MOOD DETECTION AND MEMORY PERFORMANCE EVALUATION WITH BODY SENSORS

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JJ1

Mood Detectors

They can be found in modern computers, laptops, smartphones, skin sensors, voice sensors, and more.	They can be carried everywhere and accessed anytime.	They feature lower costs, high speed, low power consumption, etc.

Slide 2

JJ1 Mood detectors can be found in modern computers, laptops, smartphones, skin sensors, voice sensors, and more. They can be carried everywhere and accessed anytime. They feature low costs, high speed, low power consumption, etc. They can be integrated in our daily lives to analyze mood and save lives.
Jonathan Jonathan, 2/26/2017

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THE SYSTEM

- The system requires BLE to work
- Mood is measured using brain and heart sensors, so it is very accurate
- Mood data and user data is sent to the web on a Dropbox web server, which is safe
- Mood data can be compared between users
- Mood data for each user can be graphed

Slide 3

JJ2 The system is an Android application written in Android Studio which is connected to body sensors communicating with it via Bluetooth Low Energy. The system requires BLE to work. Mood is measured using brain and heart sensors, so it is very accurate. Mood data and user data is sent to the web on a Dropbox web server, which is safe and secure. Mood data can be compared between users. Mood data for each user is graphed, so it makes it easy for the user to compare his/her mood on a daily basis.
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JJ3

BACKGROUND

- Mood and Memory Performance Algorithms
- Data Processing
- Resting Heart Rate
- Heart Rate Variability
- Valence/Arousal Model

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JJ3 The background is composed of the following sections: Mood and Memory Performance Algorithms, Data Processing, Resting Heart Rate, Heart Rate Variability, and the Valence/Arousal Model.

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JJ4

ALGORITHMS AND DATA PROCESSING

Algorithms

- Record Resting HR
- Record HRV
- Process EEG Data

Data Processing

- DC Offset Removed
- Tapered Window Function
- Fast Fourier Transform

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JJ4 First, we record the resting HR of the participants. Second, we record the heart rate variability of the participants. Third, we process the EEG data using the procedures described in the next subsections. Data processing works as follows: we remove the DC offset and slow drift of the raw signal. The data segment is then multiplied by a tapered window function. The FFT algorithm is then executed.

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RESTING HR AND HRV

Resting HR

- 60-100 bpm
- <60 bpm
- >100 bpm

HRV

- SDNN
- RMS-SD
- MRR

Slide 6

JJ5

The ideal resting heart rate is between 60-100 beats per minute. A resting heart rate lower than 60 could be explained by a medical condition such as taking drugs (beta blockers) or being very athletic. A resting heart rate higher than 100 could be explained by anxiety, and by smoking or drinking too much alcohol, and more... Heart rate variability (HRV) is the degree of fluctuation in the length of intervals between heart beats. A bigger regularity of heart beats lowers HRV and vice versa.   The SDNN is the standard deviation of the NN (Normal to Normal) intervals, which is the square root of their variance.   The RMS-SD is the square root of the mean squared differences of successive NN intervals. They (SDNN and RMS-SD) are measured in milliseconds.

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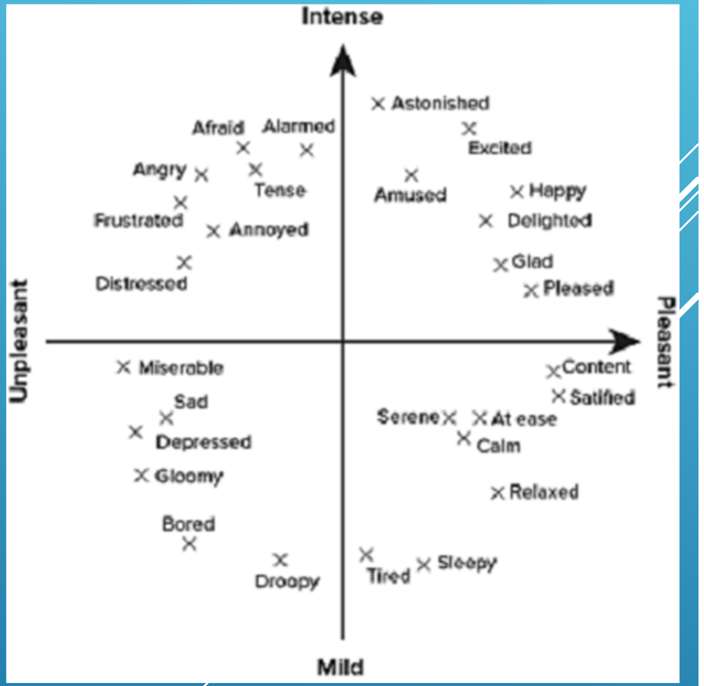
VALENCE/AROUSAL MODEL

Valence/ Arousal Model

- 2D Valence/Arousal Model
- Arousal Level
- Valence Level



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JJ6 The 2D Valence/Arousal model is used to characterize emotions such as: happy, sad, relaxed, and angry. Emotions are characterized based on their valence and arousal values. High arousal (excitation) is characterized by a high alpha power and a low beta power (a high alpha activity and a low beta activity). The ratio of the beta to the alpha power characterizes the arousal level of a person (Arousal = beta/alpha). To determine the valence level, we compare the activation levels of the two cortical hemispheres. Left frontal inactivation is an indicator of a withdrawal response, which is often linked to a negative emotion. On the other hand, right frontal inactivation may be associated with an approach response, or positive emotion.

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JJ7

EXPERIMENTAL STUDY

The System

Subjects and Stimulus

Testing Procedure

Results

Discussion

Slide 8

JJ7 The experimental study consists of the system, the subjects and stimulus, the testing procedure, the results, and the discussion.
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JJ8

THE SYSTEM, SUBJECTS, AND STIMULUS

The System

- External Sensors
- Cloud

Subjects and Stimulus

- 16 Subjects: 12 M/4 F
- Pictures and Music
- Neural Brain Activity

Slide 9

JJ8 The system is composed of external sensors, such as the Texas Instrument Sensor Tag, the Polar H7 heart rate sensor, and the Emotiv Insight brain sensor. The Cloud, where the Dropbox Core Api is used to store the users' data and access it anytime needed. Sixteen subjects (ages 22-80, 12 males and 4 females) performed the experiment,whichconsisted in evaluating their mood and memory performance levels while their heart and brain data was recorded. Both pictures and music were used to be the stimulus to elicit emotion. This procedure achieved stimulation by increasing and decreasing the neural activity of the brain.

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TESTING PROCEDURE

Mood Detection

- Polar H7 and Emotiv
- Resting HR Recorded
- Stimulus

Memory Evaluation

- 3 Sets of 4-6 Letters
- 3 Probes
- Emotiv

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JJ9	Jonathan Jonathan, 2/26/2017
JJ10	When relaxed, the participant's resting heart rate was recorded. Then, for each stimulus composed of pictures and sounds (each representing a particular mood such as relaxed, engaged, stressed, happy, angry, aroused, and sad) which was displayed on a laptop screen, the data was recorded on a tablet before evoking the stimulus, the stimulus was evoked, and the data was recorded on a tablet after evoking the stimulus. At the end of each stimulus, there was a relaxation period of 1 minute. The first part of the experiment took 35 minutes. In the second part of the experiment, the subject was first given a 1-minute resting period. The memory test was given immediately afterward, and the test subject's memory performance level was recorded. For the memory test, the participant was shown three sets of 4-6 letters displayed on a laptop screen. After being shown each set of letters, the participant was given a brief moment (2-5 seconds) to memorize the set of letters. The participant was then shown a letter which may or may not be part of the set of letters previously shown to him/her. The participant was asked to state whether or not this letter belongs to the set of letters. There were three sets of letters and three probes in the memory experiment. EEG data was recorded twice per set of letters: before showing the set of letters to the participant and just after showing the set of letters to the participant while he/she was busy memorizing them. The second part of the experiment took 10 minutes. Jonathan Jonathan, 2/26/2017

JJ11

RESULTS

Results	Temperature, humidity, and air pressure recorded
	Relaxed, seated, with minimum head movement
	Mood/Memory Level

Slide 11

JJ11 Results were gathered from the participants' brain and heart data under the following environmental conditions: the temperature ranged from 60.28 deg/F to 67.57 deg/F, the humidity ranged from 32.25 %rH to 48.18 %rH, and the pressure ranged from 999.70 nPA to 1032.32 nPA. All participants confirmed that they were relaxed at the beginning of the experiment. All participants remained seated and did not move their heads for the entire duration of the experiment. Mood and memory performance levels are in percent. A mood level of 0% suggests that the participant is not feeling at all in that particular mood, and a mood level of 100% suggests that the participant is feeling very strongly in that particular mood. A memory performance level close to 100% may be associated with strong memory activity, whereas a very low memory performance level, approaching 0%, may be associated with no memory activity.

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DISCUSSION

Mood Detection

- Younger relax more quickly than older
- Taller relax more quickly than shorter
- Taller and younger relax more quickly than shorter and older

Memory Evaluation

- Positive memory activity for the majority of participants
- 81% success rate
- Head hair and thickness of scalp account for EEG signal loss

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JJ12 Mood Detection: the results reveal that the ability of the participants to relax quickly in response to a conducive stimulus is greater for younger individuals than for older ones. Also, taller participants are better able to relax quickly than shorter participants. In general, taller and younger participants are better able to relax quickly than shorter and older participants. Memory Evaluation: the first, second, and third trial memory performance levels before and after memorizing the set of letters for each participant show that the experiment has been successful at raising the memory performance levels of the participants. Almost all participants had higher memory performance levels after memorizing the set of letters as compared to before memorizing the set of letters which is associated with positive memory activity. The success rates of all trials are 81%. Head hair and thickness of scalp account for EEG signal loss.
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JJ17 the majority of tall participants (those with height ranging from 175 to 185 cm) are 20 to 30 years old (7 participants with heights ranging from 175 to 185 cm versus 2 participants with the same height range who are 50 to 70 years old). The results mean that in general taller and younger participants are better able to relax quickly than shorter and older participants.
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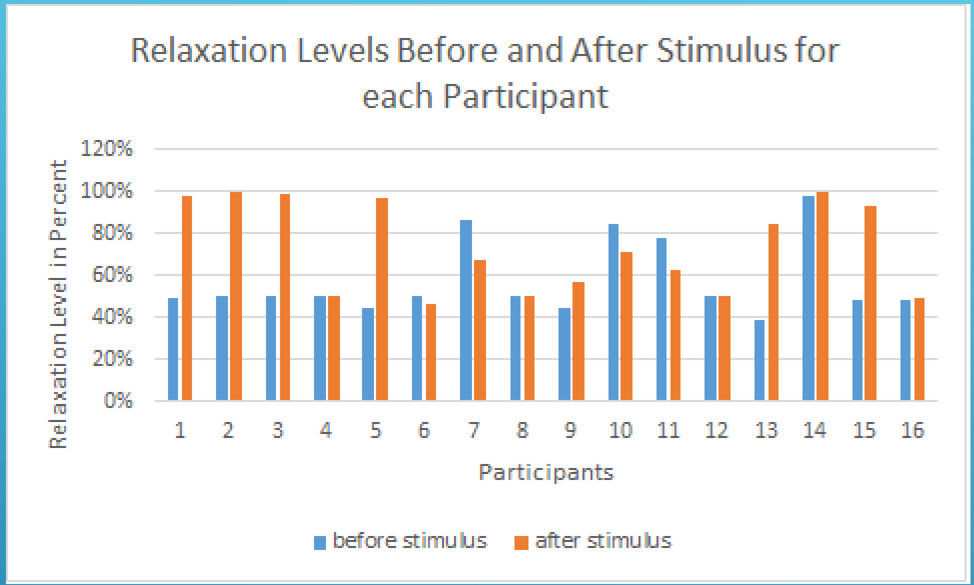
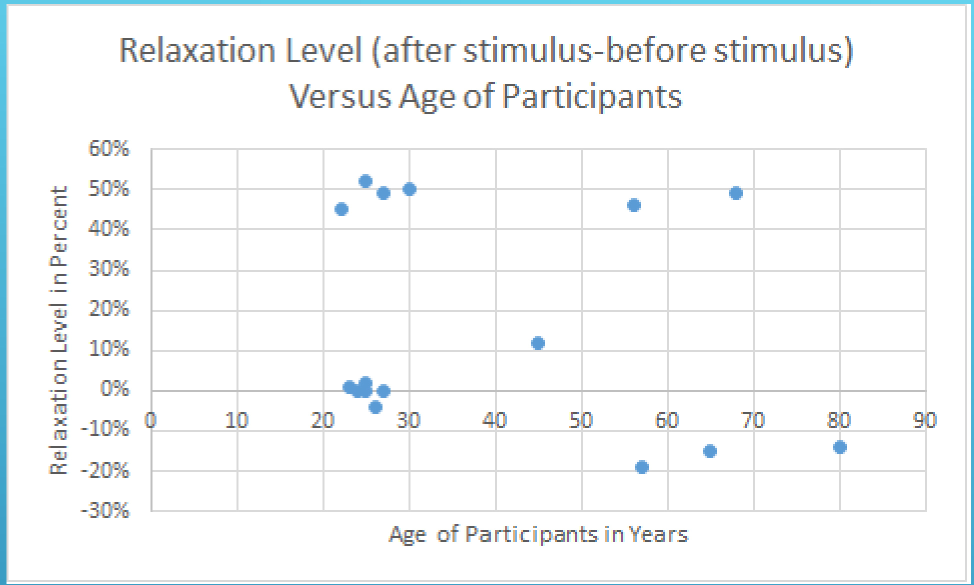
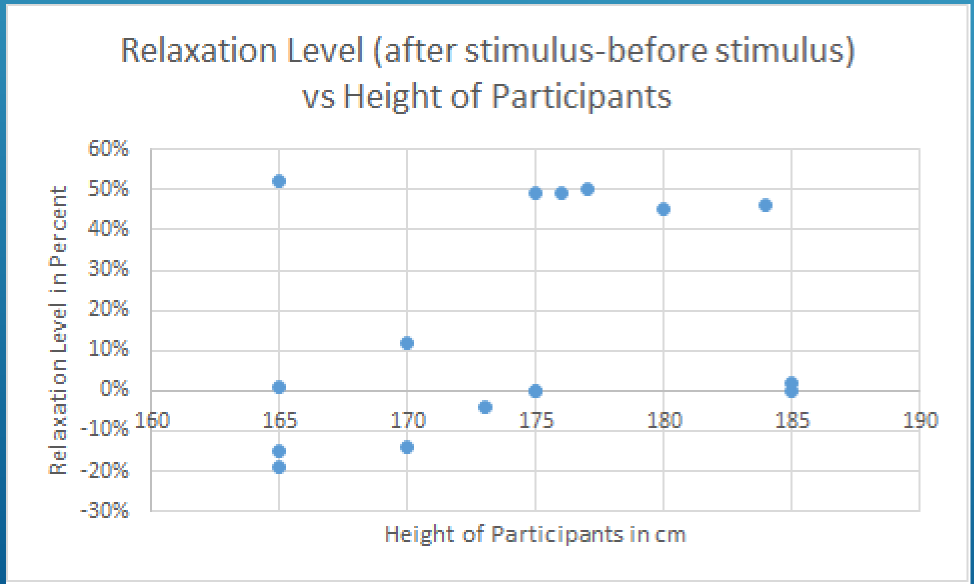
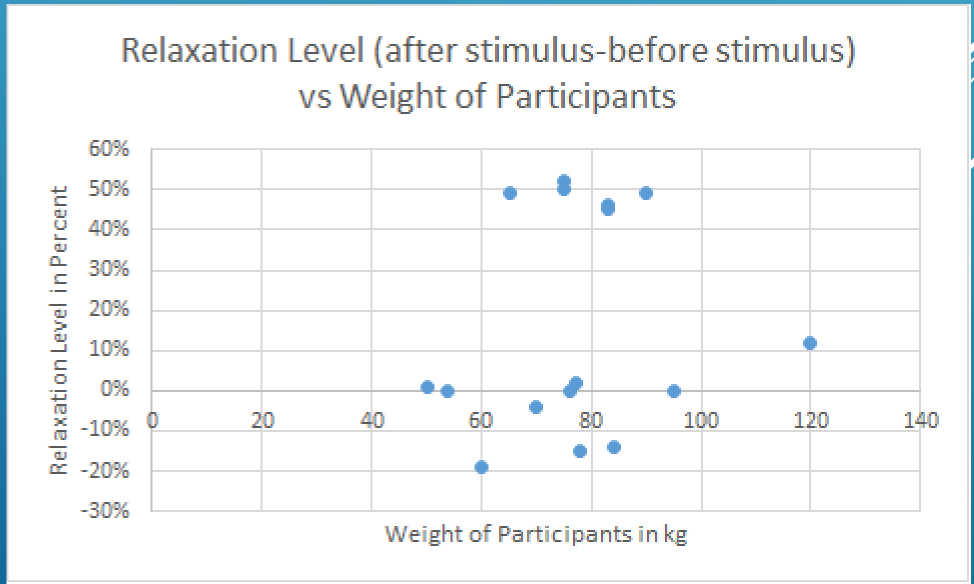
DISCUSSION - MOOD GRAPHS









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JJ13 Top left graph: about 56% of all participants had a higher relaxation level after the stimulus as compared to before the stimulus. The 44% remaining participants were found to have varying reactions when exposed to such stimulus: some of the 44% may have had other thoughts or emotions during the experiment, and may have been preoccupied with other matters, thereby negating any effect of the relaxation stimulus on them. Another problem potentially accounting for the variation in results is the fact that the brain sensor's EEG data had to travel from the brain cortex to the electrodes of the brain sensor. During its travel, the signal may have been attenuated or dampened as a result of traveling through many brain regions. Thus, the quality of the signal using this method is not optimal, and results in a lower-quality EEG signal. Top right graph: thegraphrevealsthatalmostallparticipantshad positive or neutral changes in relaxation levels and that most participants with the greatest positive changes in relaxation levels (higher than 40%) are the younger participants, those aged 22 to 30. The older population, those aged 40 to 80, had the most participants with negative changes in relaxation levels (3 participants aged 50-80 versus 1 participant aged 26). The results reveal that the ability of the participants to relax quickly in response to a conducive stimulus is greater for younger individuals than for older ones. Bottom left graph: The change in relaxation level was plotted against the height of all participants. The results reveal that the tallest individuals (heights ranging from 175 to 185 cm) had the majority of values corresponding to the highest changes (higher than 40%) in relaxation levels (5 individuals with heights ranging from 175 to 185 cm versus 1 individual with a height of 165 cm). The participants with all values corresponding to negative changes in relaxation levels are the shortest individuals (4 individuals with heights ranging from 165 to 175 cm). The results mean that taller participants are better able to relax quickly than shorter participants

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JJ14 The graph showing the change in relaxation level against the weight of participants reveals that the majority of individuals with the greatest changes in relaxation levels are those with weights ranging from 60-90 kg. The graph also shows that the individuals from the same weight range have all values associated with negative changes in relaxation levels. Therefore, the results stating that participants with a weight range of 60-90 kg are better able to relax quickly than the other participants are inconclusive

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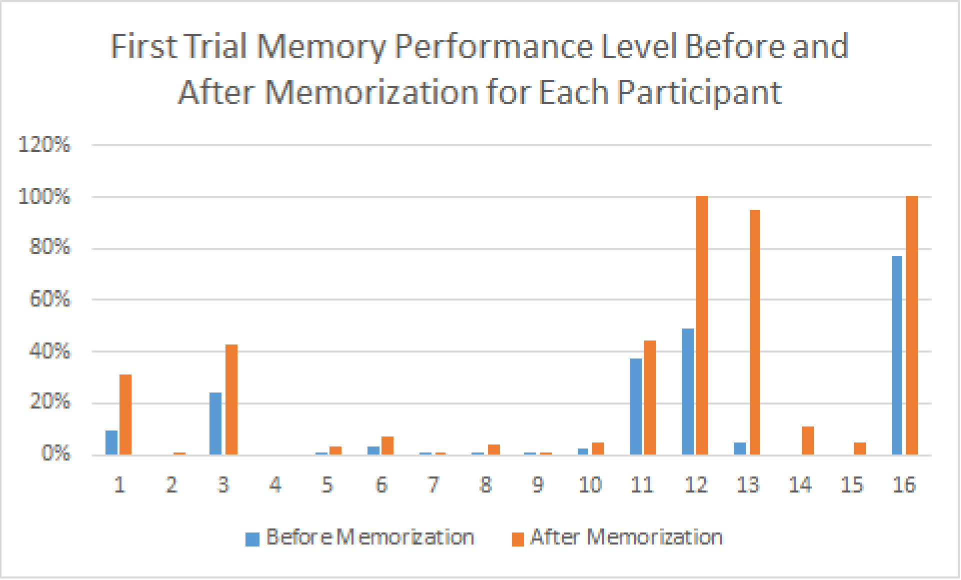
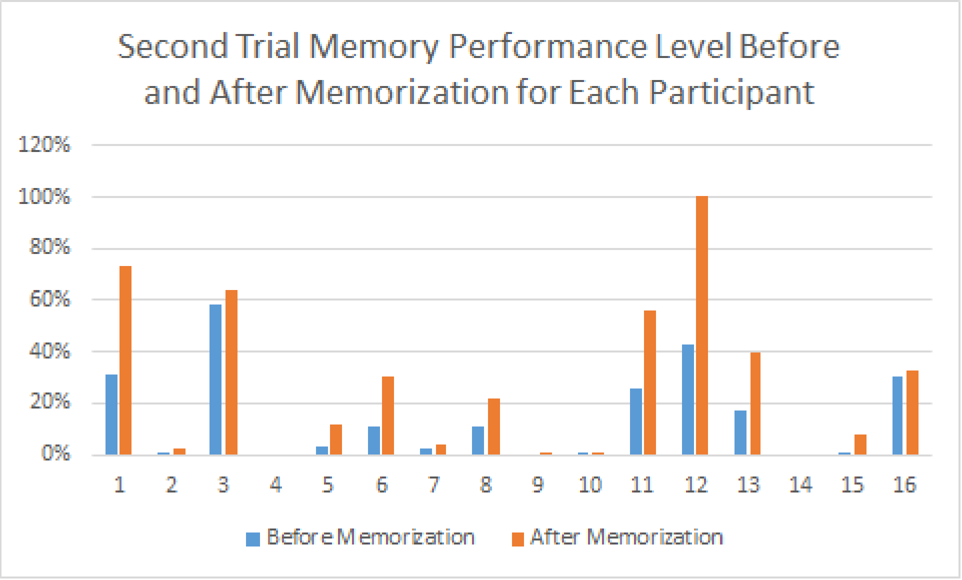
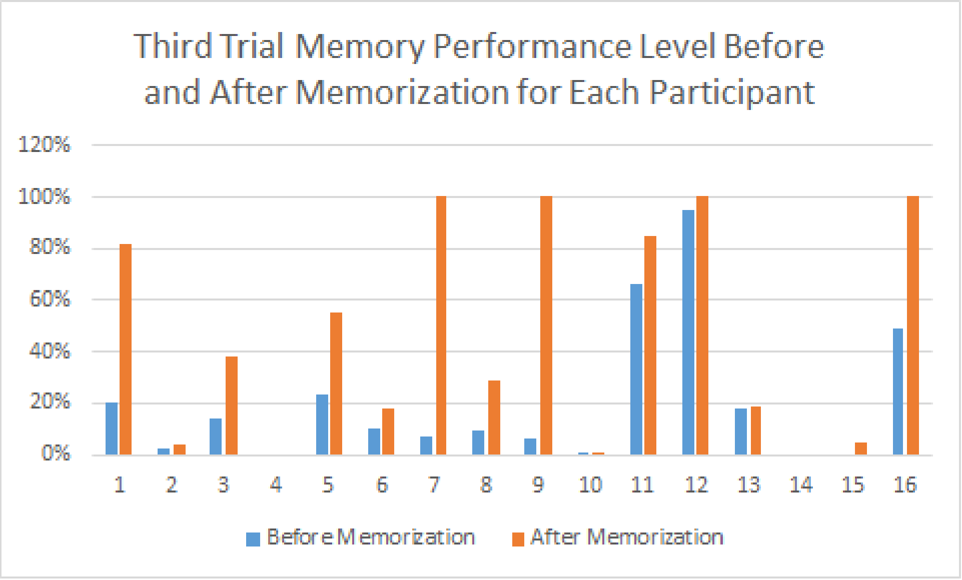
DISCUSSION – MEMORY GRAPHS







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JJ15 The first, second, and third trial memory performance levels before and after memorizing the set of letters for each participant show that the experiment has been successful at raising the memory performance levels of the participants. Almost all participants had higher memory performance levels after memorizing the set of letters as compared to before memorizing the set of letters which is associated with positive memory activity. The success rates of all trials are 81%. The 19% remaining participants for each trial had memory performance levels lower or equal after memorizing the set of letters as compared to before memorizing the set of letters. An explanation of the variation in results is the fact that the brain sensor's EEG data had to travel from the brain cortex to the electrodes of the brain sensor. During its travel, the signal may have been attenuated or dampened as a result of traveling through many brain regions before reaching the brain sensor's electrodes. It is very likely that the more head hair a participant had, the more attenuated or dampened the signal was when reaching the electrodes of the brain sensor.
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JJ16

CONCLUSION

- Skin and infrared sensors
- fMRI and MEG
- Disciplines affected: biomedicine, computer engineering, and more.

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JJ16 Skin and infrared sensors could be used to increase the accuracy of mood detection. To evaluate memory, we could use more sophisticated devices such as fMRI (Functional Magnetic Resonance Imaging) and MEG (Magnetoencephalography) to get a better view of brain activity. In order to acquire such devices, experience and funding would be required. We hope that our contribution can make difference in many fields of study, especially in computer engineering, biomedicine, mental health and other medical specialties.

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