It is well known that adding filler to a polymer affects the material's processability as well as its final mechanical properties, making it stiffer and possibly less comfortable. Therefore, when designing and selecting a material, there is a tradeoff between electrical properties and mechanical properties that must be carefully considered. Consequently, it is essential to investigate the connection between the material formulation's mechanical properties, mechanical deformation, and electrical responses [4].

Twenty-three blocks of trials, each with thirty images, were presented to participants. For each participant, the order of the categories and the images within them was chosen at random. A probe word indicating the category name was displayed for five seconds at the beginning of each category, followed by the 30 images from that category. A mid-grey background framed each image for one second. Between each image, intervals (ISIs) of varying length were displayed. The ISI consisted of a white fixation cross superimposed on a mid-grey background in the center of the screen to minimize eye movements between trials. The ISI length was randomly sampled according to a uniform distribution from a fixed list of ISI values between 1.85 s and 2.15 s in 50 ms intervals [5].

Conclusion

The issue here is that the amplifier's input impedance will degrade regardless of the resistance value. Although the amplifier's built-in protection circuits can effectively prevent electrical overstress at the input node and degradation of the high input impedance, the proposed electrode does not include the design of the bias current path.

Acknowledgement

None.

Conflict of Interest

The authors declare that there is no conflict of interest associated with this manuscript.

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