



MUSE-2 for Biomedical Disease Prediction and Unique K-16 Education and Outreach

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Abstract: It is important to study (a) 5 external senses and (b) 8 interoceptive (internal) senses using MUSE-2 to understand the roles of brain (survival) and mind (human decision maker) in human health. Survival and decision-making affect health, longevity, and quality of life. Senses for human survival are 5 external and 8 interoceptive (internal) senses, and psychological reactions. This document provides details on how to use MUSE-2 for biomedical disease prediction. Four MUSE EEG signals were measured using a Smartphone App called mind monitor (MM) in 10 different environments to predict health/disease conditions. This paper also discusses very creative and unique outreach K-16 education modules. Functionalized Bricks with Embedded Intelligence (FBEI) were developed under funding provided by NSF Center for Wireless Integrated Micro System (WIMS) [31]The FBEIs, published in 2020, are still unique in the world.

I. INTRODUCTION

It is important to study (a) 5 external senses and (b) 8 interoceptive (internal) senses [1]using MUSE-2, shown in Fig.1 [2], to understand the roles of brain (survival) and mind (human decision maker) in human health and longevity. Survival and decision-making affect health, longevity, and quality of life. Fig. 2 shows senses for human survival; (a) 5 external senses, (b) 8 interoceptive (internal) senses, and (c) psychological reactions [2]. MUSE-2 and MUSE S are available in the market with MUSE S being the latest version. MUSE-2 can provide accurate, real-time feedback on what is happening with human brain activity during meditation. Muse-2 also measures heart rate, breathing, and body movements in order to help build a consistent and reproducible approach to meditation. MUSE-2 has been used for mind-controlled LEGO robot [3] and alpha wave variability affecting health [4]. This document provides details on how to use MUSE-2 for biomedical disease prediction and outreach education. As shown in Fig. 2, its use can help detect medical conditions and provide ways to cure medical problems

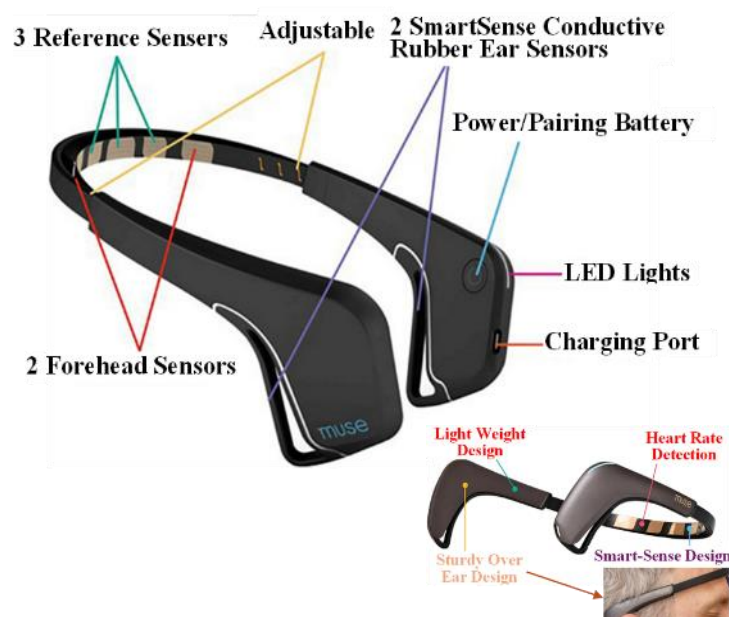


Fig. 1 MUSE-2 has 3 ground connections and 4 for EEG signals [2].

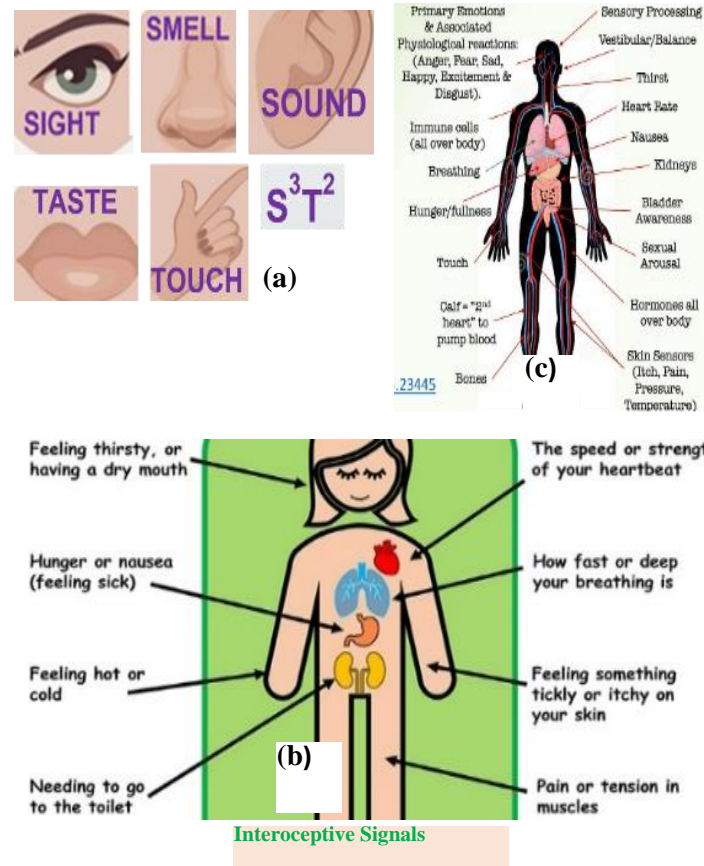


Fig. 2 Senses for human survival; (a) 5 external senses, (b) 8 interoceptive (internal) senses, and (c) psychological reactions [2]

Fig. 3 shows some early results [2]The MUSE-2 smartphone app 'mind monitor' is used to reveal how a human being feels in a crowd of large audiences such as in a cinema hall.

Functionalized Bricks with Embedded Intelligence (FBEI) were developed under funding provided by NSF Center for Wireless Integrated Micro System (WIMS) [31]The FBEIs, published in 2020, are still unique in the world.

II. EEG DATA BY MUSE-2

Mind Monitor App (MMA) can be used to transfer data to a smartphone. For data shown in Fig 3, screen capture was used to save data and transfer to laptop.

This paper addresses data using an Android phone: (a) inside, (b) going outside, (c) outside, (d) after 30 min outside walk, (e) listening to relaxing music inside, (f) lying on vibration bed, (g) working on laptop, (h) after stressful conversation with someone, and (i) after taking L-Theanine with caffeine & listening to Umme Habiba relaxing music, (j) outside walk, and (k) sitting inside and relaxed.

The wearable MUSE headset and other techniques have been used for data analysis in all frequency bands including frontal alpha wave, EEG spectral analysis, and other related research [5][12][13][14][15][16][17][18][19][20][21][22][23][24][25].

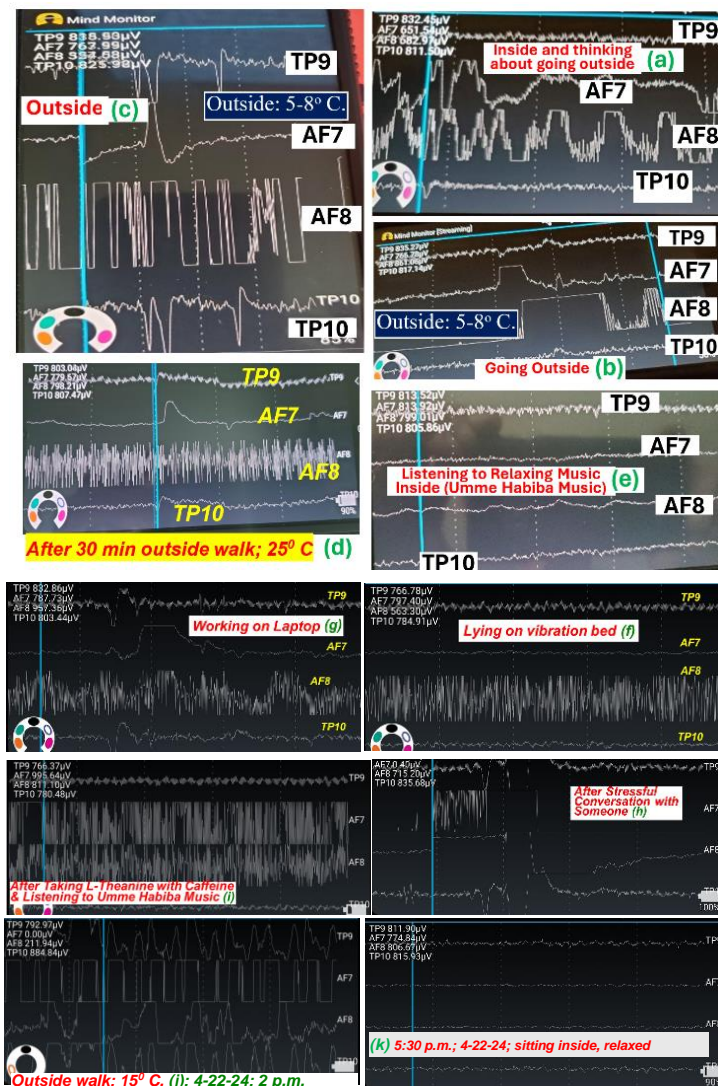


Fig. 3 Volunteer 1 data collection using MUSE-2 and an Android phone under different conditions and circumstances; effect on TP9, AF7, AF8, and TP10 data.

III. BIOMEDICAL DISEASE PREDICTION AND OUTREACH EDUCATION BY MUSE-2

How MUSE-2 can (a) detect/predict health problems for humans and (b) explain outreach education are main topics of focus for this paper. Mind-controlled LEGO robot was developed earlier [26] using single EEG sensor technology.

This technology is currently being developed to create a MUSE-2-controlled LEGO robot to introduce MUSE-2 to K-12 learners. The music by Umme Habiba is extremely relaxing for volunteer 1.

The following are possible problems and conditions uniquely studyable/treatable by MUSE-2.

1. Breast/Prostate Cancers and Heart Attack

Chronic inflammation is the major cause of cancer and heart attack. Breast cancer diagnosis and treatment affect quality of life and stress that are associated with fatigue. Cancer and heart attack are caused by an unhealthy lifestyle [14] related to SDEEP (Sleep, Diet, Environment, Exercise, and Prescription-medicine). SDEEP can also cause prostate cancer. Thus, if after chemotherapy, the lifestyle hasn't changed cancer may return. Can MUSE-2 predict the cancer return probability and heart problems? Based on MUSE-2 predictions, can cancer return, and heart problems be avoided? MUSE-2 can be used to explain some of these concepts to K-16 learners using a MUSE-controlled or stress-controlled LEGO robot.



2. Depression/Stress and Survival Phases

Are innovation/depression/survival cycles necessary for high level of creativity in humans? Are they linked to human survival? When a human is depressed the survival process is initiated which leads to creative ideas helping human survival. Can MUSE-2 help study/predict human depression and survival phases?

3. Human Mind, as Decision Maker, is Crucial for Health and Longevity

The human mind is an algorithm based on data generated within the Microbiome-Gut-Brain-Axis (MGBA). The mind, affected initially by Amygdala Scripts (AS), is involved in religious, tribal, and other fights leading to stress. Can MUSE-2 help study/predict the human mind? AS affect mindfulness practice. Can MUSE-2 predict the (a) mindfulness ability and (b) longevity of a human? What is artificial intelligence and artificial mind? Can MUSE-2 help study artificial mind related to artificial intelligence systems?

4. Longevity of Humans

Interestingly, long-term survivors were exclusive to those who attributed their longevity to something other than faith [15]. The stress levels affect religious, pollical, and non-religious humans. How can the MUSE-2 be used to study longevity and quality of life of all people?

5. SDEEP, Amygdala Scripts and Neurogenesis

Sleep, Diet, Exercise, Environment & Prescription-drugs (SDEEP) and Amygdala Scripts (AS) affect stress that leads to chronic inflammation which causes most health problems. Neurogenesis (generation of new neurons in hippocampus area of brain), that helps quality and longevity of life, increases by learning, exercise, and sex [16][17]but decreases with stress, sleep deprivation and aging. Can MUSE-2 detect/predict (a) human health problems related to SDEEP/AS and (b) neurogenesis?

6. PFC, Testosterone, Stress and Anxiety

The PFC (Pre-Frontal-Cortex) of people, under extreme stress, doesn't function properly as PFC is partially shutdown to avoid damage. As the testosterone in old age is low, older humans are not forward looking. Stress and anxiety can also lower testosterone levels [18]. Can MUSE-2 help detect (a) low testosterone and stress levels in humans and (b) PFC partial shutdown? It may be pointed out that blackseed consumption raises testosterone level even in old age [18]. Can testosterone level be checked by MUSED-2?

7. Chronic Stress and Childhood Memories

Chronic Stress is linked to Body Mass Index (BMI) [27][28][29]. Can MUSE-2 help study BMI role in health and longevity? Can MUSE-2 help (a) study childhood memories (Amygdala Scripts) and (b) personality algorithms based on childhood memories?

8. Female brain

The female brain is more active and can handle stress better than the male brain [30]. Can MUSE-2 help study (a) multitasking and (b) stress for male and female minds?

9. An Angry Person's Mind

An angry and highly stressed person's mind may have less logic than a dog's mind because a stressed person's mind has partially non-functional PFC (Pre-Frontal-Cortex). Can MUSE-2 help study an angry person's mind and related health problems?

10. Creative Person with Difficult Amygdala Scripts

A creative person, with difficult amygdala scripts, can read faces of people around her/him better than others. To survive, this person must guess/study the intentions of people around her/him. Can MUSE-2 identify the creative ability of a human to survive?

11. Consciousness Relates to Mind

Consciousness and mind are states scientifically defined as algorithms based on EEG data generated within MGBA (Microbiome-Gut-Brain-Axis). Can MUSE-2 help study mind under various circumstances? Can it help study (a) anxiety and depression in twins, and (b) differences in twins' minds if any?

12. God as Algorithms Based on Data Generated in Believer's Mind

Is God an algorithm based on data generated by believer's mind? Or was there a live link between a prophet's mind and God? Can the MUSE-2 differentiate between believers and non-believers of any religion/ideology? Can the MUSE-2 confirm the existence of God?

**13. Left/Right Hemispheres of Brain**

Women use left hemisphere of the brain more, but men use the right hemisphere more. Can MUSE-2 be used to study (a) the hemisphere usage and (b) if a couple consisting of a male and a female is better positioned to live longer, healthier, and happier life. Women living alone survive longer than men living alone. What about quality of life? How can MUSE-2 study and answer some of these questions?

14. Charity Curbs Creativity

Because charity money is received without any effort it can curb creativity. The people receiving charity money may lack creativity because they get money without much effort. Can MUSE-2 be used to study creativity in people including those receiving charity funds?

15. Current Healthcare Seems to Focus on Treating the Symptoms not the Cause

Current healthcare seems to focus on treating the symptoms which keep increasing with aging and drug use. What is the root cause of many diseases leading to a worldwide rise in health problems and are they related to mind, brain, and/or body? Can MUSE-2 be used to study the root cause of diseases?

16. Chronic Inflammation Causes Several Chronic Diseases

Chronic inflammation problems can occur anywhere along the Microbiome-Gut-Brain-Axis (MGBA). Can MUSE-2 help study symptoms and the root cause of chronic inflammation?

17. Activation of Sleeping Stem Cells

Activation of sleeping stem cells can slowdown/reverse the aging process. Can MUSE-2 be used to study awakening of sleeping stem cells? Can such MUSE-2 studies make male brain as active as a female brain?

18. Age-related Cognitive Impairment of PFC (Pre-Frontal-Cortex)

Can MUSE-2 help study how aging affects the brain/body health through age-related cognitive impairment of PFC?

19. Amygdala Scripts Role in Elderly Health

Amygdala and amygdala scripts (childhood memories) play a crucial role in elderly health. Can MUSE-2 help study the negative influence of amygdala and amygdala scripts in elderly health?

20. Efficacy of Exercise, Yoga, and Hand/Foot/Face Reflexology

Can efficacy of exercise, yoga and hand, foot and face reflexology, self-massages be studied by MUSE-2?

21. Research-Proven Benefits of Herbs

The health benefits of curcumin, black seeds, hemp seeds, coconut oil and ginkgo biloba have been studied extensively [18]. Can MUSE-2 be used to study the benefits?

IV. UNIQUE K-16 EDUCATION AND OUTREACH MODULES

Functionalized Bricks with Embedded Intelligence (FBEI) were developed using funding provided by NSF Center for Wireless Integrated Micro System (WIMS) [31]The FBEIs, published in 2020, are still unique in the world [32]. There are new details of world-unique K-16 modules shown in Fig. 4. They range from very simple (RCX LEGO motor based) to very complex (mind-controlled LEGO robots) learning modules.

A MUSE-2 controlled LEGO robot is in progress. Some modules including line follower robot, Android controlled LEGO robot, and static charge-controlled LED array use MSG430G2231 microcontroller and microcontroller programming using Android phone with M430G2553 microcontroller, and the HC-05 Bluetooth Board as seen in Fig. 4(a) which is needed to interface Android phone with the microcontroller because microcontrollers have no built-in wireless interfaces.

LASER light and static charge controlled robotic systems shown in Fig. 4(e) are unique. Another unique structure is the MUSE-2 controlled LEGO structure shown in Fig. 4 (f). More details of the MUSE-2 controlled LEGO robot, under construction, are provided in Fig. 5.



K-16 Modules Unique in the World



Fig. 4 World-unique K-16 modules for education, outreach, and research.



MUSE-2



Fig. 5 MUSE-2 controlled LEGO robot in progress.



Fig. 6 Android controlled microcontroller system.

Fig. 6 shows an Android-controlled microcontroller system that young learners love to play with. It can move left, right, or forward. Fig. 7 shows a unique polycrystalline diamond neural probe that was implanted in the brain of a guineapig to record neural signals [33]. As the polycrystalline diamond does not react with any material the probe is non-invasive and was used for the first time in the world. Although diamond is brittle this probe was made so thin that it, after bending 180 degrees, did not break. Ho-yin Chen, a doctoral candidate working under the supervision of Dean Aslam, made this probe in the Lurie Nanofabrication Facility at U of Michigan. The diamond films used in this probe were made in the diamond fabrication facility at Michigan State University.

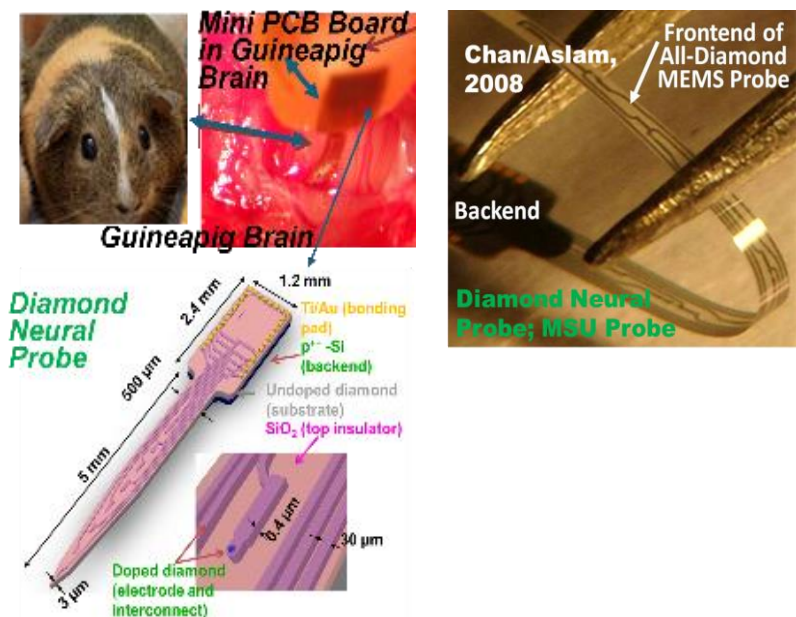


Fig. 7 A world-unique poly-diamond neural probe.



Fig. 8 Knowledge flow direction is no more fixed; a second grader builds, programs, and explains a card sorter LEGO robot to a teacher.

In a new revolutionary approach, the knowledge flow direction is not fixed as shown in Fig. 8. A 2nd grader explains a card sorter LEGO robot that he built and programmed at Michigan State U.

The visitors in this lab included a middle school teacher talking to the 2nd grader and learning about creative work done by the 2nd grader from an elementary school in Okemos, Michigan.

V. CONCLUSIONS

It is important to study (a) 5 external senses and (b) 8 interoceptive (internal) senses using MUSE-2 to understand the roles of brain (survival) and mind (human decision maker) in human health. Survival and decision-making affect health, longevity, and quality of life.

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