Share What’s in Your Mind: A Non Invasive Brain Computer Interface Catering to Mental Health Disorders Utilizing Electroencephalogram Data Collection

A preliminary overview of data recording and analysis to benefit those struggling with mental health

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1. Introduction

The public opinion of mental health and its associated disorders as well as technological applications have improved to a parabolic extent within the modern information age, and such improvements are capable of working together to solve the mental health disorder epidemic. It is well known that decades ago common mental health disorders such as anxiety and depression were underplayed and misunderstood with archaic solutions. For example, cruel and ineffective procedure such as lobotomy were performed to the victims of mental health disorders. Today, such cruel applications are no longer used yet the issue of mental health is dire. Now that society better understands and respects the legitimacy of such disorders in thanks to scientific explanation and research, surely modern technology may be able to leverage such research to develop modern solutions that prevail upon such horrid solutions. By definition, mental disorders affect the brain and the technological application must follow in addressing our brains. Such a proposition provides an appropriate suggestion; That is, we must leverage the ever evolving science of computation with the science of our brains utilizing some sort of interface. Hence, let us look into brain computer interface applications that may contribute to mental health treatment as we know it today. Within the brain computer interface, data collection and analytics are integral for a successful implementation. EEG, or electroencephalogram, is especially applicable as it allows for the recording of electrical activity within our brains. Such a use case for the development and understanding of mental health disorders has been researched previously. One such notable example is *A Mindfulness-Based Brain-Computer Interface to Augment Mandala Coloring for Depression*, recently published by JMIR Research in June of last year. Although robust and awarded generally positive peer reviews, the study does includes several issues in its implementation. Firstly, the participants of this new BCI trial were allowed upon stringent basis. Those currently experiencing depression, inexperienced in device usage such as cell phone use were disbarred, or those using medications for their mental health [1]. Additionally, the study focuses upon the science of Mandala-Coloring, which uses visual interpretation of colors to analyze mood and well-being. Finally, the study addressees depressive disorder solely, and disregards other common disorders such as anxiety. As a result, it can be seen that further development is needed within the mental health space, and utilizing BCI via EEG is an interesting proposition. Thus, I propose a new application, aptly named ‘Share What’s in Your Mind’. As a play on the common phrase share what’s on your mind, this application would allow users to report instances in which they feel an abrupt onslaught of symptoms, or even report a time period in which the symptoms were noticed or overwhelming. Such an approach would include much broader availability than the Mandala Coloring study, as those currently experiencing symptoms or taking medications would be allowed. Of course, along with such an inclusion presents liability issues in the case of death. Thus, the device would also include easy access to signal severe distress and contact the appropriate physicians and authorities in an attempt to mitigate a potential tragedy. To further understand this proposition, we will next discuss the application of such an interface and its importance.

* 1. Application

One important aspect of a brain computer interface is the fact that the interface must be physically present on the patients body for use. Additionally, such devices are usually seen as a burden as they contain materials such as plastic, metals and wires which are uncomfortable. Thus, it may be more effective to ask the user to wear the device during certain times or activities to reduce potential discomforts and data obfuscation. Due to the nature of our solution in which relies on subjects signifying their symptoms, the subjects must be awake. Users also will come from all backgrounds and partake in differing activities. When considering such acknowledgments, it is important for users to utilize the device in a similar setting to reduce noise and complexity within our data for better analysis and an improved user experience. Thus, the users will only be allowed to utilize the device in the comfort of their home and with the condition they not partake in an intensive activity. One such example could include watching media, playing games, eating or snacking, or other ordinary tasks. Such context will prove effective as EEG data is greatly affected by movement [2], of which such tasks have very little. This approach proves effective as symptoms of common mental disorders occur at random intervals just as other disorders such as diabetes, headaches, or pain disorders do. Additionally, the context of one’s home will allow the user to end a session at his or her own leisure, easily charge the device, reduce concerns of losing or damaging the device, as well as reduce the potential stigma that comes along with wearing such a device in public. Though mundane, the activity of relishing in one’s home does impact society as a whole. Such an activity is what many consider a reward for their work and as such is representative of the ideals of our society. Once the user is ready to utilize the BCI device, they will remove it from their issued device charger and apply the device as headgear. The user will then go about their leisure and indicate when they believe symptoms occur via the headset itself. Finally, once the user would like to end the session, he or she will return the device and submit a quick survey on their specific actions during this activity. To illustrate this, consider the following example. As a remote college student, said student applies the device after the completion of schoolwork. During the session, he plays video games and suddenly feels an anxiety attack oncoming. After giving it another minute or so to be sure, he will signify his symptoms via pressing a button on the device. Once finished, he plugs in the device and submits his task(s) during this activity via a simple detachable I/O device such as a recording device. Another example may include someone that suffers from severe depression. After returning from work, the user is watching a movie when she suddenly notices an incoming depressive episode. She immediately indicates said episode via the device, but does not signify the distress indicator in which case proper aid would be immediately contacted. She is unable to finish her movie and resides in her bed. She also forgets to remove the device and awakes with it still on her head. The device is then plugged back in and she reports her movie and bed tasks and that she had fallen asleep with the device on, and continues with her day. This device allows flexibility for a user by adding limited leniency upon improper use. Additionally, it may act as an immediate call for help in the case of a severe attack. Finally, the device is comfortable enough such that a user may fall asleep while it is in use, though use while sleeping is not encouraged. Now that we have discussed the application of our BCI device, we must delve into the physical makeup of the device itself.

* 1. Apparatus

Considering the context of leisurely home tasks, it is important to consider common positions such as laying down or sitting in place for long periods of time with little movement. Such contexts are great for EEG data recording, and perpetuate a need for minimum materials such as plastics that affect laying down, cooking, and long periods of leisure. One solution to such an issue is the use of elastic materials similar to that used in clothes. Such an implementation will allow for the BCI to be non invasive. The elastic material must exists to a minimal degree and must not become too tight as to create pressure. For example, the makeup of the device may be similar to a face mask, sleeping mask, or headband covering the forehead and sides of the head. The aforementioned study also utilized a headband type physical makeup in their implementation [1]. The device will primarily record activity from the temporal lobe, which is known to signify traits such as mood and behavior, with additional emphasis on the frontal lobe which has also been shown to illustrate behavior [2]. As a result of such a placement, it is important to consider which electrodes will be placed in reference to the 10-20 international system. The electrodes most prevalent near the temporal lobe include mainly the F7, F8, T3, and T4 electrodes. As for the frontal lobe, electrodes FP1, FP2, F3, F4, F7, F8 also must be utilized in placement [2]. As a result, there exists overlap in the F7 and F8 between each lobe which must be considered in the data recording implementation. Utilizing our headband material and the following electrodes, an effective and non intrusive solution is possible to aid in our mental health analysis brain computer interface implementation. Beyond the planning of all aspects of such an implementation is the need for funding. Fortunately our device enables opportunity for fund raising which will be discussed below

* 1. Funding

The proposed BCI application Share What’s in Your Mind is unique in that its primary purpose is brain monitoring. Thus, the benefits of this application are not immediately experienced by the user. However, in the long term the device may be used to predict an incoming attack, help in assessment of proper application of medication, and act as an emergency communicator for those suffering from mental disorders. As a result, participants will likely seek monetary compensation for their efforts until such benefits become apparent. The policy for payment will likely include an agreement to terms such as the anonymous collection of user data and medication and require consistent and proper usage of said device. If either of these requirements are dissatisfied to a certain extent payment will not be awarded. Additionally, at least seven electrodes per device are required as well as the latex material. Charging solutions and integration such as a detachable recording device will also be required. As a result, the price per user will stand as a hurdle to the long term development and success of the application and user base. One such funding opportunity revolves around the fact that users currently using medication to ease their mental disorders are allowed to participate. The drug manufacturers in which produce medications for a certain subset of users may be interested in paying for recorded data in regards to users and their medication. Such data may prove helpful to them in the sense of research and development as well as advertising. Additionally, users may be specifically sought out depending on their medications to allow for a conducive trial of such medication using EEG and BCI; areas in which some manufacturers likely have not undertaken. This would allow for these companies to explore such technologies without diverting funds to create their own implementations and thereby saving the manufacturers money and resources while funding our application.

REFERENCES

1. C. D. Roquet, C. Sas, S. of C. and Communications, and C. A. C. D. Roquet, “A Mindfulness-Based Brain-Computer Interface to Augment Mandala Coloring for Depression: Protocol for a Single-Case Experimental Design,” *JMIR Research Protocols,* 01-Jun-2020. [Online]. Available: https://www.researchprotocols.org/2021/1/e20819/. [Accessed: 19-Apr-2021].
2. C. Crawford. “EEG”, *University of Alabama,* [Online]. Available at <https://ualearn.blackboard.com/.> Accessed [19-Apr-2021].