# RESEARCH METHODOLOGY

## HYPOTHESIS

There is a lot of articles which support this idea, that information overload affect on humans decision making (example: Ackoff , 1967; Iselin, 1993; swain, 2000;Jacoby, 1974;owen, 1992). With increasing web shopping suppliers start to increase the amount of product and related information as a way to compete with each other, so it leads to information overload. Because of human limitation in processing the data, so consumers must start to filter the information and it causes additional cost. It reduces one type of cost and incurs another type. As a result of this new cost customers will reflect in different way such as:

1- Postpone shopping
2- Leaving the internet and looking in the traditional market for his/her need

So one of the criteria's for improving an e-commerce websites efficiency could be the load of the information those website impose on the potential customer mind. But the major problem which businesses are face is how to measure this information load. It is impossible for website developers to do a complete research when they want to develop a website it is costly and also there is not an exact amount in the literature which can say the how much is the optimum number of information. Information load depend on type of product, age, gender, brain process capacity (people capability) and also the way of presenting the information. So this area is still very new and need a lot of work to find the optimum number. I should remind from the literature that magic

number 7 ± 2 is a presented as the maximum piece of information a person can keep in his/her minds simultaneously. It is obvious that if a store or website only offers 9 or 10 model of shoes or any other type of product people wouldn't confuse or overload.

I found a solution and that's using EEG device for measuring the information load. Base on the literature EEG signals can reflect the working memory load (theta and alpha).

Regarding to literature review, and because of the relationship between working memory with theta and alpha, I want to test whether oscillation on these waves can reflect the information load, and then this device will help web designers to improve their web site profitability.

Good decision depends on keeping relevant information in mind (working memory) and irrelevant information out of mind. So working memory can be related to our decision making efficiency.

*The research question is: whether presenting more information which is lead to information overload has any relation to the EEG signals?*

Past studies are mostly about the effect of information overload on traditional shopping behavior. Only Agosto.D. E (2002) test Simon theory on youth web preference. He didn't consider the purchasing behavior. And also chan & shang & kao (2007) have done an experimental research for testing the effect of three factors on online shopping behavior. In the psychology environment researchers didn't explore the relationship among brain (EEG) signals and information load. This area is quit new and there is so much work to do, but

for step one, we have to find a strong tool for measuring information load. Using simple questionnaire is not appropriate because people have different criteria's and it is not easy to ask them whether or not they will become overload during shopping. The only questionnaire is belonging to Jacoby and his team which they use it during experiment design. The only research with a conceptual frame work is Owen (1992) research. All the other researchers have been carry out by experiment. Using experiment lead to an incontinency in the results because it all depend on the store lay out, product type, peoples who attend in the experiment, the way of offering information and so on. That's why after more than 30 years from the first research still we cannot be sure what the best number for offering product is. I have used experiment too. But because I measure the brain signals it is usable for all the web designers to use this device for making their web site efficient.

Base on above reasons, I hypothesis that:

*Hypothesis 1: There is a positive relationship between theta power and information load obtained in online store.*

*Hypothesis 2: There is a negative correlation among alpha power and information load obtained in online store.*

Base on what I mention in the literature part and regarding to the relationship between EEG signals with working memory, I want to check whether we can use this devise for measuring information overload during online shopping.

For this purpose I have chosen 6 different websites with different information load and I have tested these websites in terms of the amount of information load.

## METHODOLOGY

Because my research aim is finding the relationship between information load which costumers receive form online store and the theta and alpha power, so I have chosen 6 different online store to recording EEG signals during shopping. For choosing the websites and scoring them I have used following procedure.

### SELECTING WEBSITES

To finding websites for testing EEG signals I had to find both overloaded and under loaded websites. Because of the effect of the type of product on the information overload base on what Lee, (2004) discussed, Information overload problem is different regarding to the knowledge of product for each customer. He also mention that information overload happen mostly for that kind of product which not often bought. So I decided on 3 different categories which are not in the day to day shopping basket. I asked form 10 computer science (master degree) student to go to these websites and shop from them, and then answer some question. I asked the subjects to keep their time and find how long it takes for them to do the shopping. I also ask how confused they feel because of the information provided on the websites. The question is: *How confused did you feel because of information provided by the website (1 = not confused at all; 3= a little confused; 5= moderate; 7 = confused; 9= very confused)* based on their answered and with calculating the means of their score I categorized these web sites to 3 different category overload, under load and moderate.

Sternberg (1966) during his experiment found that reaction time increased systematically as a function of load (in his finding with a slope of 64 ms/item). So I asked the subjects to keep time also. Then I am able to do a comparison among time subjects mention during their test level and the time subjects spend during the experiment. I may find any relationship.

The brief explanations of choosing the website come as follows:

1. *From the service sector I choose vacation tour package*, I choose a website which offer huge amount of tour vacation and for consistency I select Europe vacation package. I asked the subjects to assume that they are given the opportunity to select one package to travel to the Europe, and they have 5000$ money and 14 days for vacation but they have a flexible schedule to choose the date. Average amount subjects needed to select their package was 18.3 min and the confusing level is 6. Level of confusing shows that we can consider this website as an overloaded website. (Website address: http://www.globusjourneys.com). I gave score 6 to this website as information load number.
2. For under load website I asked from the subjects to select a tour package form a website who offer different tour package in Egypt. They don't have so many choices. I asked the subjects to assume that they are given the opportunity to select one package to travel to the Egypt, and they have 1500$ money and 14 days for vacation but they have a flexible schedule to choose the date. Average amount subjects needed to select their package was 10.5 min and

the confusing level is 2.2. Base on the respondent answer I consider this web site as an under load website. (Website address: http://www.safariegypt.com). I gave score 2 to this website as information load number.

3. *From electronic device sector I choose LCD monitor and flash memory.*
4. To shopping LCD monitor subjects have so many choices and beside that there are 9 main attribute which subjects can compare monitors to each other and filter these attributes. Figure 1 shows a comparison between 6 different models as a sample. This website is completely overloaded for the entire subject. They spend at least 14.7 minutes for shopping and all of them feel some degree of confusion for the amount of information they had received. The confusion level is 5.2. Base on the answers I consider this website as highly overloaded website. The confusion level is less that Europe tour package but because the entire respondent was computer science student so they have knowledge about monitors so I still consider this website as an overload website. (Website address: http://www.pcworld.com/). I gave score 5 to this website as information load number.
5. In the electronic device category it was very hard to find under load product because there is so many brands for each type of products and also there are a lot of attributes which customers have to consider. I selected flash memory because the only attributes which are important are capacity and design so it should be easy to

choose. Subjects spent 8.5 minutes for shopping and the confusion level is 3.2. Most of the subjects said that they need more information to decide such as speed of the flash memory. Base on the answers and with comparing the other websites I consider this website as a website which has moderate load. (Website address: http://www.pcworld.com/). I gave score 3 to this website as information load number.

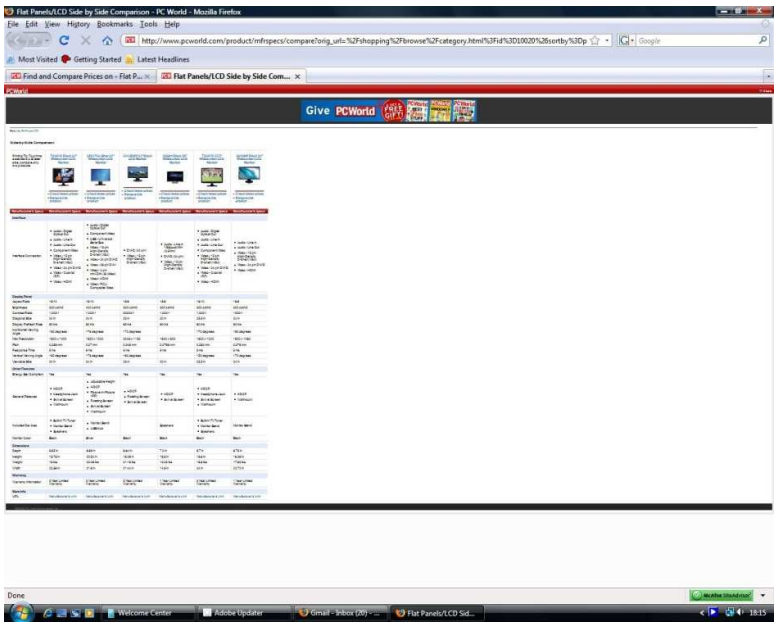



Figure 7- selecting LCD from www.pcword.com

6. *From fashion sector I choose shoes*.

For overload website I asked form the subjects to buy a pair of athletic shoes form http://www.shoebuy.com/ this website offer over 850 shoes brands and is capable to filter shoes in term of category, size, colour, material and brand. Although the website offers so many models but subjects feel fewer overloads in comparison to buying LCD or choosing

Europe tour package. It could be because of the preference or effect of the brand. Subjects spend around 24.8 Min in this website which is highest amount among all 6 websites but subjects feel less confused. It might be the result of the type of task or type of product. The average load for this site is 4.6 which I consider this as a website with moderate information load. I gave score 4 to this website as information load number.

In this category to finding an under load web site I asked the subjects to think that they have a voucher for buying a pair of Clark shoes form Clark online store. Clark doesn't offer so many models so subjects don't feel any confusion. They spent 5.7 minutes (lowest time) and the average score for confusion is 1.8 which is lowest score also. I gave score 1 to this website as information load number.

After choosing website and scoring them I had to record the EEG signals same as follow:

## MEASURING EEG SIGNALS (EXPERIMENT DESIGN)

- **Subjects**

10 master degree students from university Malaya Business School and computer science faculty became volunteer to participate in the experiment. Half of the subjects were males and half females ranging age from 25 to 35 years old.

- **Task**

Subjects ask to do shopping form pre specified websites, after I fixed the epoch on their head and ears. Each subject had to do shopping form 6 different websites. 2 websites form overload category, 2 from under load category and 2 websites with moderate information load, I have explained the procedure and scenarios in the selecting website section. I keep the duration of their shopping and also measuring theta and alpha oscillation power.

- **Electrode positioning**

Base on the literature the best part for measuring theta and alpha is frontal midline (theta and alpha which reflect working memory process). For recording this section signals, and regarding to the device manual I have to install an epoch on the position of F4. The method of finding place of F4 is:

i. Measuring length and width of the subject's head, for finding $C_z$ (if middle of width and middle of length doesn't match, it means that the subjects' head is not completely sphere. So base on the device manual we have to consider middle of the width as $C_z$).
ii. For finding F4 first I should find C4 and $F_z$. C4 is 20% of the width from the $C_z$ to the right ear and $F_z$ is 20% of the width from the $C_z$ to the Nasion or front of the head.
iii. Next step is drawing a line between $F_z$ and C4 and the finding the middle of this line. Middle of C4-$F_z$ line is F4. And I have to put the epoch on this place.

Figure 2 and 3 showing where F4 is and how we can find that.

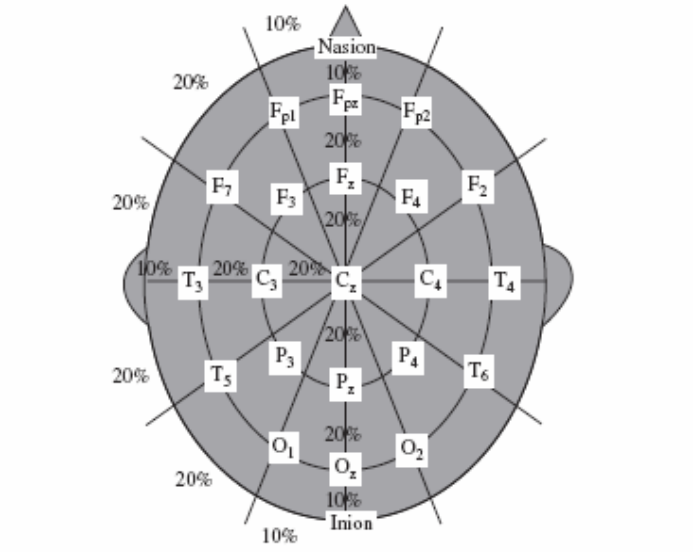



Figure 8- brain divisions

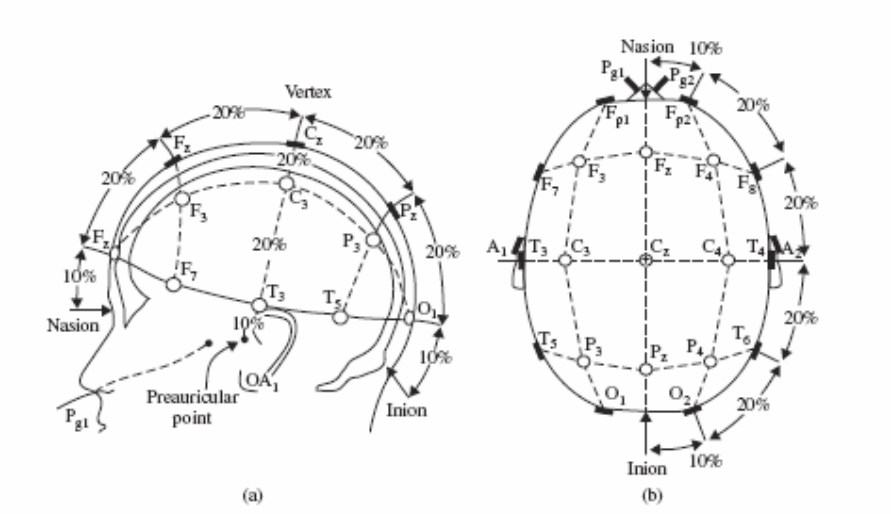



Figure 9- Finding EEG electrods position

## DATA PROCESSING

Since my research objective is finding the relationship between memory load and theta and alpha power, and I am going to find the change in alpha and theta power with memory load, the power spectra for each website load (6, 5, 4, 3, 2, 1) were normalized by the power integrated from 5 to 20 Hz for Load=1 for each subject. This allowed comparison and average among subjects.

I used a t-test to find out whether increasing the power of theta and decreasing the power of alpha with increasing the information load is statistically significant or not.

The equation of increasing power of alpha and theta with respect to load is:

$$P(\alpha) = bL + a$$

$$P(\theta) = cL + d$$

## RESEARCH RESULTS

Table 1 show the results which obtained from EEG device. From 10 volunteer the result from one of them is useless because he had ear problem so I had to remove the data related to him. Each of the 9 remain subject perform two tasks meaning that each of the subject shopping from 2 different websites, 3 from overload websites, 3 from moderate load websites and 3 from under load websites. I had measure the theta mean and also alpha mean. This presented in table 1. Data's come from subject 3 is not usable.

Table 1- Theta means and Alpha means during online shopping

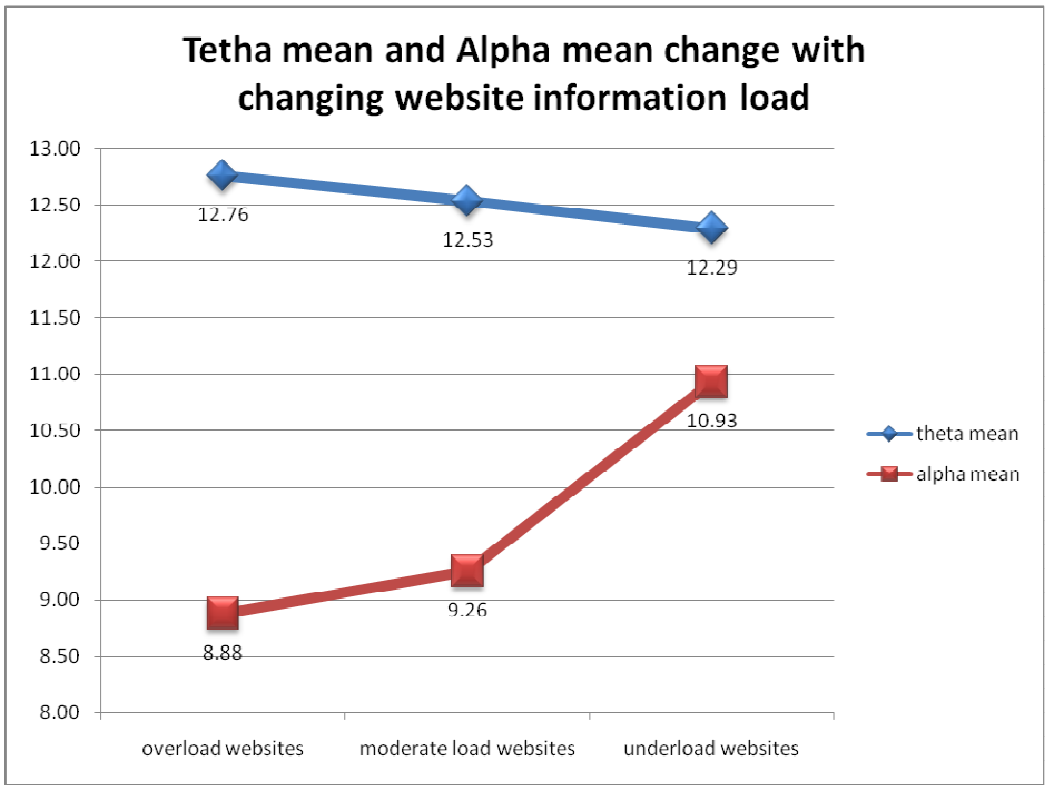
| | theta mean | alpha mean | theta mean | alpha mean | theta mean | alpha mean | theta mean | alpha mean | theta mean | alpha mean | theta mean | alpha mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | overload 1 | | overload 2 | | moderate 1 | | moderate 2 | | Under load 1 | | Under load 2 | |
| Subject 1 | 16.56 | 13.83 | 12.27 | 7.21 | | | | | | | | |
| subject 2 | 13.24 | 10.17 | 9.8 | 8.74 | | | | | | | | |
| Subject 3 | 7.54 | 6.93 | 7.43 | 5.89 | | | | | | | | |
| Subject 4 | 9.89 | 6.64 | 11.28 | 7.32 | | | | | | | | |
| Subject 5 | | | | | 10.87 | 6.61 | 14.28 | 8.27 | | | | |
| Subject 6 | | | | | 12.64 | 8.45 | 11.63 | 11.01 | | | | |
| Subject 7 | | | | | 12.8 | 7.32 | 12.54 | 13.79 | | | | |
| Subject 8 | | | | | | | | | 16.66 | 13.98 | 16.87 | 14.07 |
| Subject 9 | | | | | | | | | 8.9 | 7.71 | 8.57 | 9 |
| Subject 10 | | | | | | | | | 11.28 | 6.7 | 11.55 | 14.12 |

Figures 10 and 11 shows the EEG waves for subject 4 while shopping from an overload website and comparing this to figures 12 and 13 which is the waves from subject 6 while shopping from an moderate load website and figure 14 and 15 which belong to subject 9 during an online shopping from an under load website. If we look at the theta mean in each of the website we can find that theta mean in overload website is 13.25 while alpha mean is equal to 11.23, in moderate load website theta mean is equal to 11.63 while alpha mean is 11.01, and for under load website theta mean is 8.09 and alpha mean is 7.71. Decreasing trend in theta mean is obvious but for alpha the trend is not obvious for one sample comparison but when I use total mean comparison the trend appeared, as shown in table 2 and graph 1 this result support both hypothesis. Meaning that theta power will increase with accumulating data, and alpha power decreasing with accumulating the data in the websites.

Table 2- average of theta means and alpha means

***Result Table***

| | theta mean | alpha mean |
|---|---|---|
| Overload websites | 12.76 | 8.88 |
| Moderate load websites | 12.53 | 9.26 |
| Under load websites | 12.29 | 10.93 |




**Graph 1- Theta and Alpha change with information load**

Above table show the trend of theta and alpha mean with increasing information load in the websites. We can see downward trend in theta mean power and upward trend in alpha mean trend.

Theta trend slop is lower than alpha trend and that's because of the power of theta wave which is less than alpha wave. Actually alpha wave is stronger that theta. I illustrate this issue in figures 10 and 12 and 14.

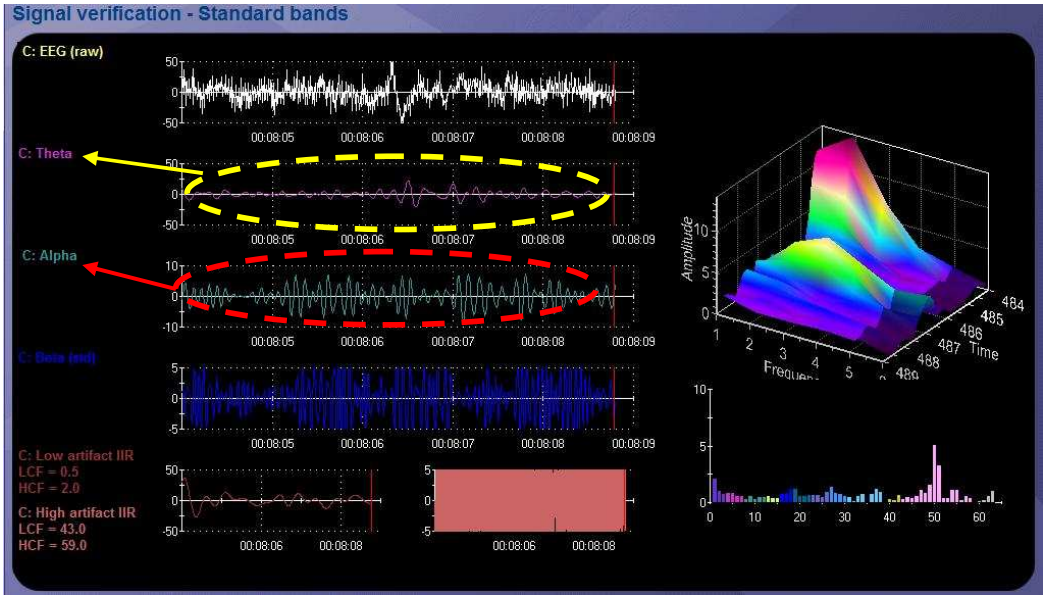



Figure 10- EEG results during online shopping from an overload website


Figure 11- Theta and Alpha during an online shopping from an overload website

This 2 picture are samples of one of the subjects while she tries to find a Europe travel package. The duration of shopping is 8 minutes. Changing in theta and alpha is drowning by the software and also the mean of whole

session for theta and alpha and beta and also theta/alpha, but the last two is not related to my research.

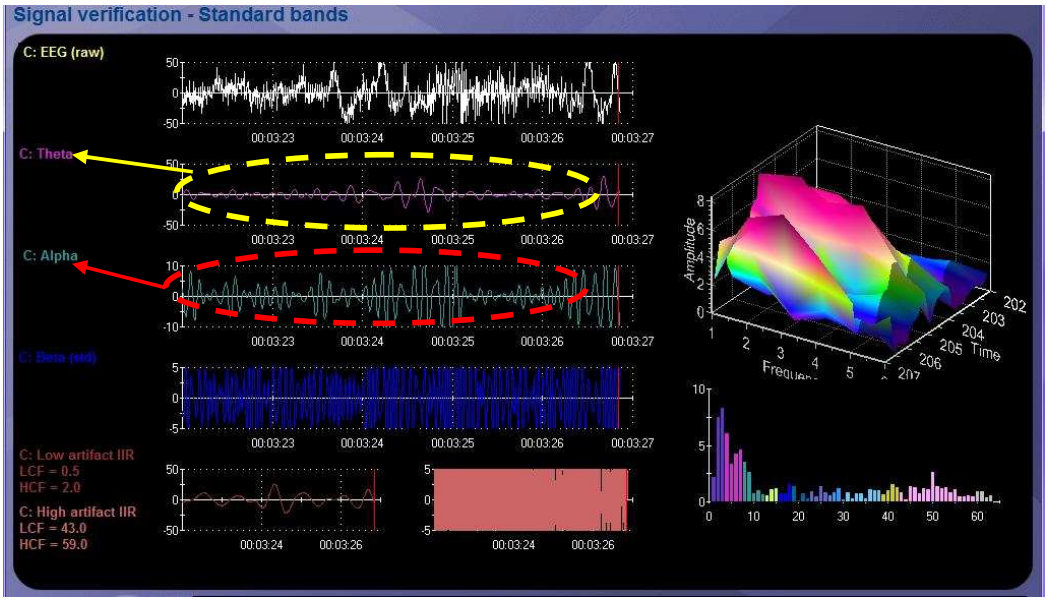



Figure 12- EEG results during online shopping from a moderate load website

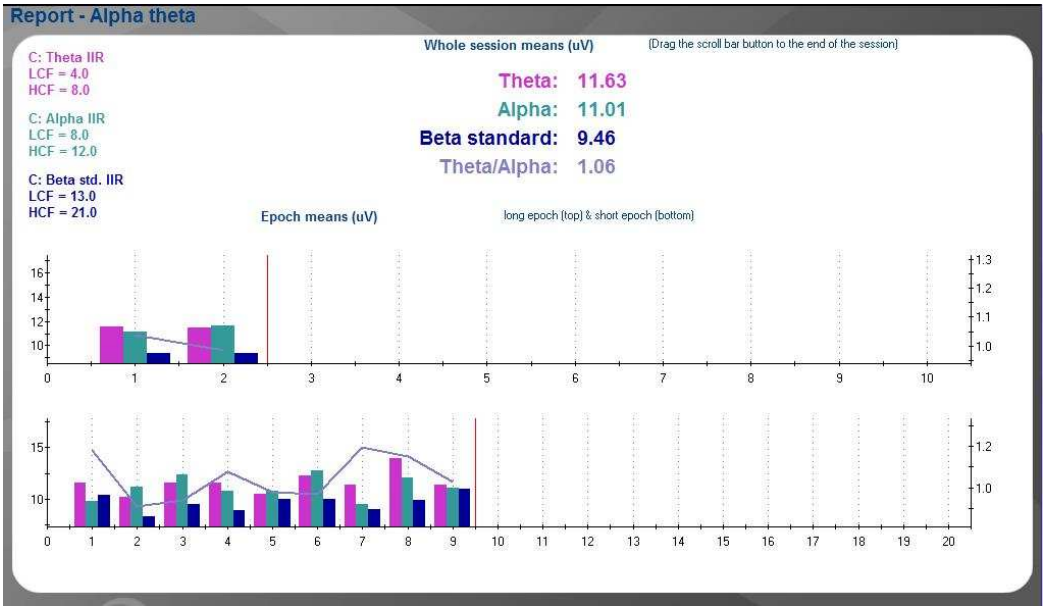



Figure 13- Theta and Alpha during an online shopping from an moderate load website

This 2 picture are samples of one of the subjects while she tries to buy an athletic show. The duration of shopping is 3 minutes and 27 second.

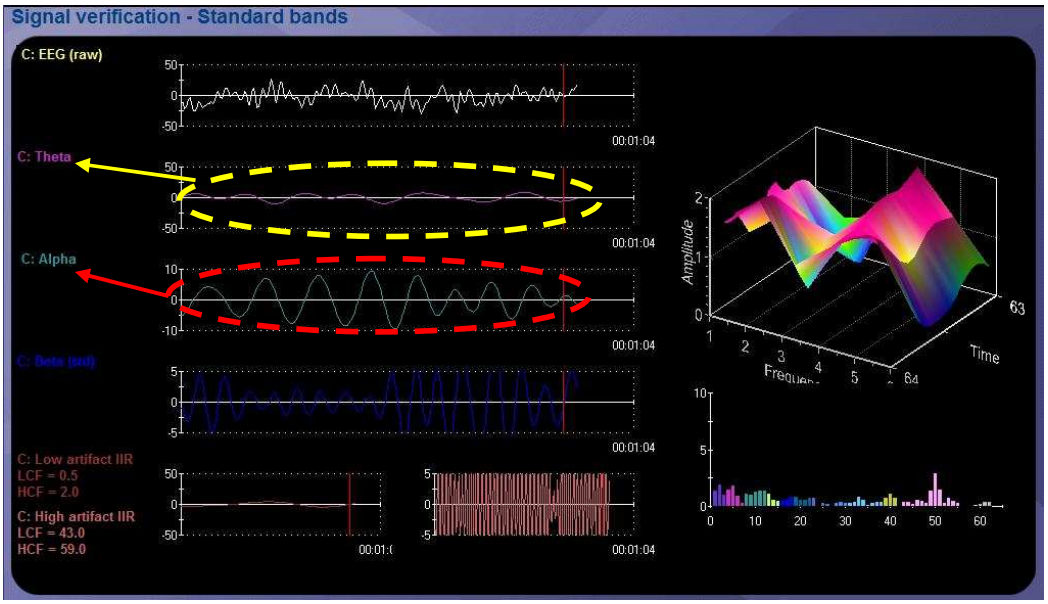



Figure 14- results during online shopping from an under load website

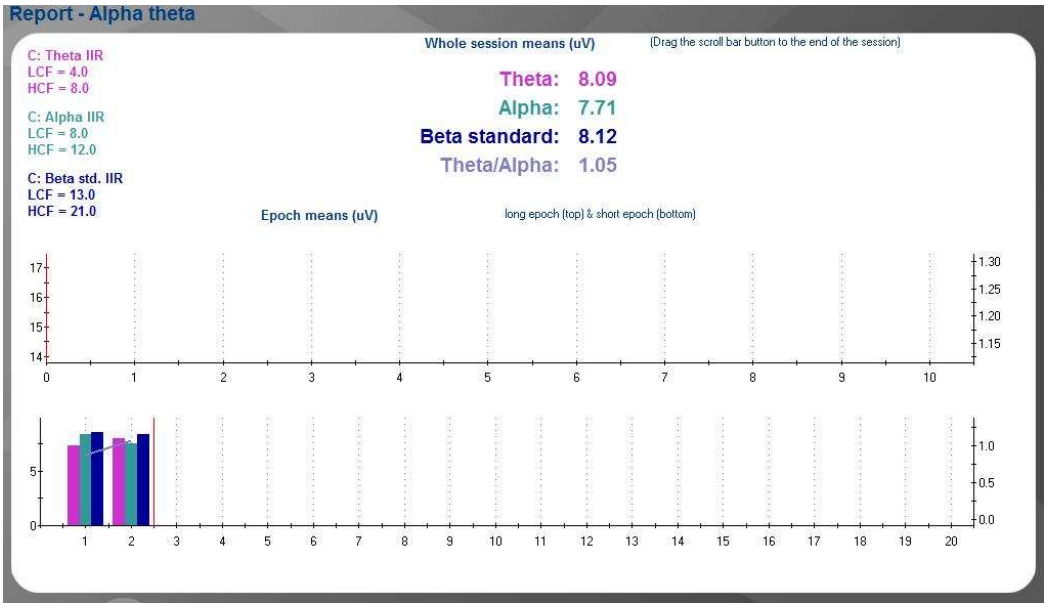



Figure 15- Theta and Alpha during an online shopping from an under load website

This 2 picture are samples of one of the subjects while she tries to buy a Clarks show. The duration of shopping is around 1 minute. Because the duration is less than 2 minutes so the software couldn't draw first chart.

With using t-test I have checked the significance of my data and SPSS result my hypothesis as well. SPSS result are shown in table 3.

**One-Sample Statistics**

Table 3- one sample statistics

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Thetamean | 18 | 12.3128 | 2.49630 | .58838 |
| alphamean | 18 | 9.7189 | 2.94146 | .69331 |

**One-Sample Test**

Table 4- t-test results

| | Test Value = 0 | | | | | |
|---|---|---|---|---|---|---|
| | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
| | Lower | Upper | Lower | Upper | Lower | Upper |
| thetamean | 20.926 | 17 | .000 | 12.31278 | 11.0714 | 13.5542 |
| alphamean | 14.018 | 17 | .000 | 9.71889 | 8.2561 | 11.1816 |