UNDERSTANDING PATHOPHYSIOLOGY OF SOCIAL MEDIA ADDICTION

by

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(15348)

Dissertation submitted in partial fulfillment of

the requirements for the

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CERTIFICATION OF APPROVAL

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Approved by,

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(Dr. Lila IznitaIzhar)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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MUHAMMAD IZDIHAR BIN IBRAHIM

ABSTRACT

Internet is a very powerful technology and provides many benefits to its users. However, more and more people are becoming addicted/preoccupied with the internet which can give negative impact to the quality of life of its users.

This work studied the impact of internet or social media to its user using Functional Near Infrared(FNIR) based on the criteria used to diagnose other addictions. Using FNIR, we investigated the effect of social media addiction to working memory and decision making based on brain activation during working memory and decision making tasks.

ACKNOWLEDGEMENT

Alhamdulillah. Praise be to Allah SWT., the Almighty and may Allah's peace andblessings be upon His servant and Messenger Muhammad and upon his family andCompanions. Thanks to Allah whom with His willing giving me the opportunity tocomplete this Final report.

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CHAPTER 1

INTRODUCTION

1.1. Background

Nowadays, smart phone has become the most needed gadget in people's life. This is likely the first thing people reach for when people wake up, and the last thing people look at before bed [1]. The way people absorbing the information are also changing and our memories will get the impact either the long term memory or the short term memory. The long term memory is information stored in the brain and retrievable over a long period of time, often over the entire life span of the individual. The short term memory also known as primary or active memory is the information we are currently aware of or thinking about [6].

A psychotherapist based in Oakland, Michael Y. Simon, Calif., [1]tells that, "Technology canchange us, as we change technology." In other words, internet activities are more deeply rooted than everyone thinks.

Addiction studied on thedrug and video gaming can be used for brain related studies [2]. FNIR can be used to measure the brain activities. FNIRs is highly portable, safe and measure the blood flow at the cortical part though neuroimaging [4]. FNIRs give information on blood oxygenation and deoxygenation measurement of relative changes in hemoglobin concentration through the use of light attenuation at multiple wavelengths [4]. In this work, an attempt to use FNIRs for study of pathophysiology of social media addiction is proposed.

1.1.1. FNIRs (Functional Near Infrared)

FNIRsis aneuroimaging modality that can employ non-ionizing radiation. It is also easy to be used and portable, thus can monitor brain activities at bedside and it is economical for population studies[4].

Figure 1: Functional Near Infrared (FNIR)

1.1.2. Measurement of Oxygenation and Deoxygenation (Blood Flow)

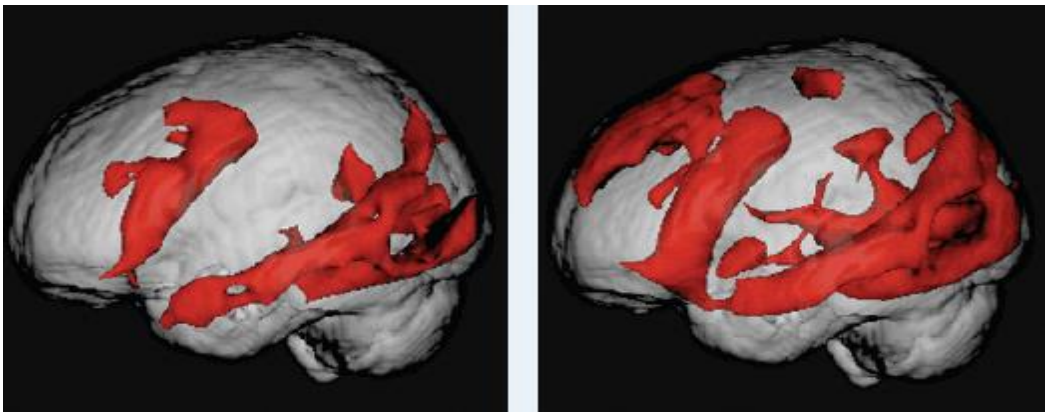


Figure 2: Activated areas for reading task (right) and internet task (left). Reproduced from [7].

Oxygenation and deoxygenation are the neuron activation in the brain. When an area in the brain is in use, blood flow in that region also increases[7]. Generally, it is the continuous circulation of blood in the cardiovascular system that is though the heart and connected to the brain. **Figure 1** show the activation (both left and right) of neural circuitry when searching online. This is the brain of people that participated in MRIs test [7]. It showed the brain activities and blood flow during book reading and internet task which activates the temporal, parietal, and occipital parts of the brain [7].

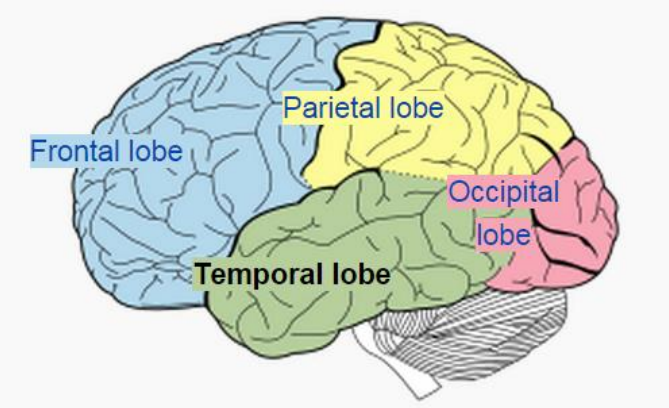


Figure 3: Parts of the brain. Reproduced from [8].

When internet is used, the brain will activate the blood flow,cerebral blood flow in frontal lobe were measured in desicion making and complex reasoning which located in frontal lobe and cingulate areas [8].

In particularly,the frontal lobe is known as the prefontal cortex which is the part where blood flow increases when people is addicted to something. The prefontal cortex, is an important part in the brain where it can process short term memories and retain long term memories and this is how people that is addicted to smoking and drug will erase the short term memories and sometimes they don’t remember what they are doing [6].

1.2 Problem Statement

Nowadays, social media can be regarded as a common tool that is use in human's social life. Social media can affect a human's life depending on how much the person is addicted to it. If the person is addicted, he or she may experience lack of sleep and fatigue will result unhealthy lifestyle. Lack of sleep will cause the brain to work with less oxygen. That will affect the problem solving and decision making.

This project aims to see and compare the blood flow and the activities between users who are addicted to social media and people who are not addicted to social media. FNIRs will scan the brain and collect the data for both of the group and see whether internet addiction effect brain activation or not.

1.3 Objectives and Scope of Study

The objective of this project is to study the pathophysiology of internet addiction and non-addict using FNIR based on the oxygenation and de-oxygenation level in brain.This study also wants to show the effect of social media addiction to the working memory and effective decision making functions.

CHAPTER 2

THEORY AND LITERATURE REVIEW

2.1. Theory

2.1.1FNIR -Continuous wave (CW)

Actually,FNIRs uses light source that can emit light at a constantfrequency and amplitude. To get a smooth and accurate result, FNIRs use beer lambert law (BLL) to see the changes in light intensity. It is related to change in relative concentrations of hemoglobin [5].

2.1.2 Beer Lambert Law

It is relate to the attenuation of light to the properties of the material through which light is travelling. The law is commonly applied to chemical analysis measurements and used in understanding attenuation in physical optics. Theoretically, it is expressed as:

Transmittance,

$$T = \frac{I}{I_0} = e^{-\Sigma \ell} = e^{-\varepsilon \ell c}$$

Attenuation,

$$A = -\ln\left(\frac{I}{I_0}\right).$$

T =transmission

∑ =product of the attenuation coefficient

ℓ = distance the light

c =concentration

σ =cross section

ε =absorptivity of the attenuator

I = incident radiation

I_0=transmitted radiation

2.1.3 Spectroscopic of NIRs Signal

In human body, there are absorbers that can make near infrared wavelength detects water, oxygenated and deoxygenated hemoglobin in brain. To make the near infrared functioning well, the light needs to be strongly absorbed by hemoglobin and it must be greater than 650nm to detect the oxygenated and deoxygenated blood flow wavelength. If itlowers than 650nm, the absorption of light is low and the light is able to diffuse several centimeters through tissue and before it is detected by the FNIR [9].

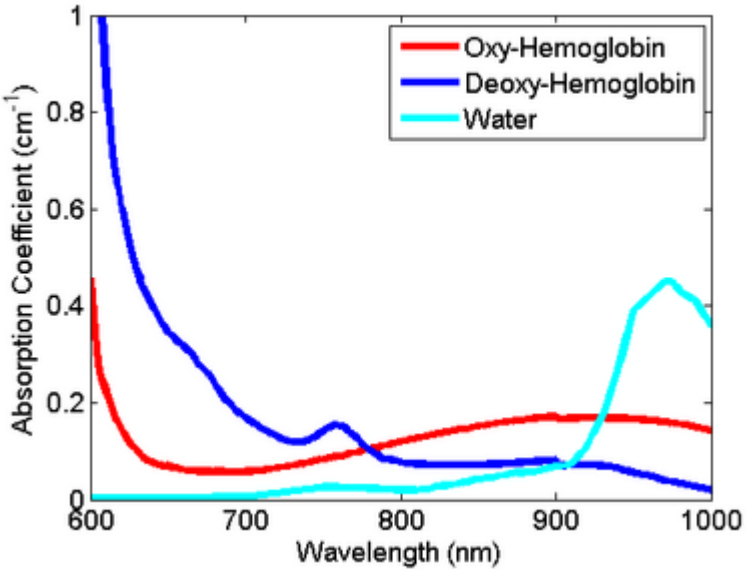


Figure 4: Oxy-hemoglobin, deoxy-hemoglobin and water wavelength. Reproduced from[9]

2.1.4 Oxygenated and Deoxygenated Hemoglobin

Deoxygenated is blood that has no oxygen. Blood becomes deoxygenated after receiving carbon dioxide inexchange for oxygen, which occurs at the cell membrane during respiration and circulation. When deoxygenated blood flows though the brain, it will not be carrying oxygen into the brain and this is not good for our body and health [7].

Oxygenated is blood/hemoglobin that has more oxygen. When neurons become active, local blood flow in those brain regions increases, and oxygen-rich (oxygenated) blood displaces oxygen-depleted (deoxygenated) blood around 2 seconds later.

2.2. Addiction Study

For conducting this research, a number of relevant literatures have been reviewed to get clear idea on this topic. People in the age of 12-30 years are addicted to internet and the percentage of using internet among these people is 91.9% who were males [1]. Study also shows that people surf internet 4-18 hours every day.Study shows that almost 70% of people who use internet frequently can suffer from disorder such as psychotic disorders and borderline personality disorder [1]. Researches also show that people who are addicted to video games are people who is lonely and stress. Games are used as a medium to release their stress and to get the happiness in another world [2, 3].

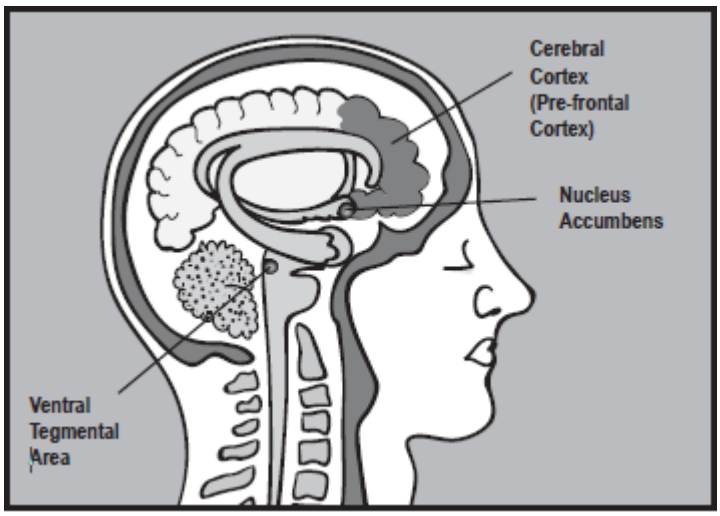


Figure 5: Inner brain. Reproduced from [4].

There is an specific part of the brain that is called ‘reward system’ and that is the ventral tegmental area, the limbic system and part of the cerebral cortex as show in figure 5. The reward system is activated when a person is feeling good. For example, when a person eats something that tastes good, neurotransmitters in the brain’s ‘reward system’ are released and make that person feels good. Drugs affect the brain in the same way [4].

In NIDA research [4], they compare three brains; one is a normal brain, second is the brain of drug abusers that have not taken drug in 10 days and the third is the brain of drug abusers that haven’t taken drug in 100 days. Even after 100 days without the drug, the activity in drug abusers brains is still much less than in the normal brains. This means that there are less oxygenated blood flows in the drug abusers brains [4].

CHAPTER 3

METHODOLOGY

The procedures to achieve the objectives of the project are shown in the figure 6. The step-by-step explanation of project work to be done is shown clearly in the flow chart below.

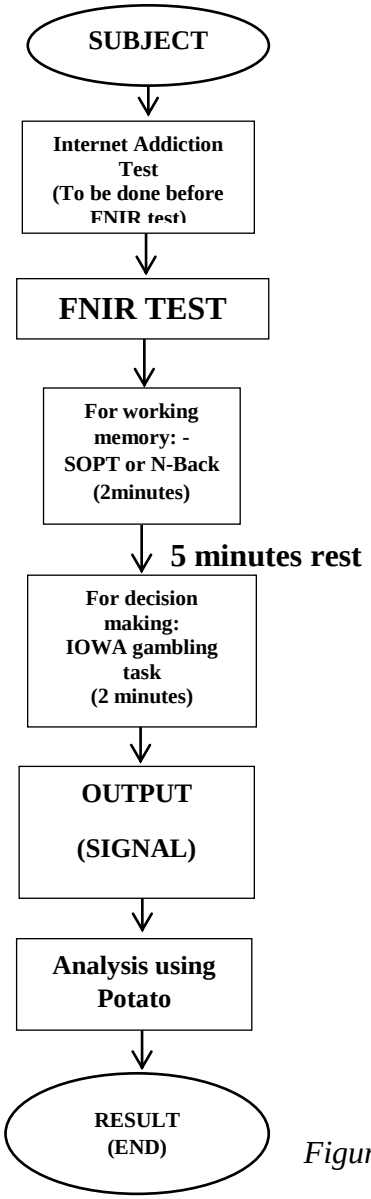


Figure 6: Flow Chart

Below are the steps taken for setting the experiment:

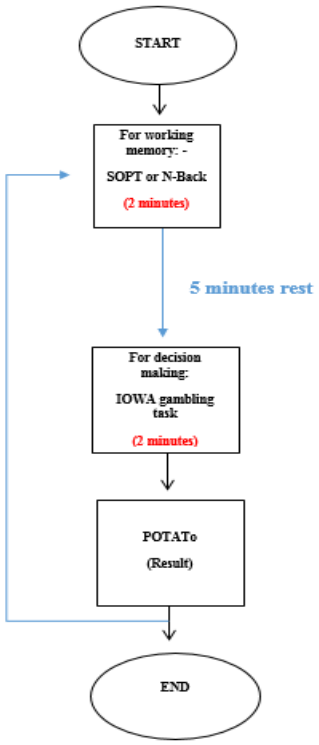
Step 1:

Firstly make the subject feel comfortable. Make them feel relax with the surrounding. Student were recruited from the Universiti Teknologi Petronas. This subject have been selected based on their routine in their social life at UTP.

Step 2:

Give them briefing on what we are trying to do in the experiment. Give them full understanding about the internet addict test..

Step 3:



FNIR Test. The device is placed at the head of the subject while doing the task given. Ask subject if they feel hurt or unconfortable. Keep them relax and stand still while doing the test. Proceed with the first test that is SOPT or N-Back test to see the working memory. After finish in 2 minutes, let them rest for about 5 minutes then continue with the second test that is IOWA gambling test for decision making and take 2 minutes also. After second test is finish, take out the device at the head. Check the result in POTATo, if the results still not achieve the objective then we need to do the test again from working memory test.

3.1. Flow diagram

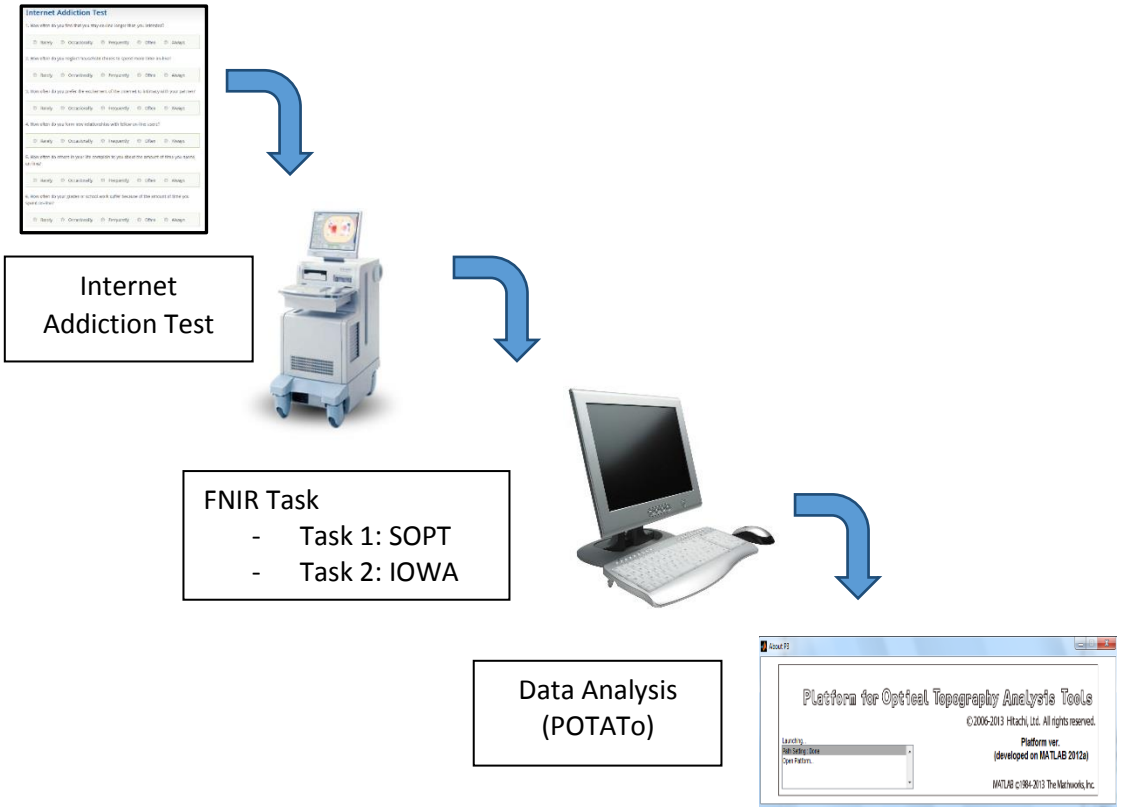


Figure 7: Flow Diagram

Figure 5 is the flow diagram on how the experiment is done. First, before testing subject with FNIR, subject must answer a questionaire**(Appendix c)** to see whether the subject is addict or non-addict to internet[10]. Then, the subject will undergo FNIR test with the task given in the computer. The task will be the SOPT and the IOWA gambling test (see section 3.3). Lastly, the data collected from both the task will be transfered to Matlab using POTATo software. POTATo is a software that can analyse the FNIR data [6].

3.2. Mapping of FNIR Data – Topographic Map

Figure 6 below depict FNIR probes that are designed for forehead. All light sources and detectors form a rectangular grid and positioned on the head surface. The probe is made to be flexible and fits in the forehead.

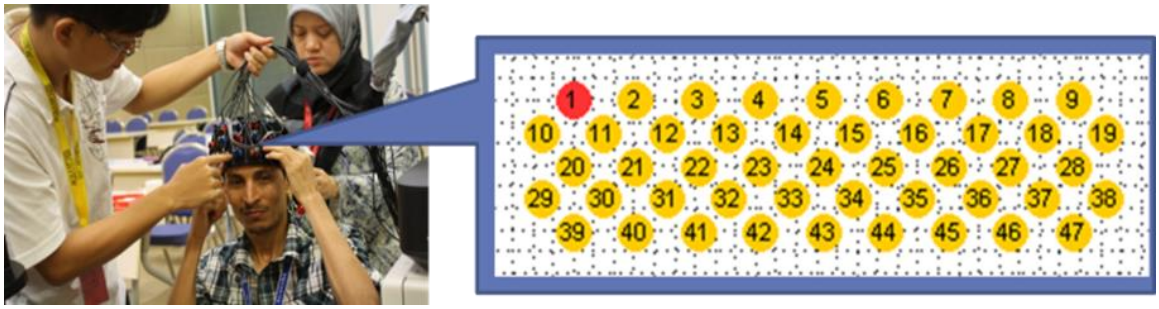


Figure 8: FNIRs probe. Reproduce from [4].

Mapping is used to collect data from FNIR using probe on to 2D brain surface images. The purpose of the mapping technique consists of 3 steps.

Step 1: Identify the reference atvoxel location on the brain surface points (blue colour) as shows in the **figure 9**. In the 41 channel of the probe, the reference point is in the middle between nose that is channel 25 and 26. So, probe must be placed in the middle of the nose between 25 and 26.

Step 2: Check the sensor. After placed the probe, checking must be done to detect all the sensor. If all sensor is detected it will give green light, if not it will give yellow light in the monitor.

Step 3: Subject must not move.The subject must not move after the probe is placed on the head. If the subject move the graph data will have more noise and it is hard for the researcher to collect the data.

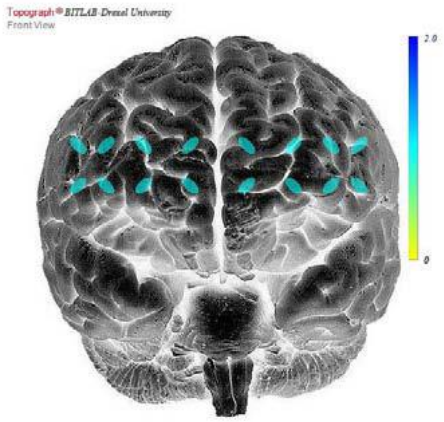


Figure 9: Voxel location on the brain surface image. Reproduce from [4].

3.3. The Tests

1. Participants.

At least 10 participants of addictand non-addict to social mediawere tested. The average age of all the participants is around 20-26 years old and all of them are males.They met with the criteria of addiction based on and questionnaire for internet addiction test.

2. Self-ordered Pointing Test (SOPT) [11]

The participant were presented with Self-ordered Pointing Test (SOPT) for working memories.The task consists of both verbal (concrete) and non-verbal (abstract) components, each with three trials. In the verbal component, pictures of concrete and nameable objects are presented, whereas in the non-verbal component, abstract designs difficult to name verbally are presented. In each trial, 12 pages are presented sequentially on the computer with the same 12 pictures, but in different spatial arrangements [11].

Figure 10: Self-ordered pointing test

Subjects have to point to a different pictures on each presentation until the 12 pages are fully pointed. The total number of correct selections represents the working memory score. Higher scores reflect better working memory capacity. There is a possible maximum score of 12 on each trial and 72 for all trials in this task.

3. Iowa Gambling Task (IGT) [11]

For decision making, it was based on the Iowa gambling test (IGT) by the FNIR.In the task, participants were required to select one card at a time from one of the four card decks labeled A,B, C, and D, with the goal of maximizing their net profit over 100 card choices. Unbeknownst to participants, decks A andB yield high immediate gain but a greater loss, while decks C and D result in lower immediate gain but a smaller loss. Total gain is $1000 in every 10 cards in decks A and B, compared to $500 in decks C and D. Total losses amount to$1250 in every 10 cards in decks A and B, compared to $250 in decks C and D. Therefore, decks A and B are disadvantageous and decks C and D are advantageous in the long run. In the IGT, net score was calculatedand analyzed, that is, total number of selections from advantageous decks (C + D) minus that from disadvantageousdecks (A + B) [11].

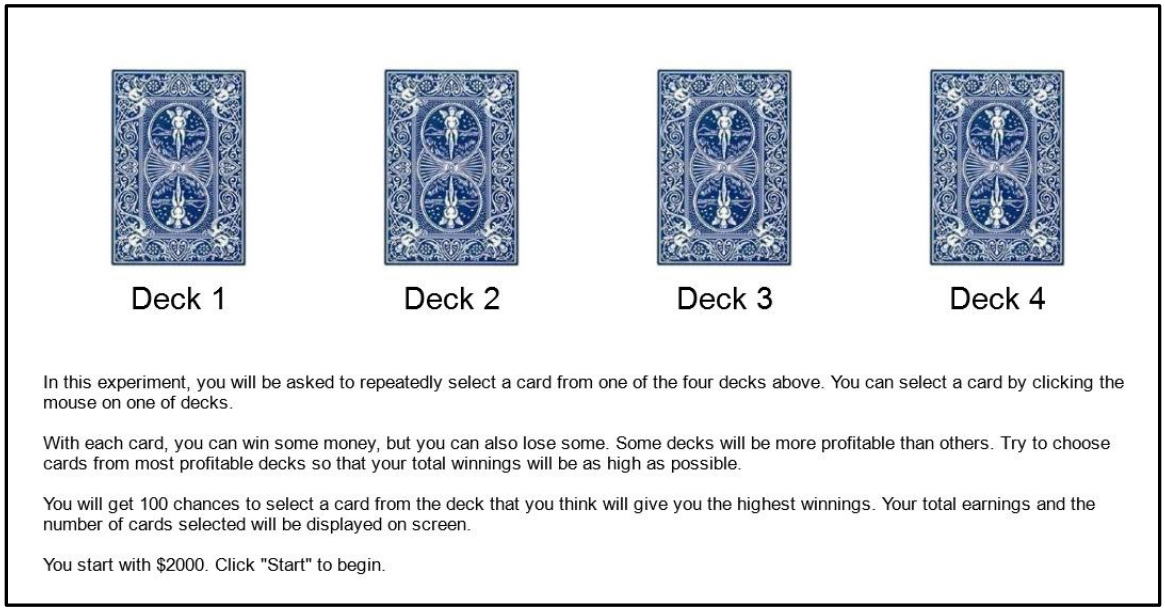


Figure 11: IOWA Gambling Test [11].

Thus, positive numbers of net score reflect advantageous or non-impaired decision-making ability, while negative numbers of net score reflect disadvantageous or impaired decision-making ability. In addition, the 100 card choices could be divided into five blocks with 20 cards each according to the time sequence, so as to test the change of decision-making strategy.

3.4.FNIR Task Design

The tasks are divided into two; Task 1 and Task 2. For Task 1, the subjects are tested with SOPT Task. These are the procedure:

Test 1:

a) Subject is placed with the device.
b) Then, set the time for 2 minutes on device.
c) The first 10 seconds subject must be ready for the SOPT task given and after 10 seconds, the subject will start doing the task.
d) When the time finishes in 2 minutes the subject must relax.

Test 2:

For test 2, the subjects are tested with the IOWA task. These are the procedure:

a) After done with SOPT task, subject is given a rest for 5 minutes.
b) Then subject will continue with IOWA task, the FNIRs device is places on the subject.
c) Then the time is set for 2 minutes on FNIRs device.
d) Repeat step c) and d) in **Test 1**.

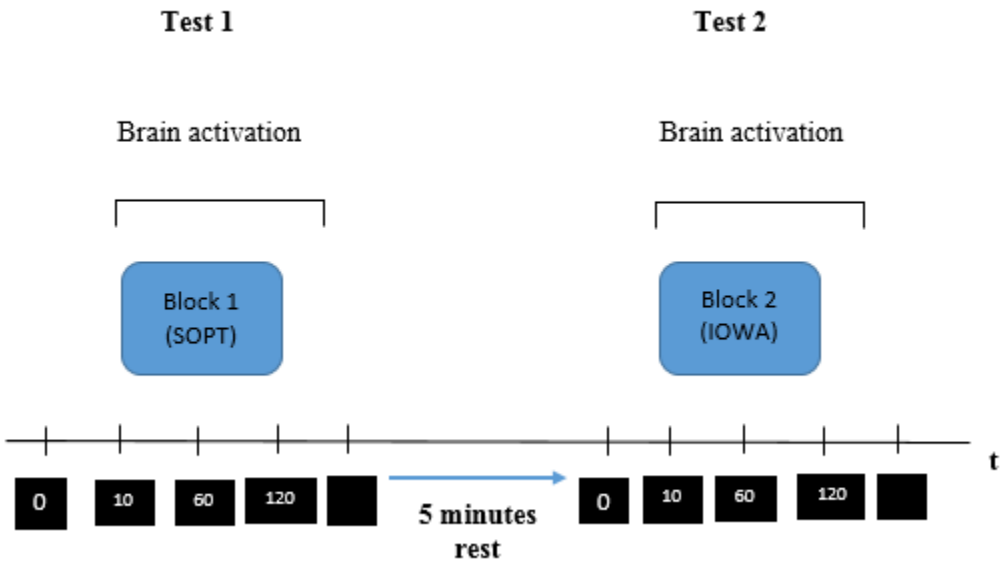


Figure 12:The ongoing test block by block for FNIR data acquisition.

3.5. Key Milestones and Gantt Chart

Gantt chart on the next page shows the relationship between work and time. It contains key milestones and time allocated to complete each work. Figure 11 shows the key milestones in final year project.

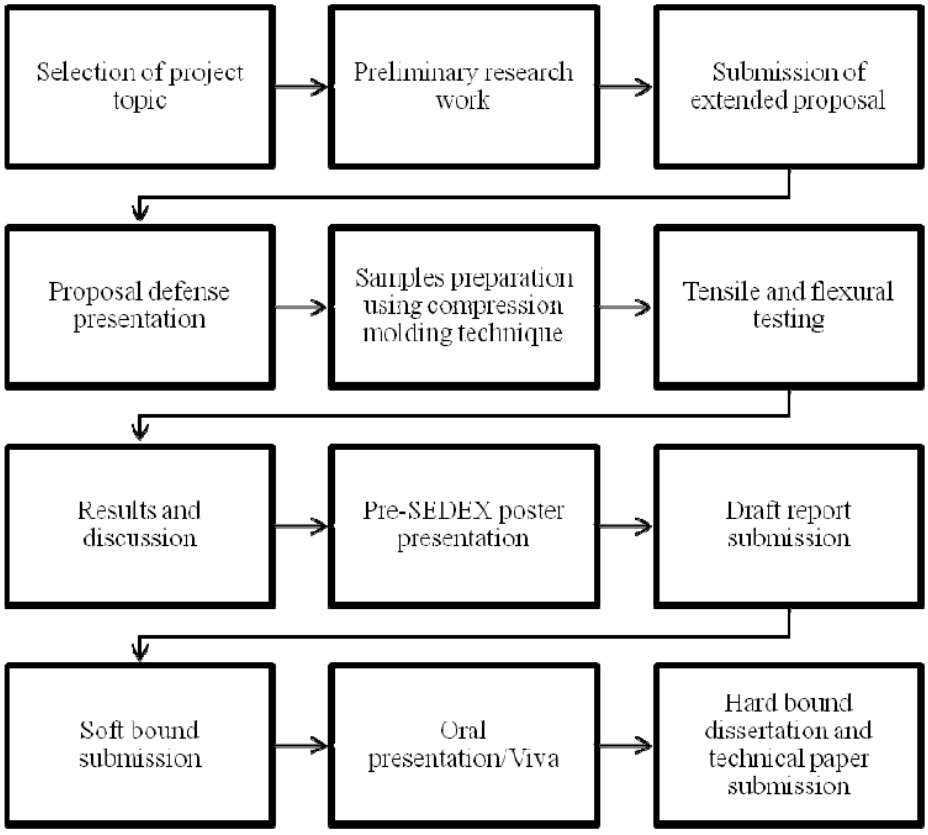


Figure 13: Key Milestones

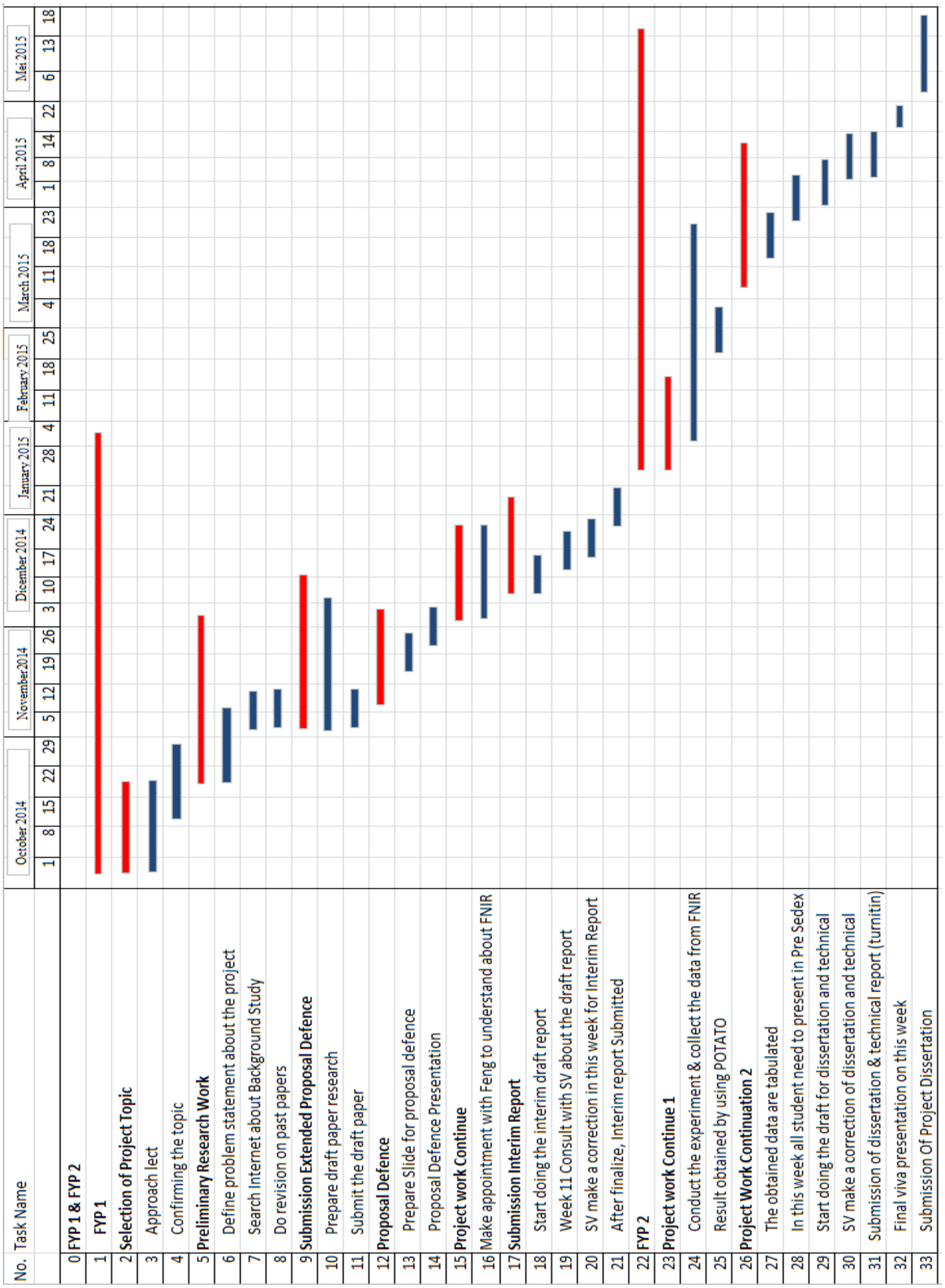


Figure 14: Gantt chart

CHAPTER 4

RESULT

Based on the literature reviews, it is understood that subject who is a non-addict to social media has higher oxygenation level in their brain [4]. When doing the task, it can also be observed that non-addicted subjectscan memorize and make decision better than addicted subjects.

From the experiment using FNIR, wefound that a person with high social media addiction show poor performance in SOPT and IOWA. When doing the task they will slowly become not interested in the task, their focus seems interrupted and they need to take more time to analyse the solution on the task. Compare to non-addict, social media subjects we found that they were more interested in the task and they focus more on what they are doing. They can memorize and make decision well in the tasks given.

4.1. Addiction to Social Media

As the focus of this project is the oxygenation and de-oxygenation level in the hemoglobin, the results of this experiment are indicated by the two different graphs with different colors (red and blue). Red indicates the oxygenation level in the hemoglobin and blue indicates the de-oxygenation level of hemoglobin. Both readings are presented in the graph of hemoglobin level (g/dl) versus time (s).

The result of memory and decision making is analyzed from the graph, the maximum peak of the red graph (for oxygenation level) of the blue graph (de-oxygenation level) between activation times 40-80s.When de-oxygenation is in high

peak, it means that the subjects have lower working memory and decision making. When oxygenation is in high peak, it means that the subject have good working memory and can make a good decision making [6].

Subject 1

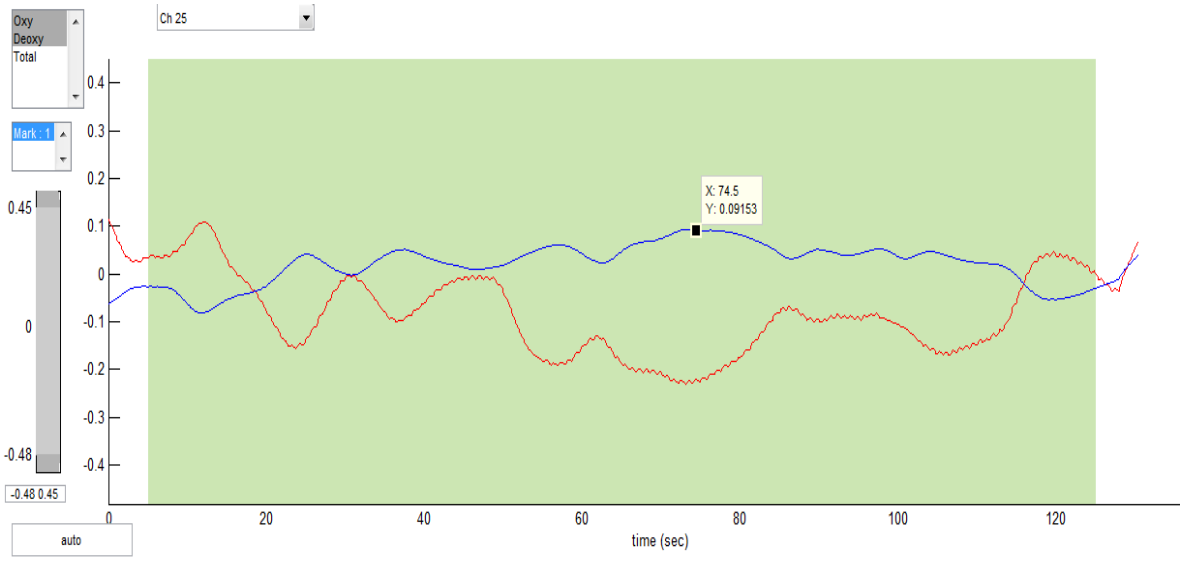


Figure 15 (a)

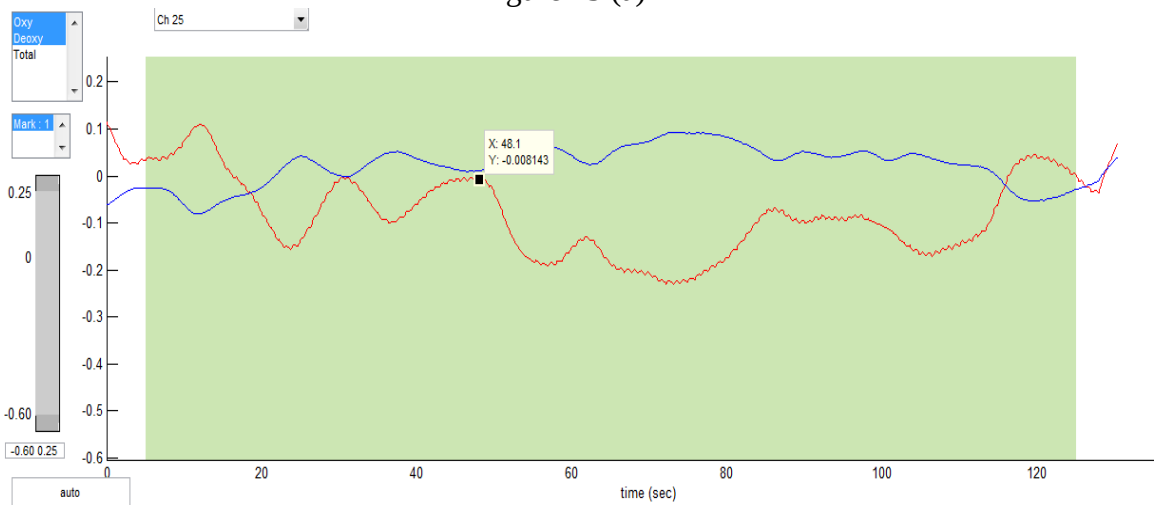


Figure 15 (b)

SOPT Test: The Figure 15 (a) shows the de-oxygenation level value is higher (0.09153) than oxygenation level (-0.08143) in Figure 15 (b) due to the internet addiction.

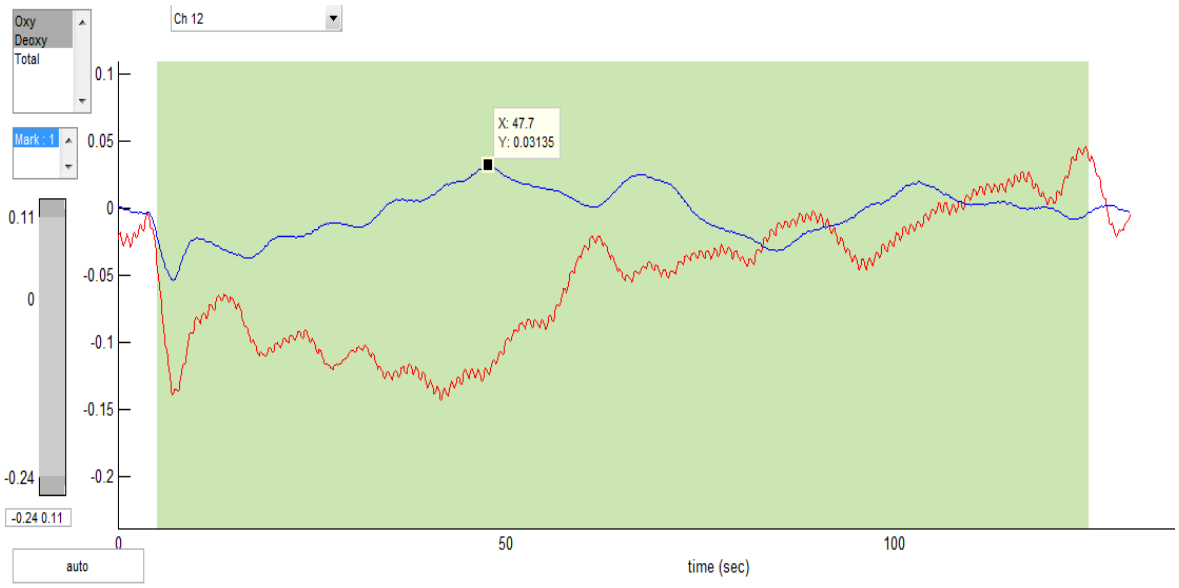


Figure 16 (a)

Figure 16 (b)

IOWA Gambling Task: The Figure 16 (a) shows the de-oxygenation level (0.03135) in the peak time of doing the test compare to oxygenation level (-0.04817) in Figure 16 (b).

Subject 2

Figure 17 (a)

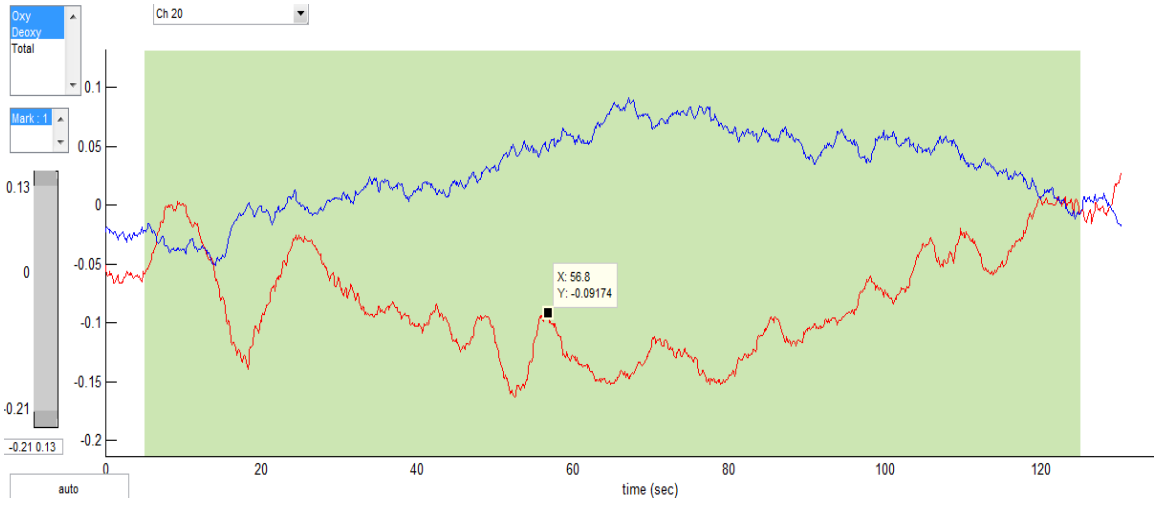


Figure 17 (b)

SOPT Test: Figure 17 (a) shows higher de-oxygenation level (0.08845) compare to Figure 17 (b) that has lower Oxygenation level (-0.09174).

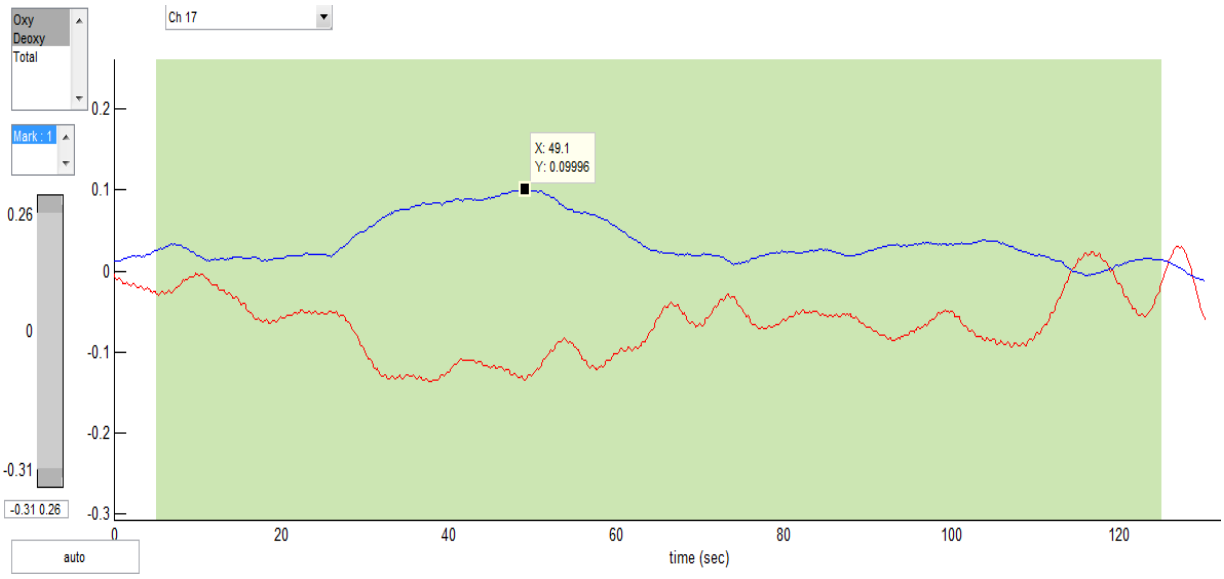


Figure 18 (a)

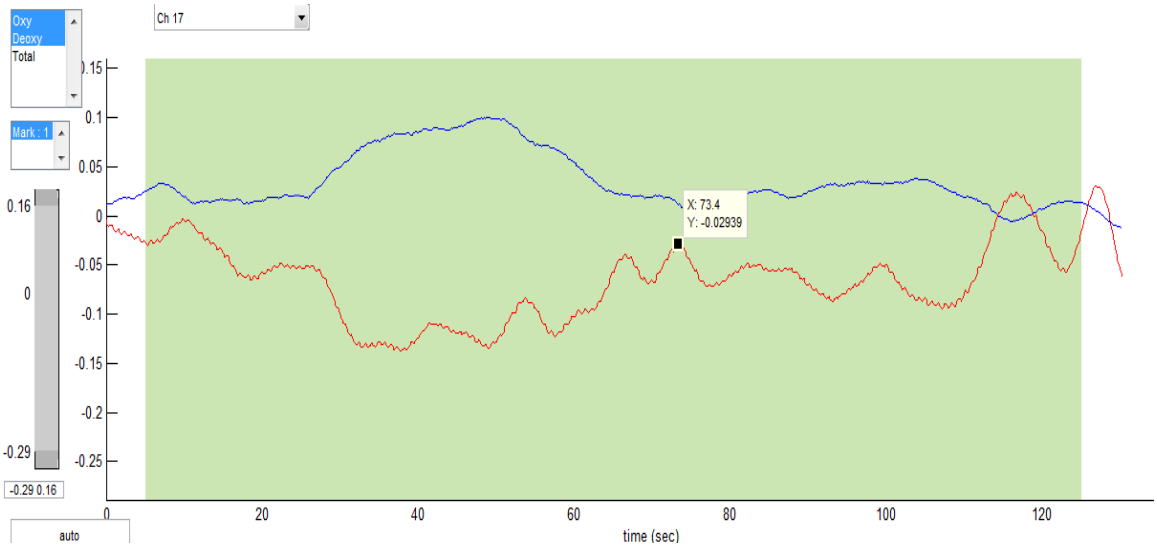


Figure 18 (b)

IOWA Gambling Test: Figure 18 (a) shows the maximum level of de-oxygenation level (0.09996) compare to oxygenation level (-0.02939) in Figure 18 (b).

Subject 3

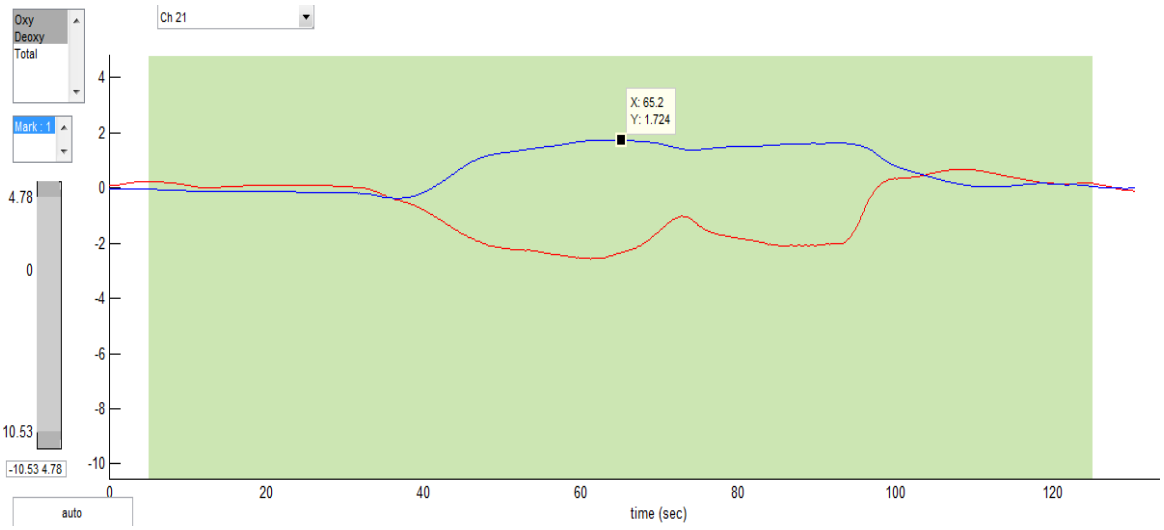


Figure 19 (a)

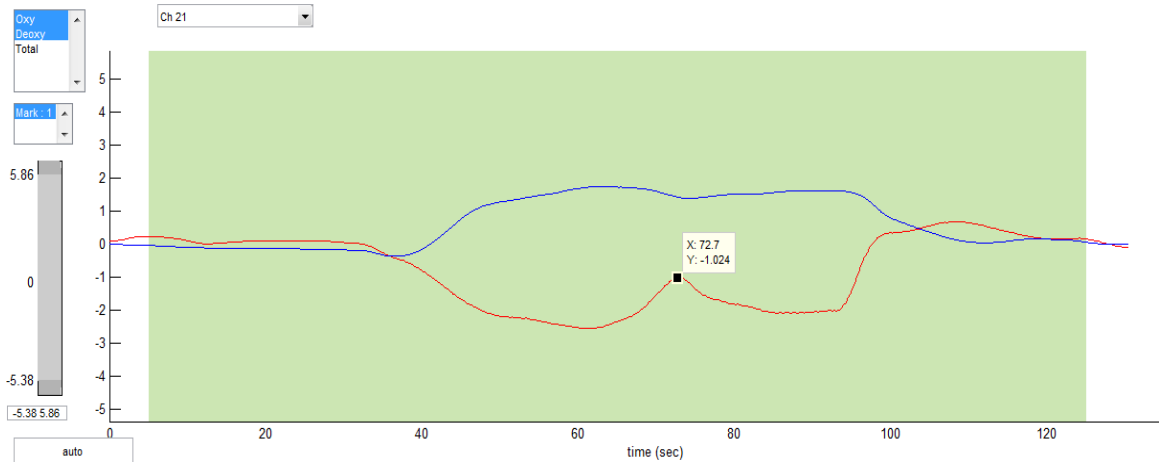


Figure 19 (b)

SOPT Test: Figure 19 (a) show the de-oxygenation level (1.724) and this is the highest rate maybe because of not enough sleep or tired. Figure 19 (b) show oxygenation level (-1.024).

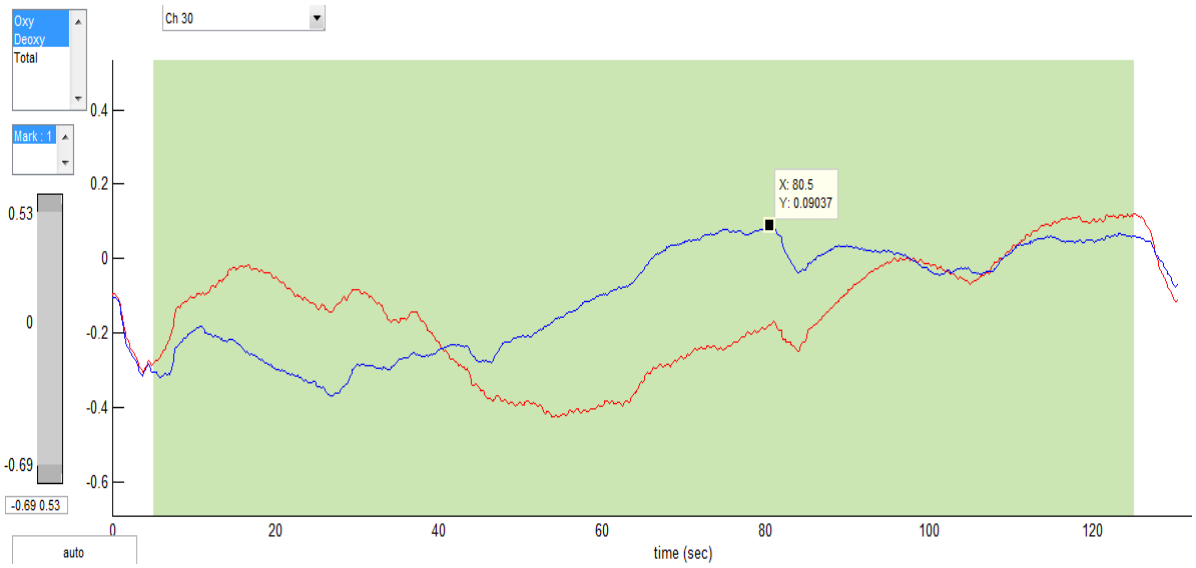


Figure 20 (a)

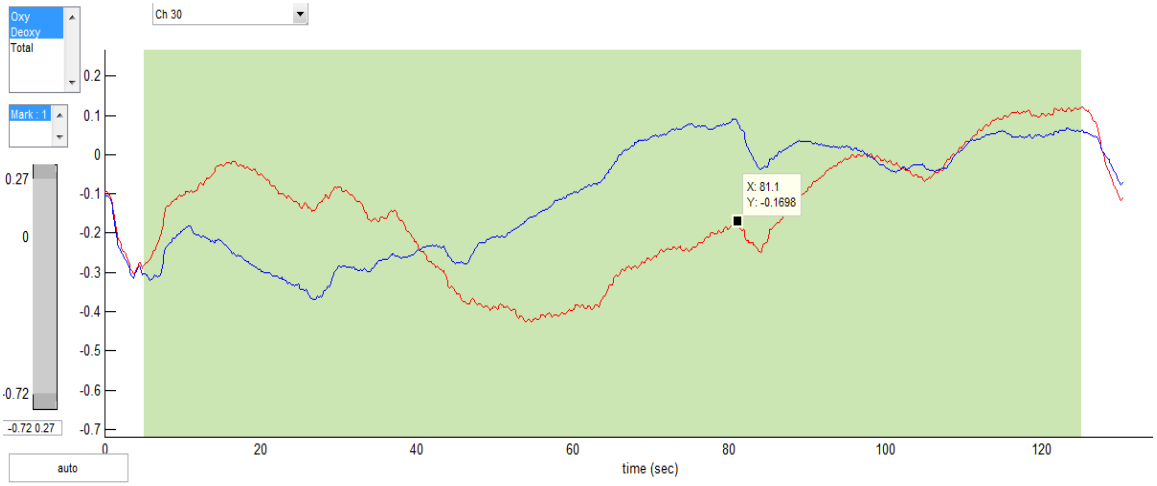


Figure 20 (b)

IOWA Gambling Test: Figure 20 (a) show the de-oxygenation level (0.09037) compared to oxygenation level (-0.1698) in Figure 20 (b).

4.2. Non to Social Media Addiction

Subject 4

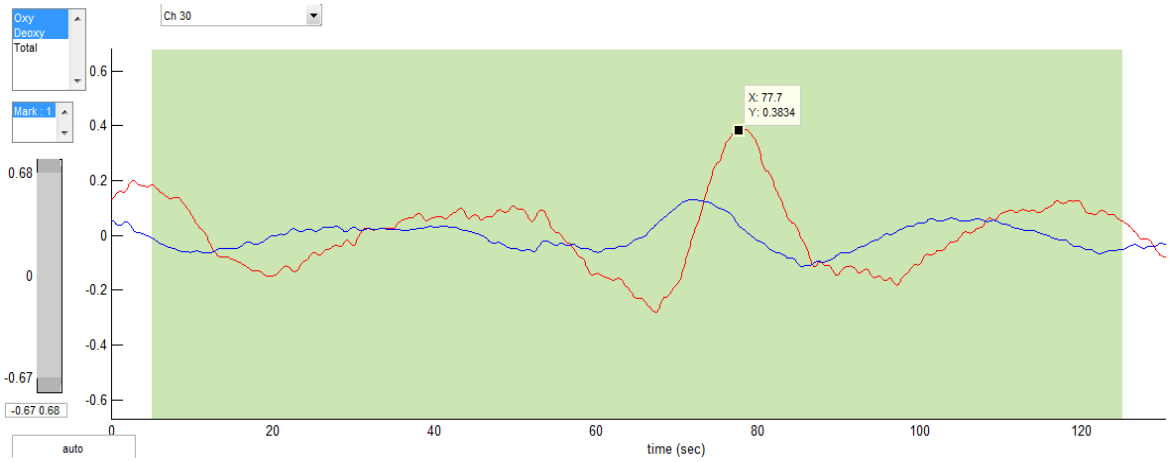


Figure 21 (a)

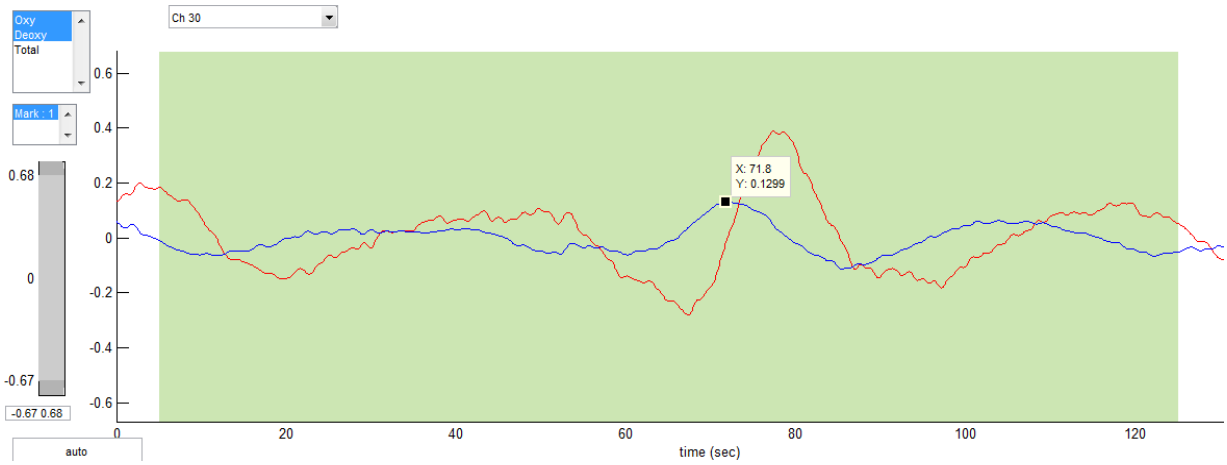


Figure 21 (b)

SOPT Test: The Figure 21 (a) shows the oxygenation level value is higher (0.3834) than de-oxygenation level (0.2199) in Figure 21 (b).

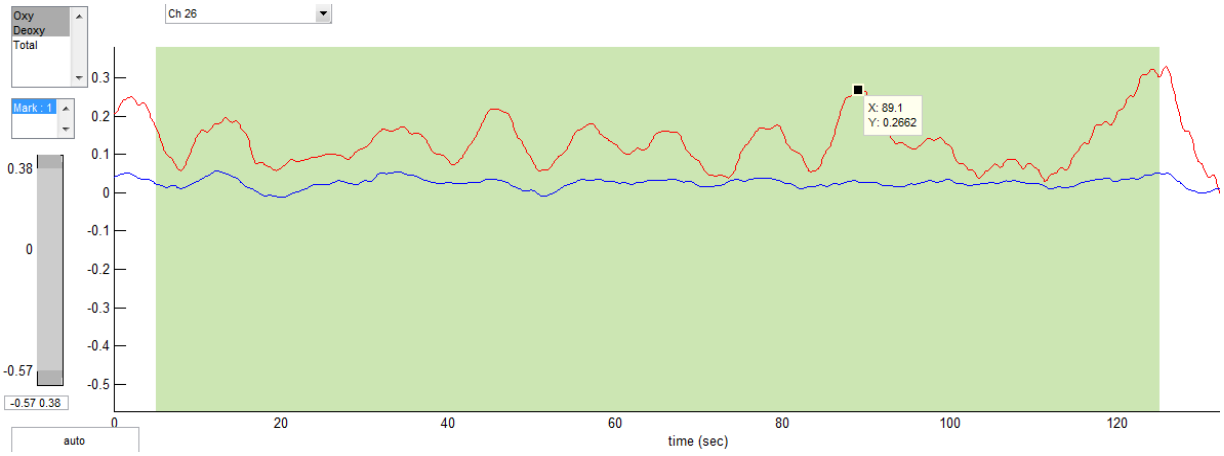


Figure 22 (a)

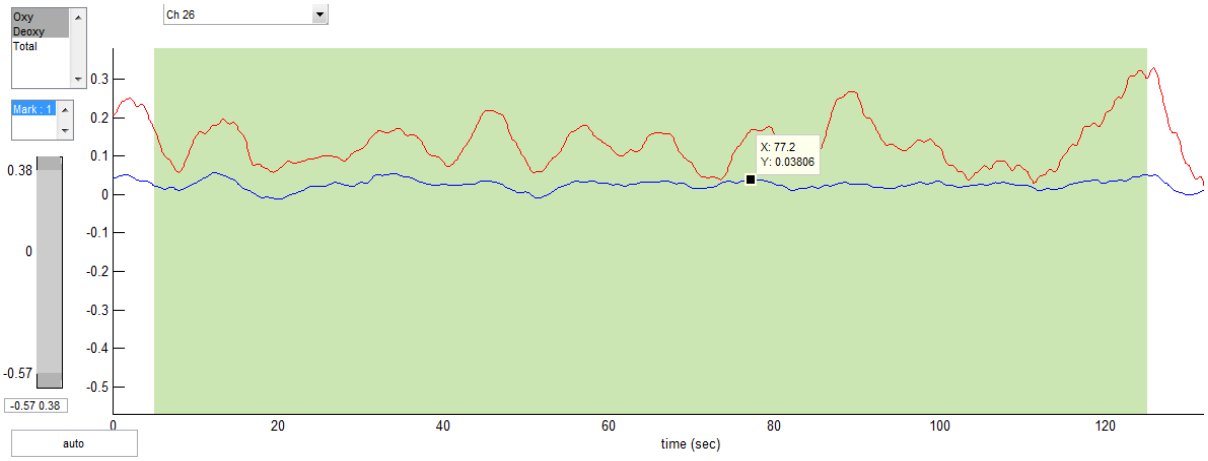


Figure 22 (b)

IOWA Gambling Test: Figure 22 (a) show the oxygenation level (0.2662) compared to de-oxygenation level (0.03806) in Figure 22 (b).

Subject 5

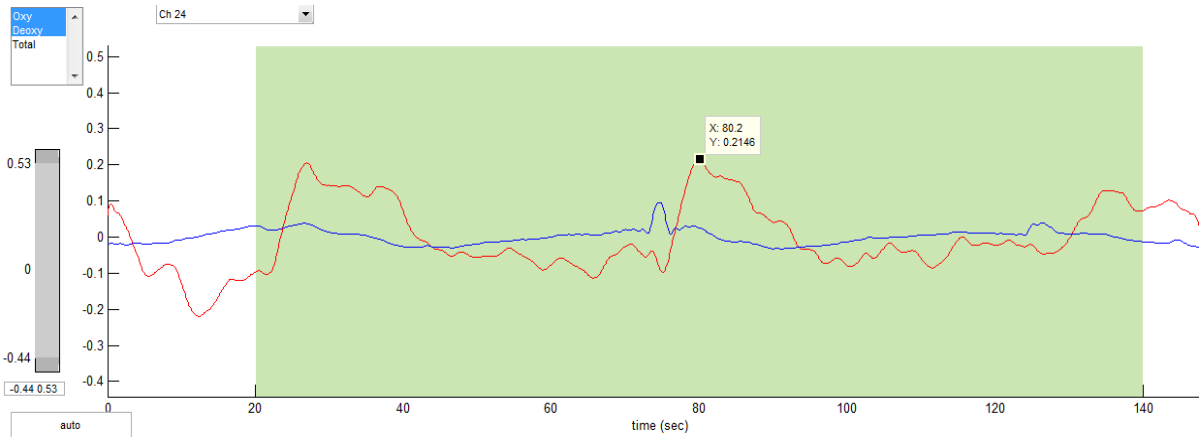


Figure 23 (a)

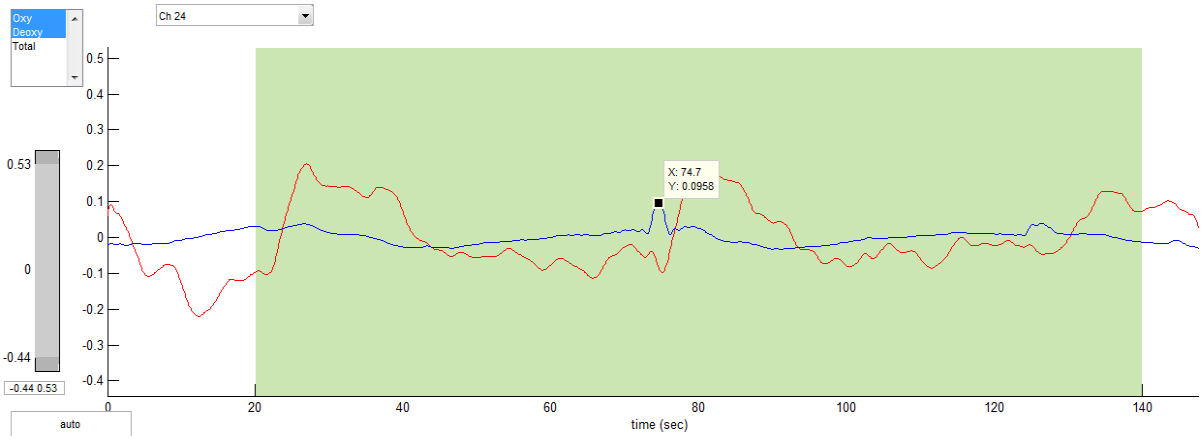


Figure 23 (b)

SOPT Test: The Figure 23 (a) shows the oxygenation level value is higher (0.215) than de-oxygenation level (0.0958) in Figure 23 (b).

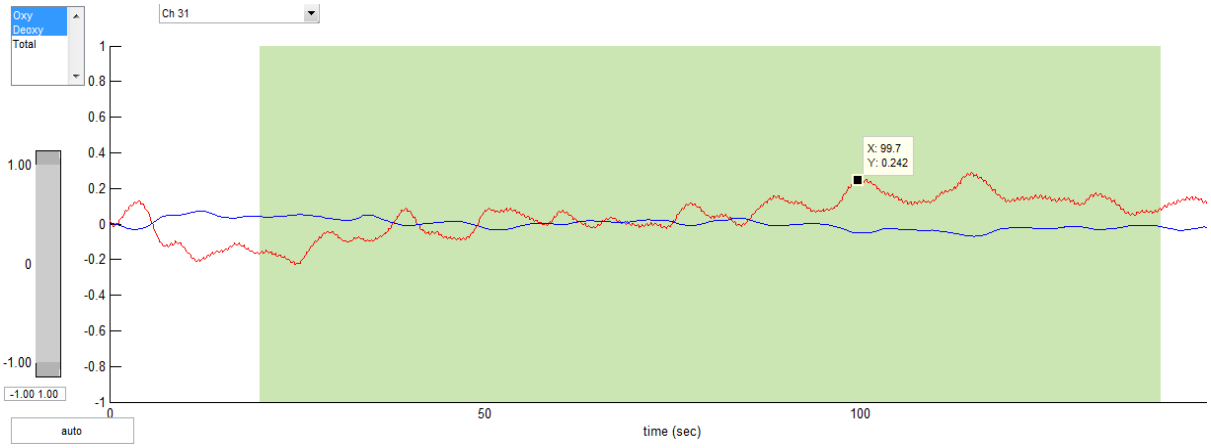


Figure 24 (a)

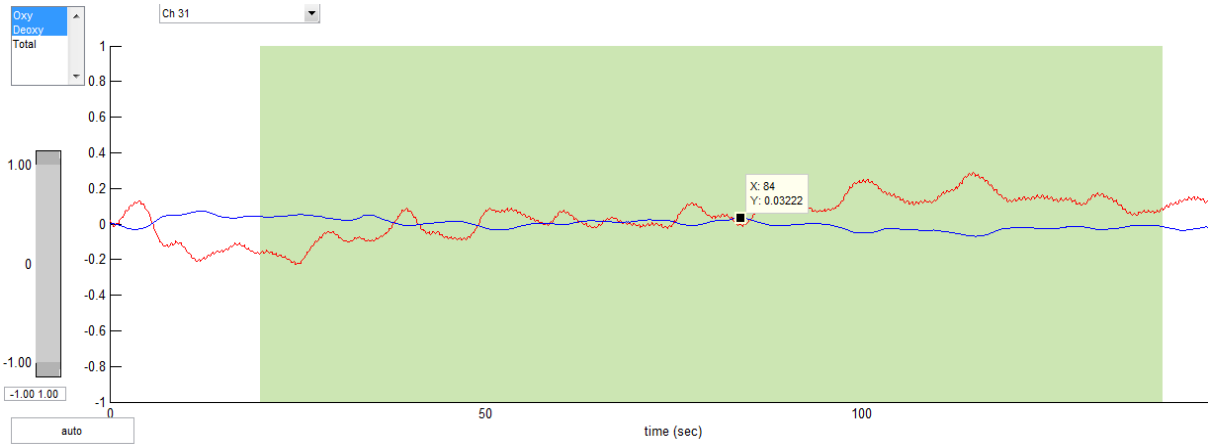


Figure 24 (b)

IOWA Gambling Test: Figure 24 (a) show the oxygenation level (0.242) compared to de-oxygenation level (0.0322) in Figure 24 (b).

Subject 6

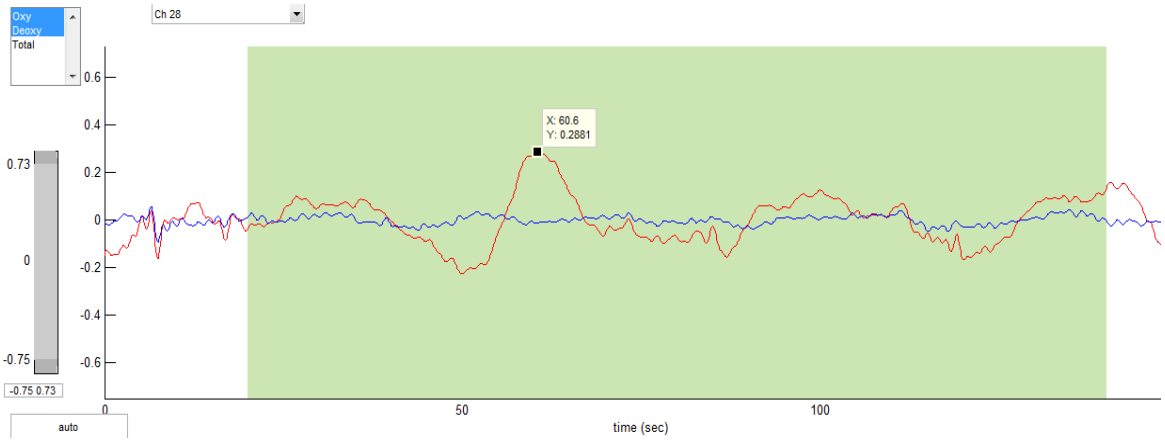


Figure 25 (a)

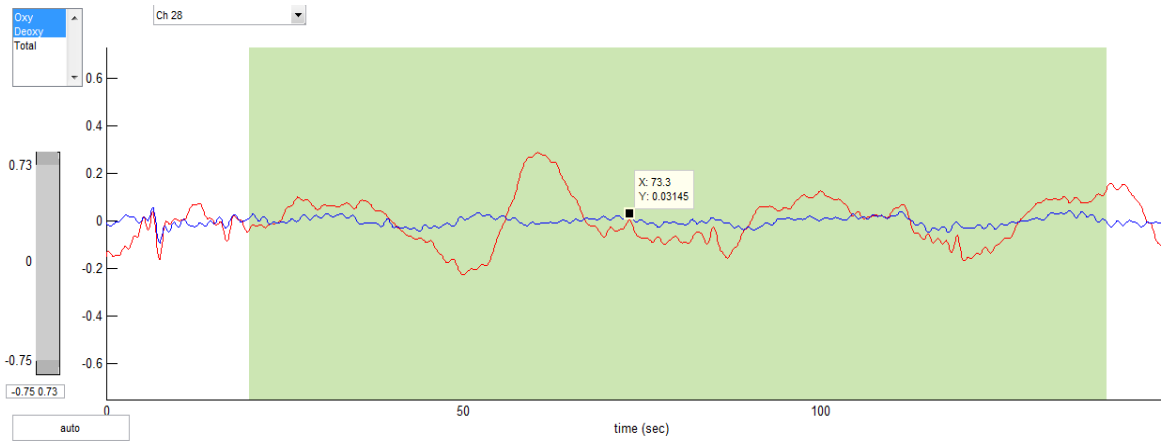


Figure 25 (b)

SOPT Test: The Figure 25 (a) shows the oxygenation level value is higher (0.2881) than de-oxygenation level (0.0314) in Figure 25 (b).

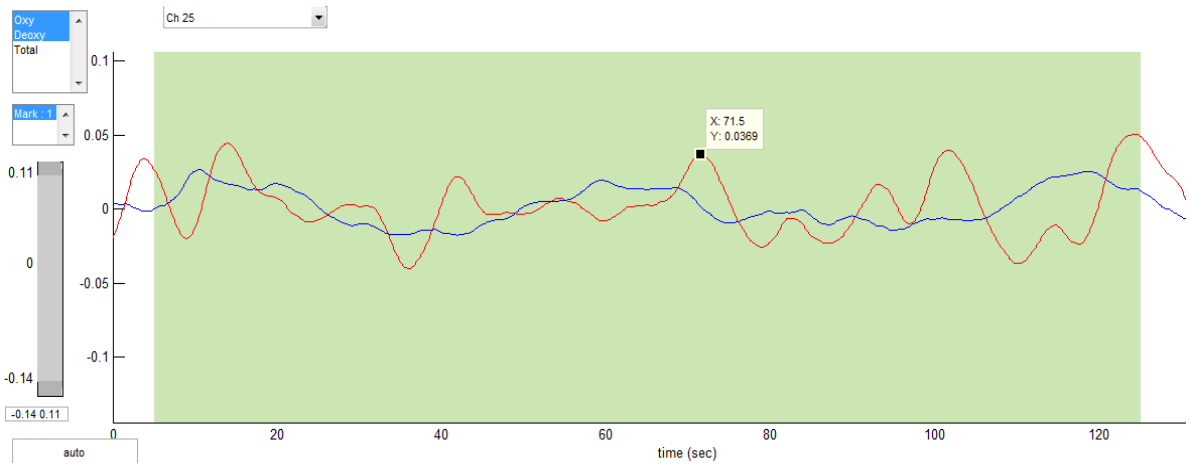


Figure 26 (a)

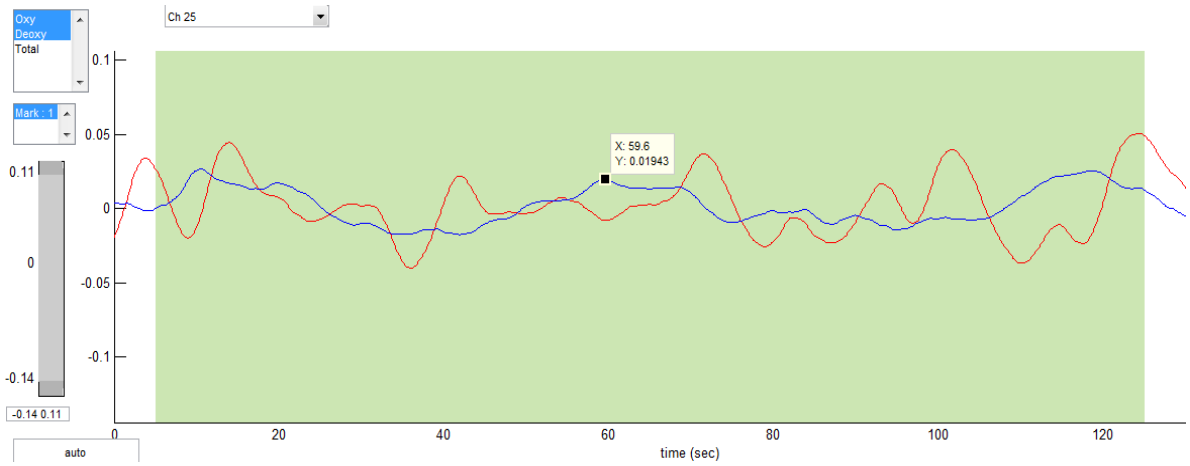


Figure 26 (b)

IOWA Gambling Test: Figure 26 (a) show the de-oxygenation level (0.0369) compared to de-oxygenation level (0.01943) in Figure 26 (b).

The maximum peak (oxygenation level) and minimum peak (de-oxygenation level) for every subject is tabulated and analyzed in the discussion section below.

CHAPTER 5

DISCUSSION

In this section, the results from the previous section are analyzed by tabulating the maximum peaks of blue and red graph respectively. Then the values will be compared between the subjects with social media addiction and subjects with non-social media addiction.

5.1. Social Media Addiction

Table 1: Self-Ordering Pointing Task and IOWA Gambling Task value

Subject	Self-Ordering Pointing Task (SOPT)		IOWA Gambling Task	
	Oxygenation	De-oxygenation	Oxygenation	De-oxygenation
1	-0.08143	0.09153	-0.04817	0.03135
2	-0.09174	0.08892	-0.02939	0.09996
3	-1.024	1.724	-0.1698	0.09037

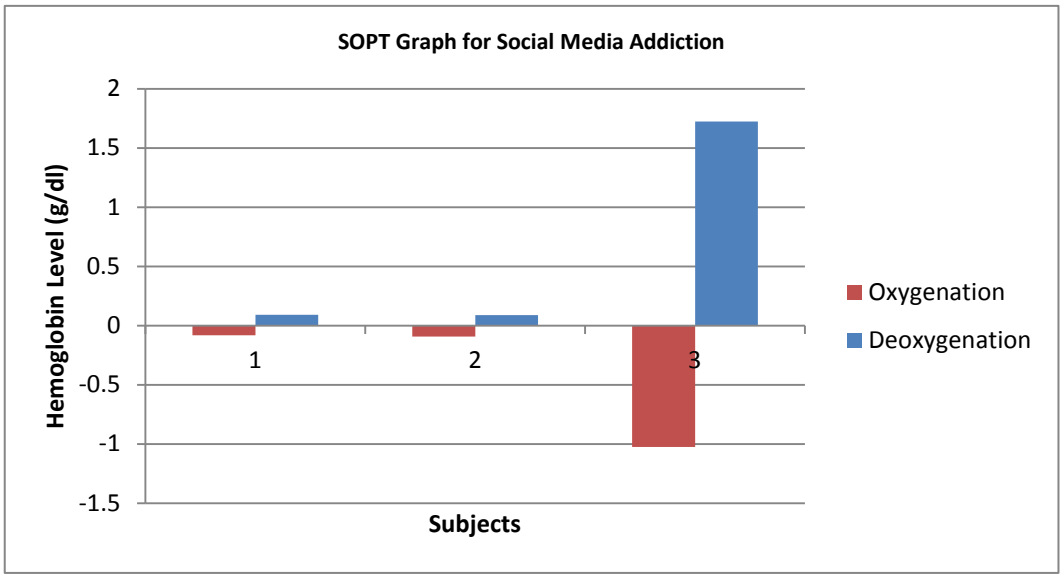


Figure 27: Level of Oxygenation and De-oxygenation for SOPT

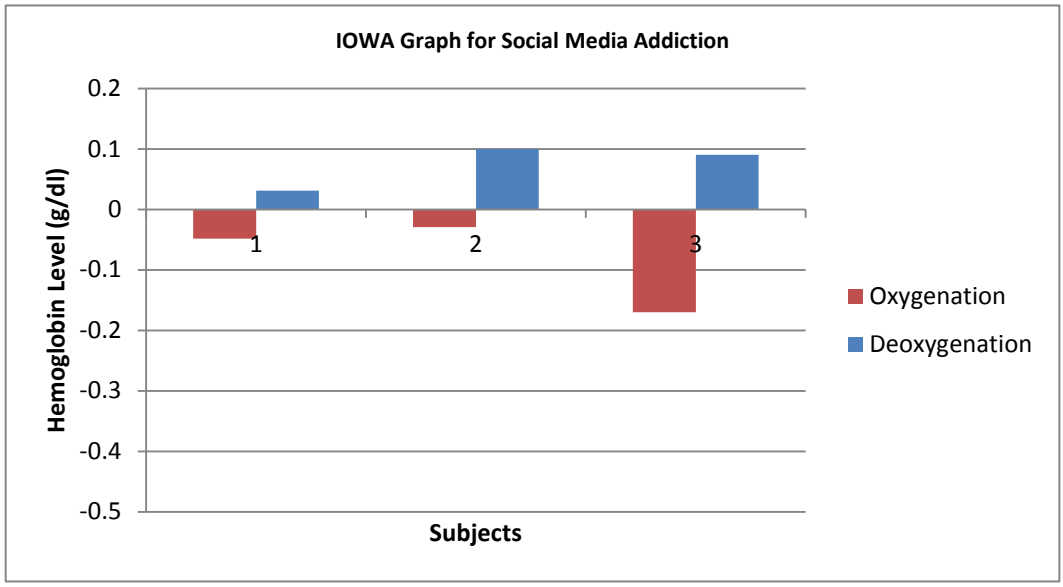


Figure 28: Level of Oxygenation and De- oxygenation for IOWA Gambling Task.

Based on the results obtained, all subjects deprived of oxygen are the de-oxygenated level is higher than oxygenated. The result for SOPT is recorded during the task. For subject 1, the oxygenation level is about (-0.08143) and de-oxygenation is (0.09153). For subject 2, the oxygenation level is (-0.09174) and the de-oxygenation is (0.08892). For subject 3, the oxygenation is (-1.024) and the de-oxygenation is (1.724). From the results, all of the subject have low oxygenation levels. This shows

that subject with internet addiction have lower working memory. From the tasks that we are doing, we can see that subject with internet addiction cannot focus on what they are doing and they become not interested on the task.

The result for IOWA also recorded during the task. For subject 1, the oxygenation is about (-0.04817) and de-oxygenation is (0.03135). For subject 2, the oxygenation is (-0.02939) and the de-oxygenation is (0.09996). For subject 3, the oxygenation is (-0.1698) and the de-oxygenation is (0.09037). Subject 3 has lack of oxygenation due to not enough sleep and heavy smoking (**Appendix: Volunteer Information Form)** compares to subject 1 and 2. From observationin IOWA task, subjects who are addict to internet cannot make a good decision in the task based on de-oxygenation level in the social media addict figure 15, 16, 17, 18, 19, 20. They will get more stress when doing the task, they cannot focus and this is why the de-oxygenation is overtake with the oxygenation levels in blood cells.

From the graph, it shows that the first 20 second the brain doesn't have the brain activation. After it reach to 40-80 second the graph of hemoglobin levels are increase which means that the first 20 second the brain is not active yet when subject doing the task and after 40-80 second the brain start to activate. If the graph at 20 second has activated which means that the subject moves some part of his body and this does not interfere the result obtained.

5.2. Non-social Media Addiction

Table 2: Non Social Media Addiction

Subject	Self Ordering Pointing Task SOPT)		IOWA Gambling Task	
	Oxygenation	Deoxygenation	Oxygenation	Deoxygenation
4	0.3834	0.1299	0.2662	0.03806
5	0.215	0.0958	0.242	0.0322
6	0.2881	0.0314	0.0369	0.01943

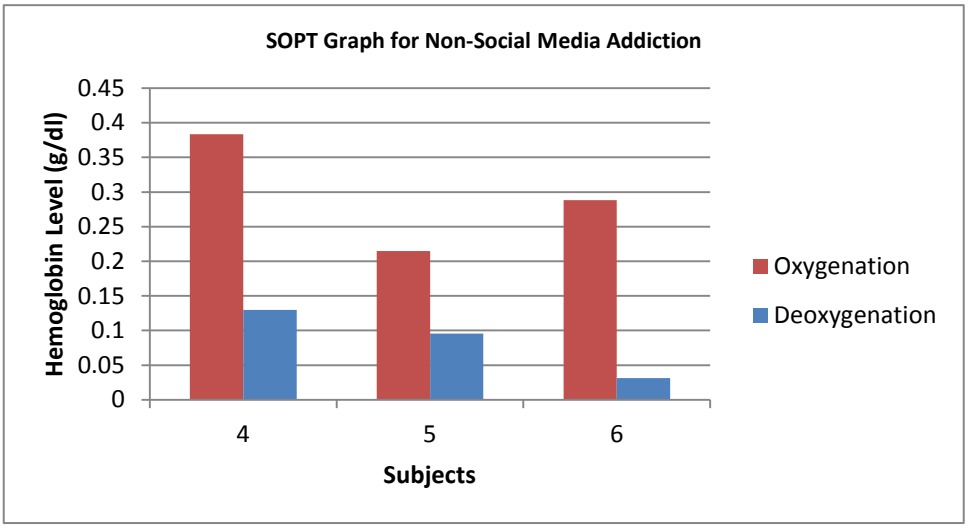


Figure 29: Level of Oxygenation and De-oxygenation for SOPT

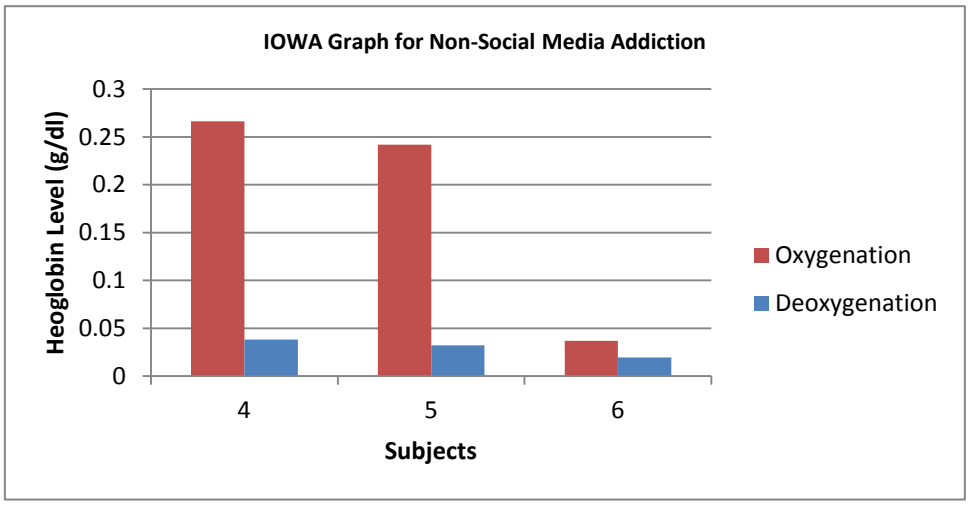


Figure 30: Level of Oxygenation and De- oxygenation for IOWA Gambling Task.

Based on the FNIR data analysis on non-social media addiction during the task, the oxygenation in the brain is higher than de-oxygenation. So, who is not addicted to social media has higher working memory and can make a good decision making.Based on the results obtained, all subjects have more oxygen in their blood flow compare to addicted subjects. The result for SOPT is recorded during the task. For subject 4, the oxygenation level is about (0.3834) and de-oxygenation level is (0.1299). For subject 5, the oxygenation level is (0.215) and the de-oxygenation level is (0.0958). For subject 6, the oxygenation level is (0.2881) and the de-oxygenation level is (0.0314). From the result, all of the subject have higher oxygenation levels and this is prove that non internet addiction have high oxygenation in their brain. From the task that we are doing, we can see that subject with non-internet addiction can focus on what they are doing and they become interested on the task.

Next is the result for IOWA, the task is also recorded. For subject 4, the oxygenation is (0.2662) and de-oxygenation is (0.03806). For subject 5, the oxygenation is (0.242) and the de-oxygenation is (0.0322). For subject 6, the oxygenation is (0.0369) and the de-oxygenation is (0.01943). Subject 4, 5 and 6 has more of oxygenation because their lifestyle is healthy. They have enough sleep, not smoking and active in sports (**Appendix: Volunteer Information Form)**. In both tasks, these subject enjoy playing with the picture and cards. They become more focus

when doing the tasks, this is why oxygenation levels in their brain are higher than the de-oxygenation level.

Based on the figure 21, 22, 23, 24, 25, the SOPT is a better task to see the hemoglobin levels in brain activation compare to IOWA gambling task.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

In future, this research can used as a potential approach to study the oxygenation and de-oxygenation level in human brain activities. Based on the result obtained, it shows that subjects with more social media addiction tend to have more de-oxygenation in their brain, and vice versa to non-social media addict. This approach is recommended due to its effectiveness and simplicity in obtain the data.With enough data, experiment can be done by using FNIR as a medium to analyses theblood flow in human brain. Using FNIRs is more easy compared to any other devices because FNIRs is low cost, portable, high quality and the result is almost the same with functional magnetic resonance imaging(FMIRs).

From this research, we can know how blood in human brain work based on their IQ. We expect that human with no interest in social media have more oxygen blood flow in their brain compared to human that are preoccupied with in social media.

In the future, with this research we can help the people that is addicted to social media to slowly reduce their online time. This addiction can drop their performance in academic and work place.

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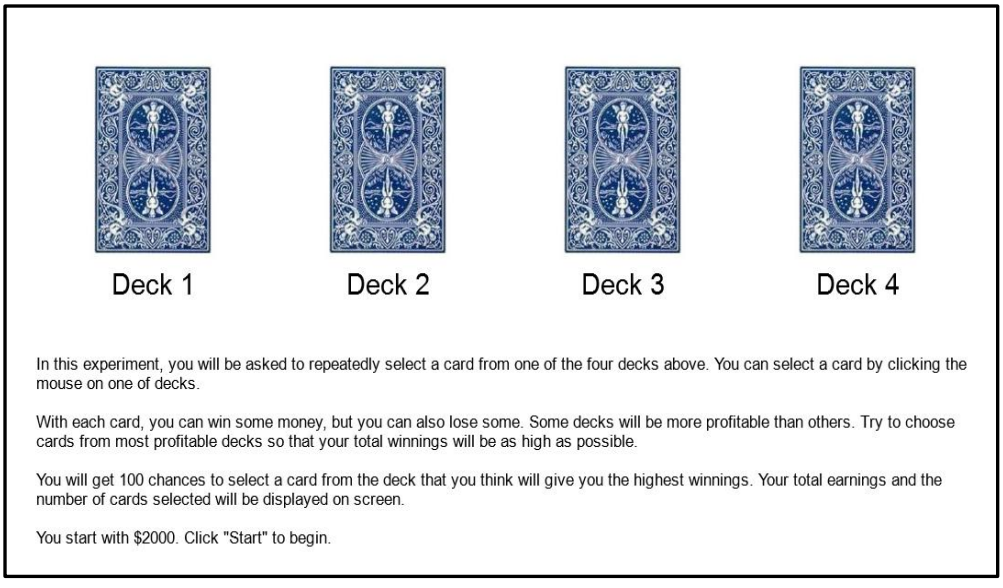
APPENDICES

Appendix (A)

SOPT

IOWA Gambling Test



Appendix (B)

VOLUNTEER INFORMATION FORM

Personal Information			
Name:		NRIC/Passport No:	
UTP Matrix No:		Email:	
Nationalty:		Phone No:	
Address:			
Course of Study:		Semester/Year:	

Research Related Information			
Date of Birth:	Age: ( )	Smoking?	No: ☐ Yes: ☐ (Hours:___) ago
Gender:		Coffee?	No: ☐ Yes: ☐ (Hours:___) ago
Dominant Hand:		Familiar with SOPT & IOWA Task?	No: ☐ Yes: ☐
Education Level:			

Health Condition			
Hours of Sleep:	Hrs	Mental Condition:	
Having illness from family history?		No: ☐ Yes: ☐	( )
Under Medication? No: ☐ Yes: ☐		_____	

I hereby declare that all the above information given is voluntary, true and accurate as to the best of my knowledge. I do understand that researchers will do the best to maintain the confidentiality of my personal information and solely use it for research only.

signed,

_____

Name:

Date:

Appendix (C)

Internet Addiction Test

1. How often do you find that you stay on-line longer than you intended?

Rarely Occasionally Frequently Often Always

2. How often do you neglect household chores to spend more time on-line?

Rarely Occasionally Frequently Often Always

3. How often do you prefer the excitement of the Internet to intimacy with your partner?

Rarely Occasionally Frequently Often Always

4. How often do you form new relationships with fellow on-line users?

Rarely Occasionally Frequently Often Always

5. How often do others in your life complain to you about the amount of time you spend on-line?

Rarely Occasionally Frequently Often Always

6. How often do your grades or school work suffer because of the amount of time you spend on-line?

Rarely Occasionally Frequently Often Always

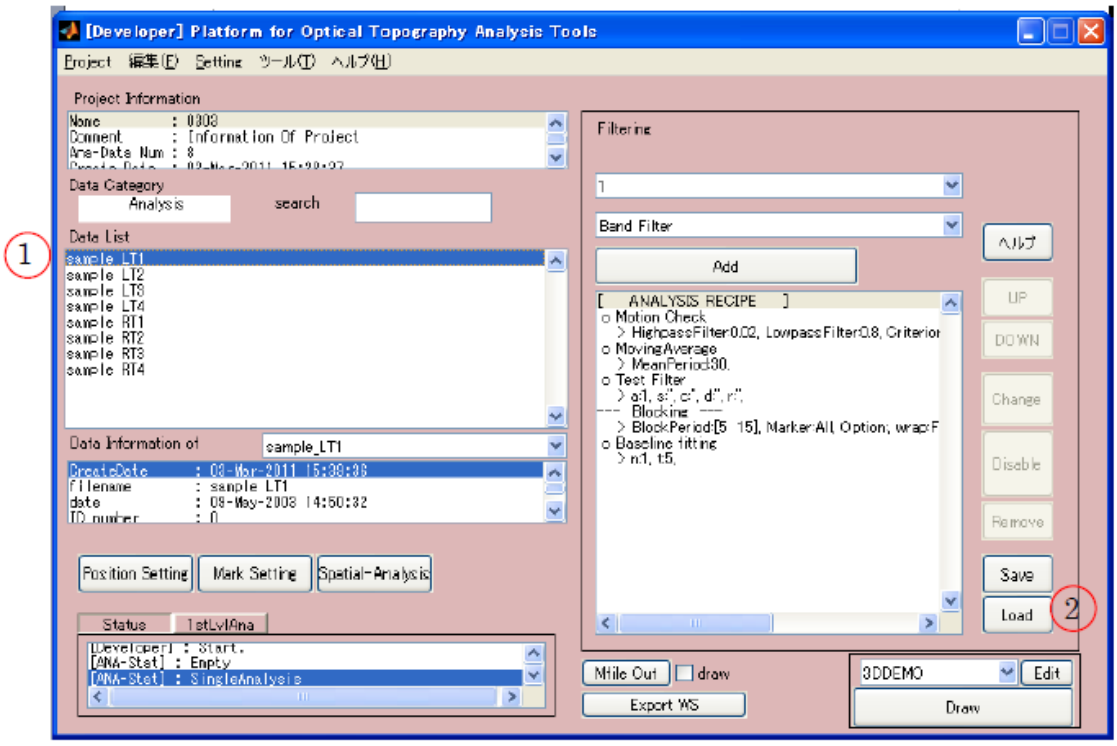
Appendix (D)

Platform of Optical Topographic Analysis Tools (POTATo)

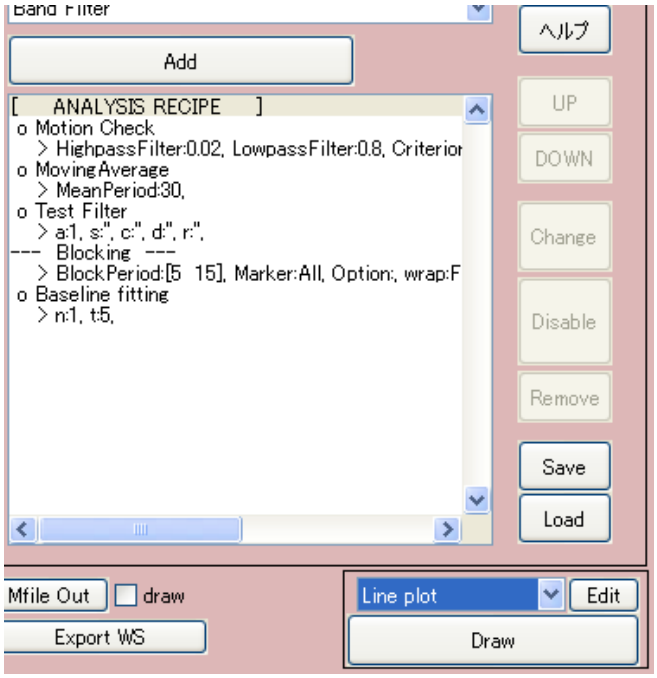
In this section, we are going to demonstrate the analysis of NIRS data with POTATo.

1. Import The Data

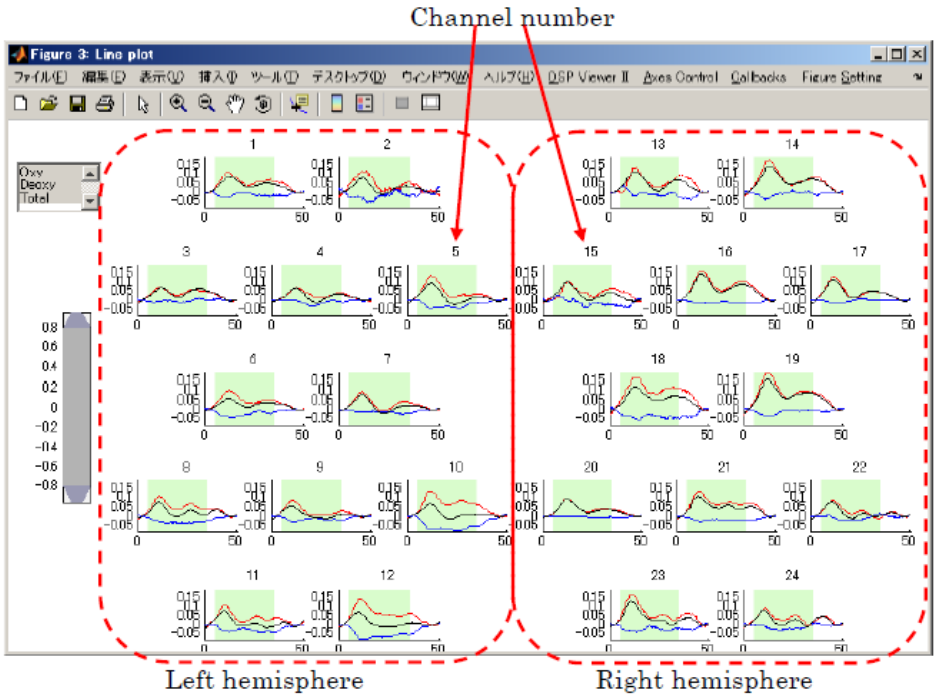
After importing the raw data into POTATo, these data should be listed in the “Data List”.



In the right section of the main window click on “Load” and load the recipe file “Recipe_sample1.mat”.The RECIPE should appear in the field ANALYSIS RECIPE:

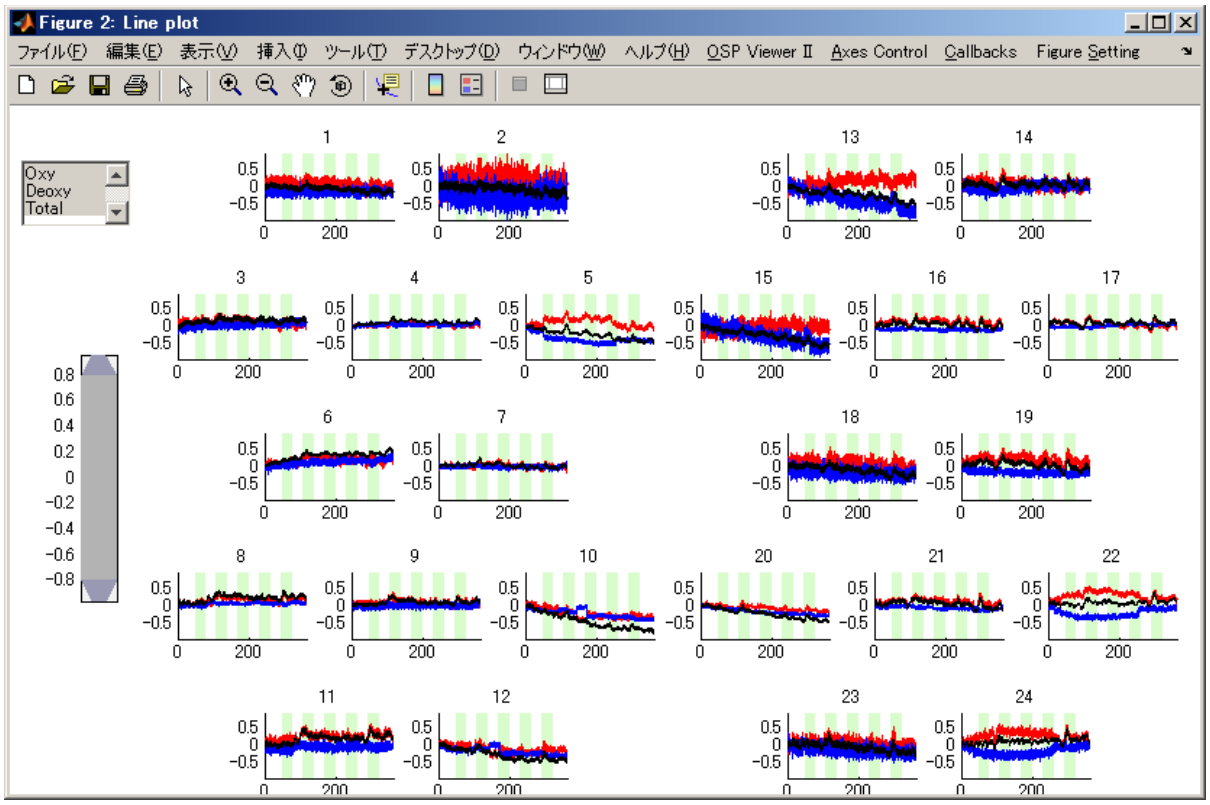


From the pull-down menu above the "Draw" button select "Line plot" as layout and click "Draw". The result of the analysis will be presented in a new window:



After demonstrating the analysis with a sample RECIPE, we are going design our own analysis RECIPE. First remove the present RECIPE by selecting each tool and clicking on the "Remove" button.

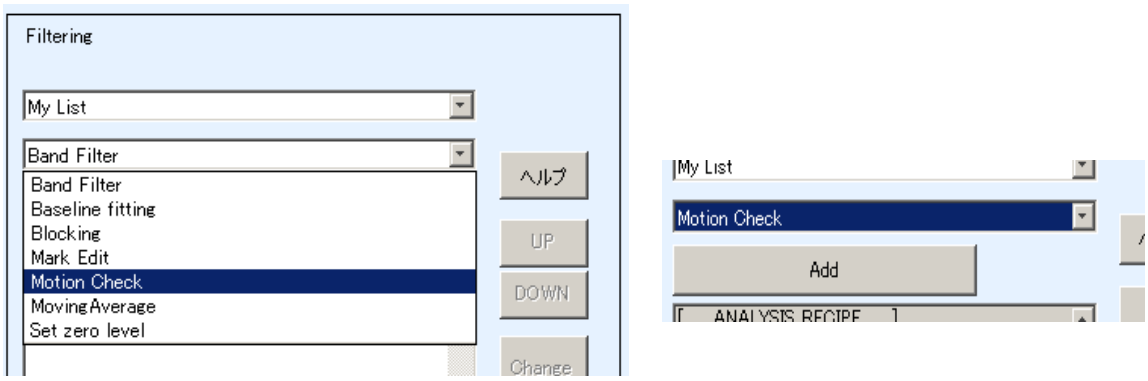
Again, select the raw data to be analyzed (e.g.” LT1”), select a display mode (Line plot) and click on “Draw”. The new window shows the raw data from file “LT1”:



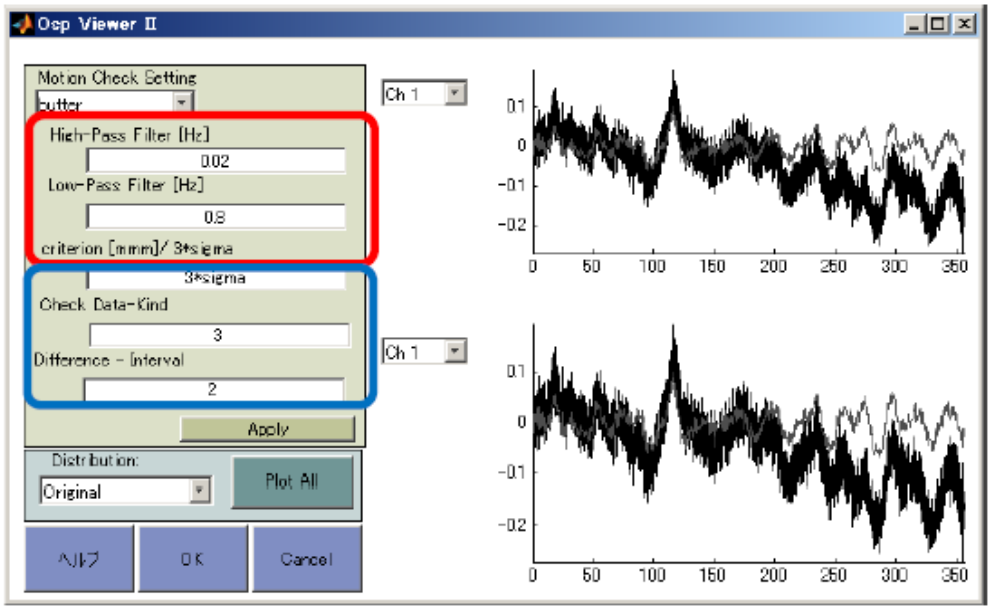
Before starting with the design of an analysis RECIPE it is advisable to first look at the overall quality of the raw data. As we can see above, we have several channels with a low S/N ratio, e.g. channel 2, or movement artifacts may influence further data interpretation (channel 10).

2. Noise Reduction

Instead of discarding the noisy data we are going to try to recover the data using analysis tools plugged into the POTATo platform. We are going to mark the data intervals that are affected by motion artifacts and will exclude them from any further analysis.



A new window where the parameters for the “Motion Check can be set will appear:

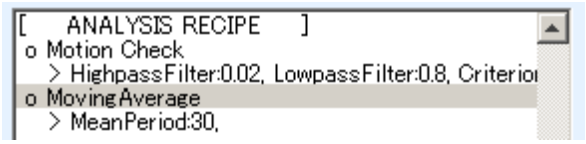


As for the bandpass filters (encircled in red), we leave the default settings unchanged.

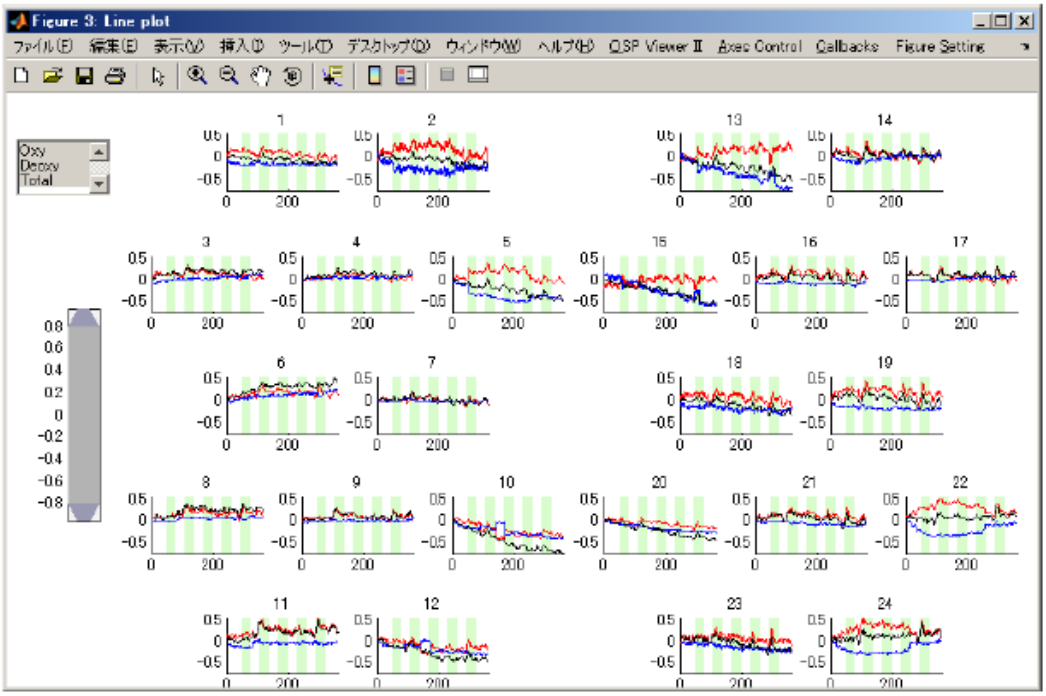
The settings in the field encircled in blue we change according to the image below (0.1, 1, 2) and click “Apply”. The “criterion” of 0.1 defines changes larger than 0.1 mmol*mm as movement artifact. “Data Kind” 1 corresponds to oxy-Hb, d”Data Kind”

2 to deoxy-Hb and “Data Kind” 3 to total Hb; in the example shown below, oxy-Hb data are displayed. In the third field, “Difference Interval” we leave the default value of “2” unchanged, which means that the changes for each data point will be calculated.

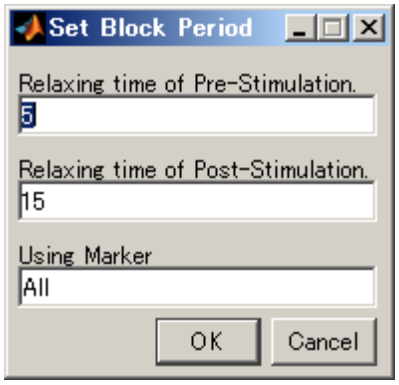
Further smoothing of the data can be achieved by applying a “Moving Average”. From the tool list (“Filtering”) select “Moving Average” and add it to the ANALYSIS RECIPE.



This will reduce the high frequent noise. Further smoothing can be achieved by averaging over a number of data blocks (“block average”), which are defined by start and stop markers (each green area represents one block):

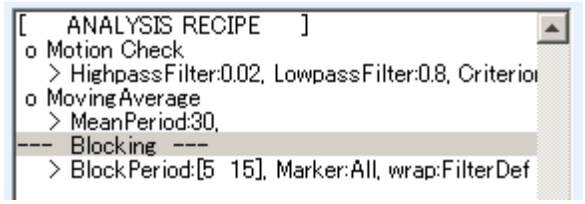


To convert “Continuous” data into “Block” data, select “block average” from the tool selection and add it to the “ANALYSIS RECIPE”.

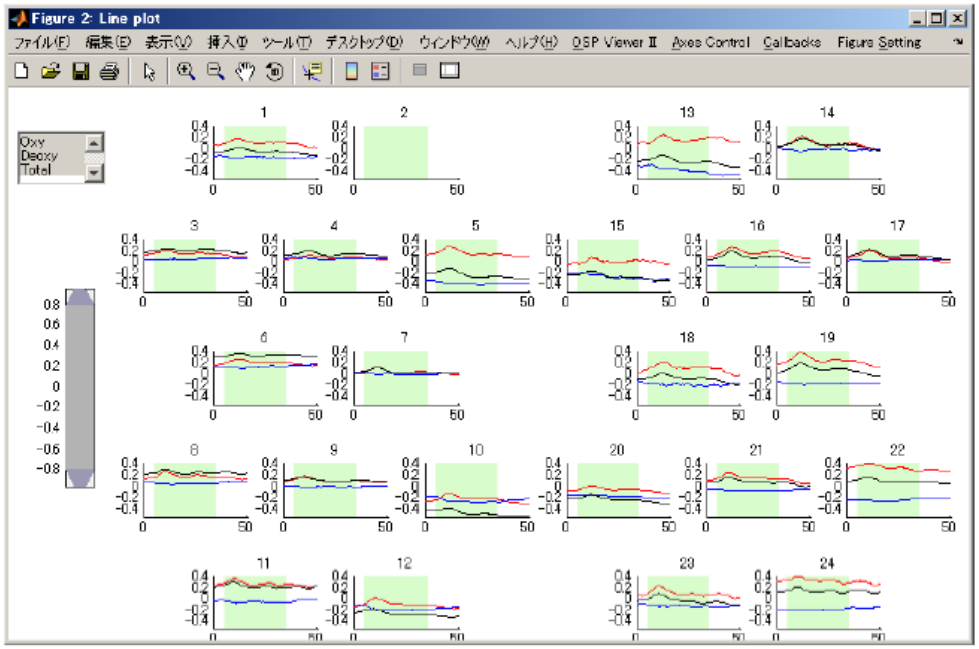


In the “Set Block Period” dialog box set the “Pre-Stimulus” and the “Post-Stimulus” times (in seconds), which will divide the continuous data into blocks. In the category “Marker type” select “All”, if you want to use all markers set during the measurement. In the case only a selection of blocks are going to be averaged select the appropriate number (“1” = “A”; “2” = “B”; etc.).

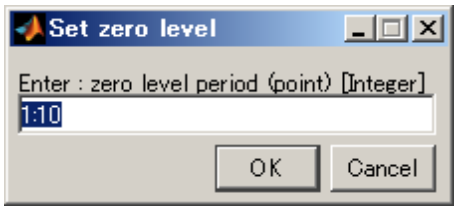
Click “OK” to add function of analysis recipe:



Select “Draw” to view the result of the analysis:

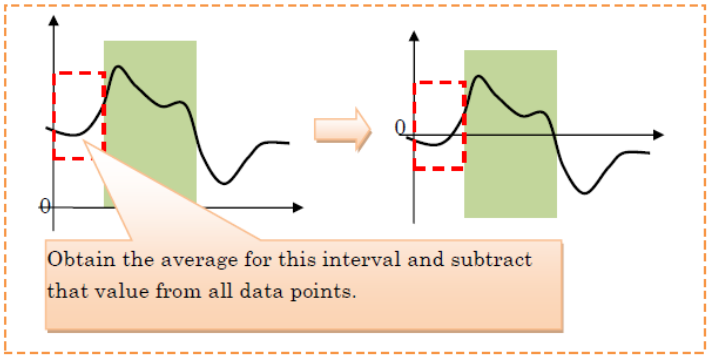


In the dialog box give the data interval which will serve as reference for the correction of the baseline.



The interval s given in data points and not in seconds! The (MatLab-specific) expression "1:10" describes an interval from sampling point 1 to 10. If we enter "1:50", the tool will use 50 data points, which corresponds to 5s in front of each block, as reference.

The tool will calculate the average of this interval and subtract the obtained value from each data point:



Clicking on "Draw" will show us the result of the baseline correction: