# CALIFORNIA STATE SCIENCE FAIR
# 2017 PROJECT SUMMARY

**Name(s)**

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**Project Number**

**S0415**

**Project Title**

## A Novel Cost-Effective Brain Computer Interface (BCI) System with Emoticons: An Approach for Paralyzed Patients

**Abstract**

**Objectives/Goals**

There is an increasing need for assistive devices as expressed by patients in critical care, with speech and language difficulties, as well as those with disabilities. As a result, the proposed system intends to bridge the gap in communication. Through this research, I projected to (1) compare the effectiveness of modern picture boards and the proposed emoticon board, (2) determine frequently used expressions of patients with Locked-in Syndrome (LiS), (3) develop a mock board as a prototype for an electronic communication board, and (4) integrate BCI technology to enhance a cost-effective communication system.

**Methods/Materials**

The study involved simulating a patient-caregiver interaction as volunteers generated and translated relevant messages. Prior to the study, messages were evaluated for uniformity using the L2 Syntactic Complexity Analyzer. Emoticons were strategically selected and categorized into a computerized system that enabled a maximum of seven emoticons as supported by Miller's Law. Participants (N=12) were randomly assigned to be the patient or the caregiver. The patient was first given a message to generate using the provided board. The caregiver translated the received message into an English sentence, which would be evaluated for accuracy by the patient. The BCI aspect was created using an Arduino micro controller, LCD touchscreen, and an EEG signal acquisition/amplification module and subsequently paired with the emoticon board.

**Results**

A total of 120 messages were interpreted; 63.3% of the messages were correctly interpreted using the emoticon board (mean time 112.45 seconds +/- 67.93) and 43.3% were correctly interpreted using the standard (mean time 146.62 seconds +/- 103.01). Even though the time to convey and interpret messages was not statistically different ($p=0.1443$), the emoticon board proved to be more accurate for decoding messages correctly. The frustration level was significantly lower ($p=0.0340$) using the emoticon board.

**Conclusions/Discussion**

The improved communication board not only addresses the inadequacies of the current system, but also can potentially reduce medical error and prevent serious health complications. The applications for emoticons are widespread as individuals face communication difficulties in the health system.

**Summary Statement**

This interdisciplinary study has led to the iterative development and simulative testing of an enhanced mode of communication, as enabled by Brain-Computer Interface and an emoticon-based board.

**Help Received**

Dr. An Do (UCI Department of Neurology; Director of the Brain-Computer Interface Lab) and Colin McCrimmon (MD-PhD student) were supportive in integrating the BCI aspect. The Neuroscience Electronics course material and specific guidance provided by Dr. Do proved to be instrumental.