Information, Communication and Cognition

How does the use of marijuana effect brain activity when experiencing fear triggered by a shock?

by

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Outline

Introduction

It has been scientifically proven that marijuana usage affects the mental state of an individual. In the Netherlands usage of marijuana is tolerated and marijuana can be purchased and freely used. Research shows (Mehling, 2003, p. 15) that the use of marijuana causes the transportation of THC to the brain via the blood streams. Once in the brain, the THC compounds bind with the cannabinoids receptors of the nerve cells and alter their activities. These cannabinoid receptors are mostly found in the regions of the brain, which control memory, thought, sensation of pleasure, perception and concentration. Consequently, smoking Marijuana triggers a change in these sectors adversely affecting memory, concentration, thinking capacity and perception skills.

We wish to examine the effects of marijuana on brain activity when experiencing fear due to shock. The brain activity of each volunteer will be monitored by using an EEG; with the consequent data we hope to find a pattern, which will support our theory and prove that there is a correlation between Marijuana usage and intensified brain activity. This leads to the following research question: "How does the use of marijuana effect brain activity when experiencing fear triggered by a shock?"

We want to explore whether there is a significant difference in the experience of anxiety due to shock when having used marijuana and without having used marijuana. We want to explain the possible outcome from a neuro-scientific context.

Background

Although there exists research analyzing marijuana usage from a medical context, where the focus is primarily on physical effects, there is little attention to the emotions and physiological mechanisms. Literature sources in this field are hard to come by and most research is outdated; literature for marijuana usage and its effect on fear is almost nonexistent. Our research question "How does the use of marijuana effect brain activity when experiencing fear triggered by shock?" seems to represent a knowledge gap, and our research may be seen as a break through in medical knowledge and is indeed invaluable. Nonetheless we have examined some research that has been done on different aspects of our research question.

Several studies have been conducted on the effect of marijuana on brain activity. A research by DeGrad et al. (1997) looked into the effects of marijuana, namely of THC (tetrahydrocannabinol) which is the active substance in marijuana, on the cerebral blood flow (CBF) in the human body. They found that the intoxication of marijuana affects the brain activity in the frontal cortex, insula and cingulate gyrus. This was proven by two scans; one before and one after the subject was infused by either THC or a placebo.

Another research on the effects of marijuana on brain activity is a research by O'leary et al. (2002). They also measured the brain activity among 12 volunteers while having smoked Marijuana and while having smoked a placebo. They found that smoking marijuana significantly increases the heart rate and blood pressure, which results in extensive changes in the regional cerebral blood flow (rCBF). Moreover, this maybe the neurobiological basis of the changes in mood that are frequently induced by smoking marijuana. This possibility is supported by the fact that the orbital frontal activation appears to include the extended amygdala, which may influence autonomic and hormonal changes, as well as covert motor behavior and attentional processes, in response to stimuli that have both positive and negative valence. The amygdala, moreover, appears to be involved with the feelings of fear. Smoking marijuana also increased the rCBF in ventral forebrain regions that have interconnections with the limbic system.

Besides measuring brain activity, they also let the volunteers perform a auditory attention task. They found that the smoking of marijuana decreased the rCBF in a number of brain regions, and altered the pattern of rCBF during the performance of an auditory attention task. So whereas rCBF increases were localized to ventral forebrain and cerebellum, decreases in rCBF were localized to brain regions that mediate sensory processing and attention.

These articles could be of significant use as they discuss a significant part of our topic: the brain activity after and before intoxication by marijuana. Moreover, they give more neuroscientific background on the effects of marijuana on the brain activity.
As mentioned in the former articles, lesion- and brain imaging studies implicate that the amygdala is strongly connected with processing emotions, and thus fear (Davis, 1992, p.3). Further it is found that "emotions [engage] structures related to the representation and/or regulation of organism state, for example, the insular cortex, secondary somatosensory cortex, cingulated cortex, and nuclei in brainstem tegmentum and hypothalamus" (Damasio et al, 2000, p.3).

For our research, these articles may be of use to the extent that they give clear information about the different parts that become activated while being intoxicated by marijuana and while experiencing fear. We aim to use this knowledge when conducting our research.

Methods and Materials

Our test subjects were found using a Facebook invitation, which we created. The event asked people to volunteer for a test on colour perception where subjects would have to use marijuana. This was done so as not to alert them of the fact we were testing for fear as any knowledge of our experiment could alert the subjects and dampen their reactions which would result in less effective results. We made the event public and after receiving numerous requests, we contacted twelve people to be our test subjects. All volunteers were made aware of the use of marijuana in this experiment. In our first experiment, all test subjects were sober. Our second experiment involved a group with the use of marijuana. In both experiments we had six test subjects of which three were males, and three were females, to keep the gender ratio equal.

The test subjects were placed in a room where only 3 people were present: the test subject, lab assistant Jeroen, and one member from our group. We purposely chose to isolate test subjects, removing any external stimuli which could distract and result in a test bias. Our testing area was set up in such a manner that would allow for this isolation, we minimize the number of people present in the room, closed the blinds and made the room silent and avoided any quick movements.

While the EEG was being calibrated, we “explained” to the subjects what the ‘false’ research was about. We said that the research would consist of several colour perception tests of which the first one would be a clip containing a test on colour-blindness. In order to make the ‘false’ research more convincing and credible and to make them more comfortable, we asked them some questions relating to colour-blindness.

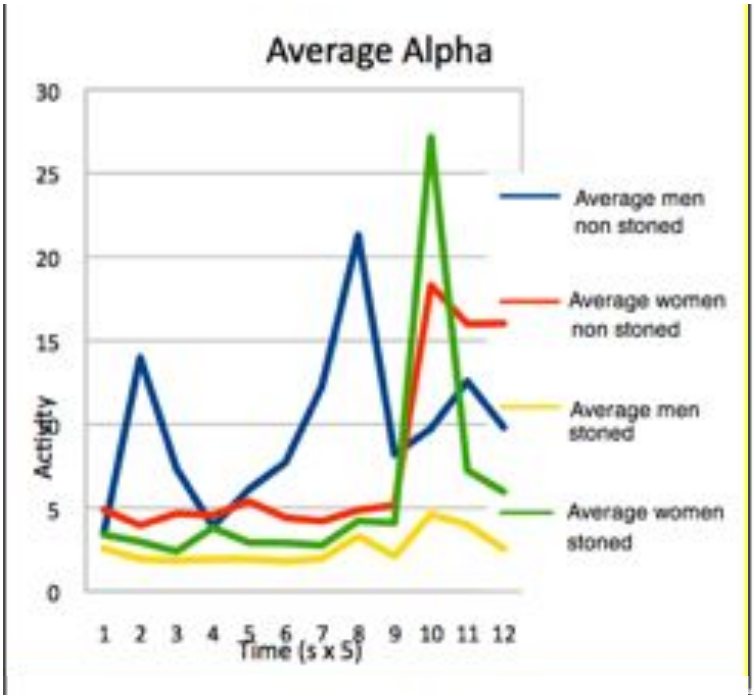
The clip that we used seemed to be an ordinary color perception test, however at the end of the test is a frightening image, which will evoke fear in the subjects. Test subjects were instructed to continually focus on the screen and say out loud what they saw, what colours and most importantly, the number that was displayed. When the EEG headset was correctly in place, we started the recording of the brain activity. We also used the webcam to record their reactions.

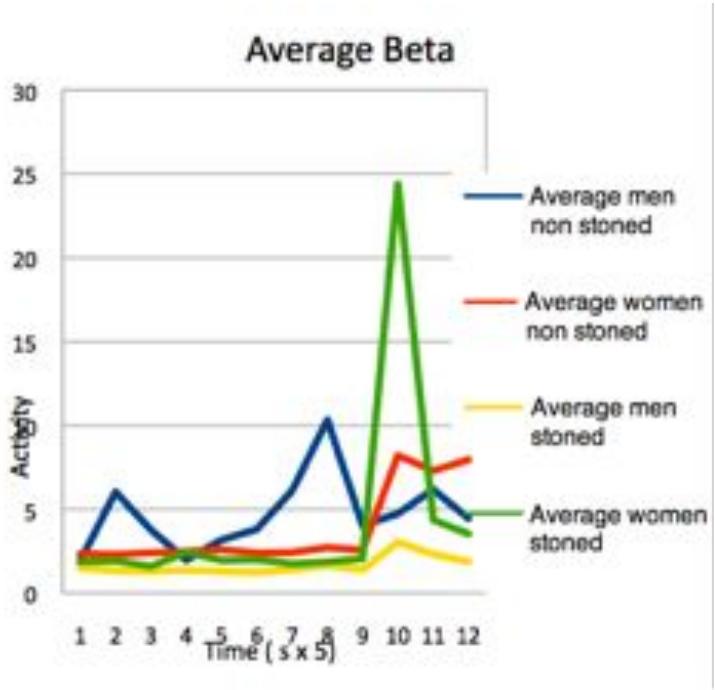
The participants, who were required to smoke marijuana for the test, did this in a controlled and fair manner. The subjects have consumed an equal amount of marijuana and their inhalation was controlled. We will focus on the moment of shock and see how that influences their brain waves and the difference between sober subjects and subjects under influence of marijuana.

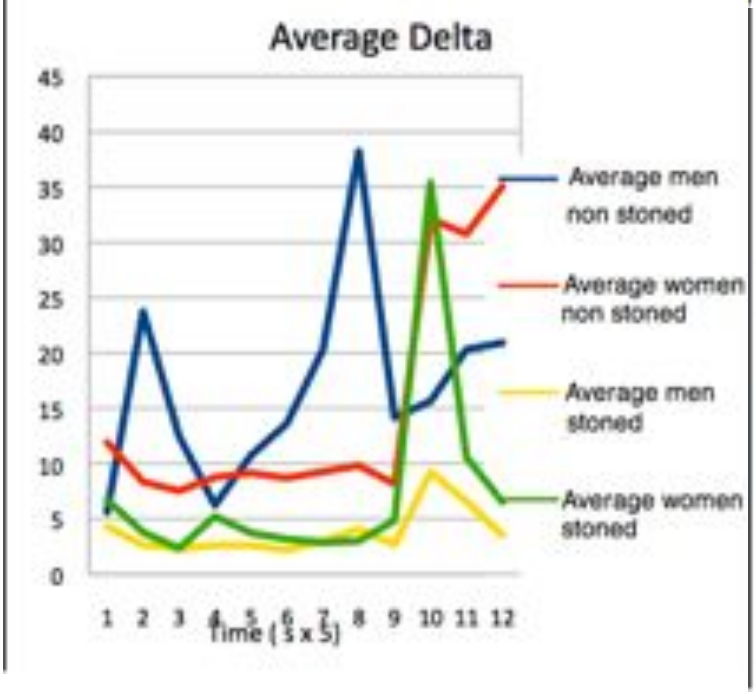
The EEG device measured different brainwaves in order to be able to find a correlation between the changes in the brainwaves of stoned and non-stoned participants during the moment of shock. These waves were measured on fourteen different places on our participants' heads. Our movie was relatively short; we have only 13 measuring moments.

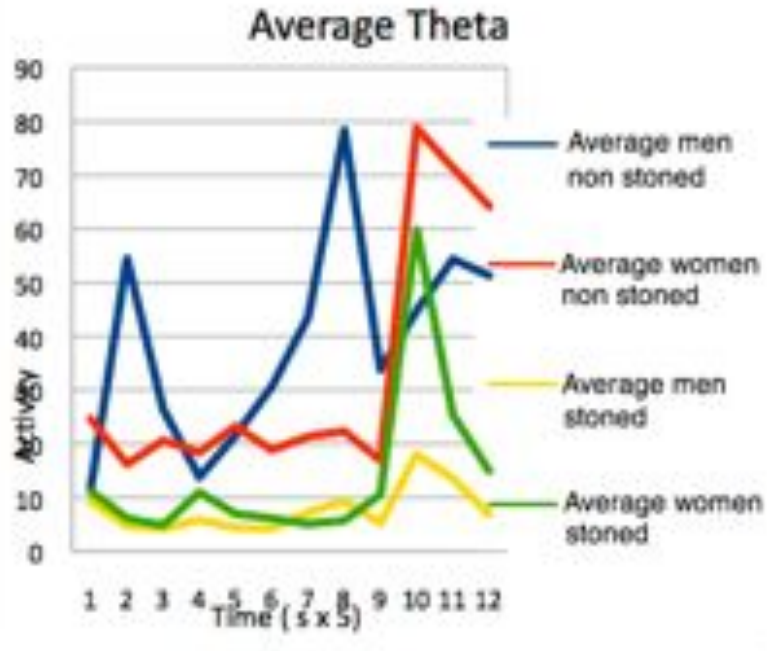
Results

After the initial data collection phase, the retrieved data was analysed and made into four graphs that shows the averages of all wavelengths from the emotiv EEG signals; alpha, beta, delta and theta, for each electrode: AF3, F7, F3, FC5, T7, P7, O1, O2, T8, P8, FC6, F4, F8, AF4. On the x axis we placed time and brain activity level was placed on the y-axis. Four separate data series were plotted, these included: men stoned, men not stoned, women stoned and women not stone. These graphs are shown below.



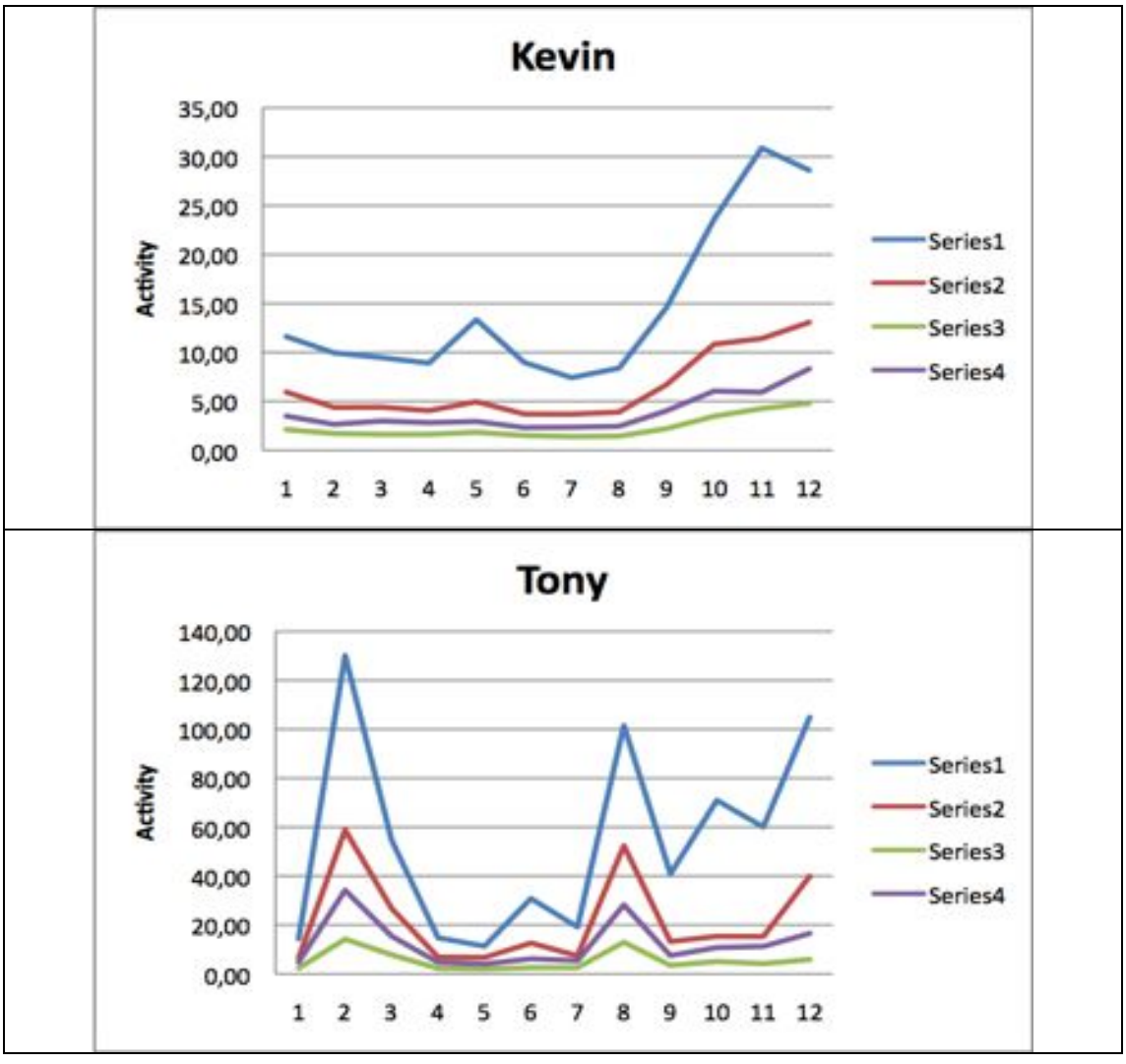


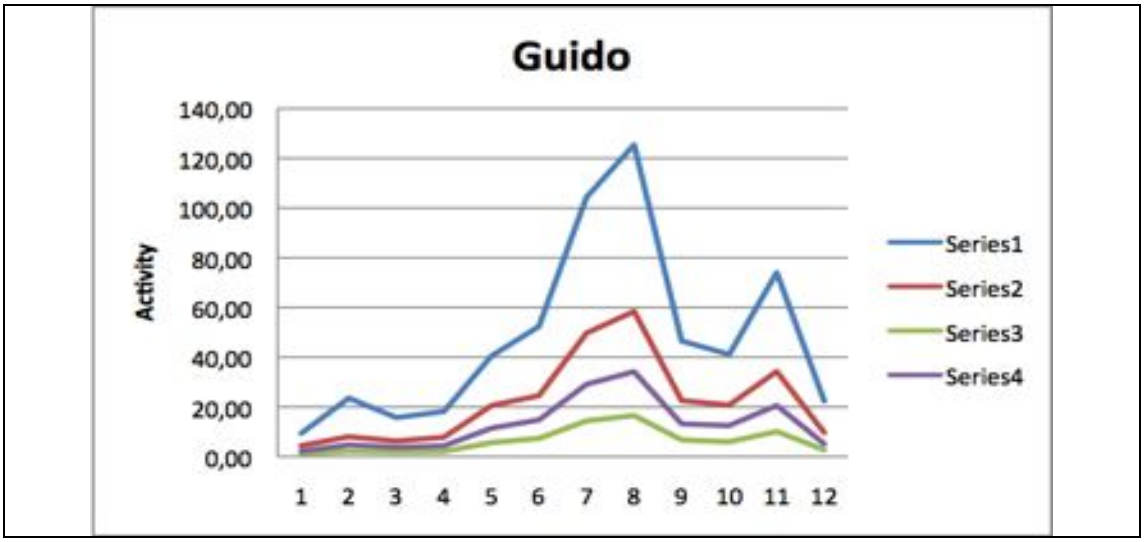




Clearly, we see that at time-point nine, the time point of the shock, something is happening in the brain, which we account to the shock-stimulus. Whether this peak indeed represents fear remains a question for now, but we can at least conclude that here is a correlation between the shock-stimulus and measuring higher activity in all the brainwaves. Also, it is clear from all the results that girls generally have a stronger reaction to the stimulus than boys do.

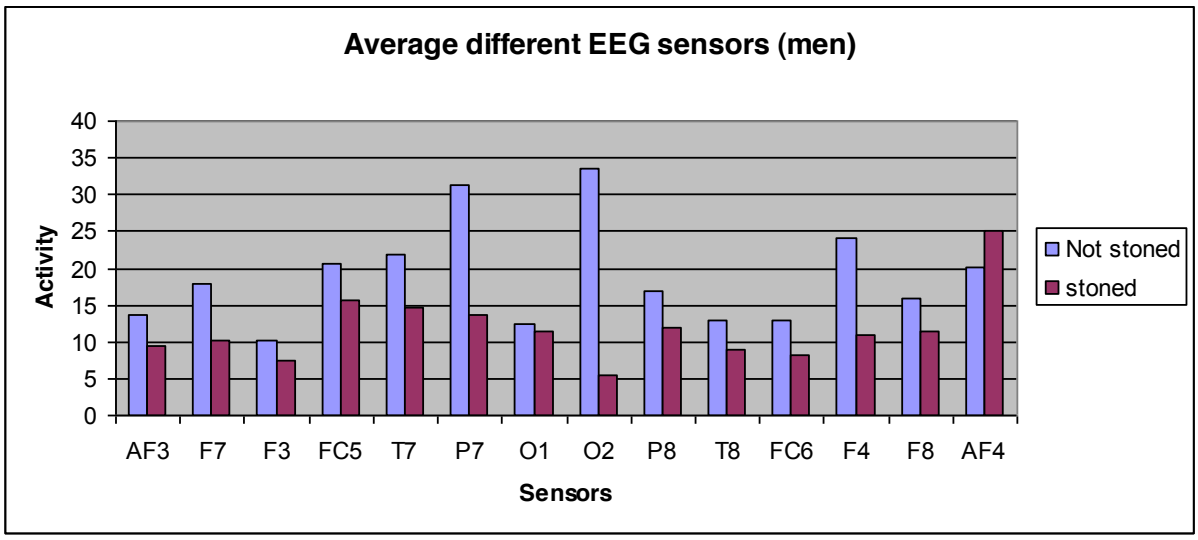
Based on these first graphs, however, we do not consider it possible to draw conclusions that might bring us closer to finding the answer to our research question. The biggest problem here is the graph of the boys that were not stoned, which does not follow the trend of the non-stoned girls, stoned boys, and stoned girls; there is no clear increase in brain activity during the shock reaction. Therefore, we checked if the graph was like this because of one outlier, these are the averages of the boys, series 1, 2, 3 and 4 stand for alpha, beta, delta and theta.

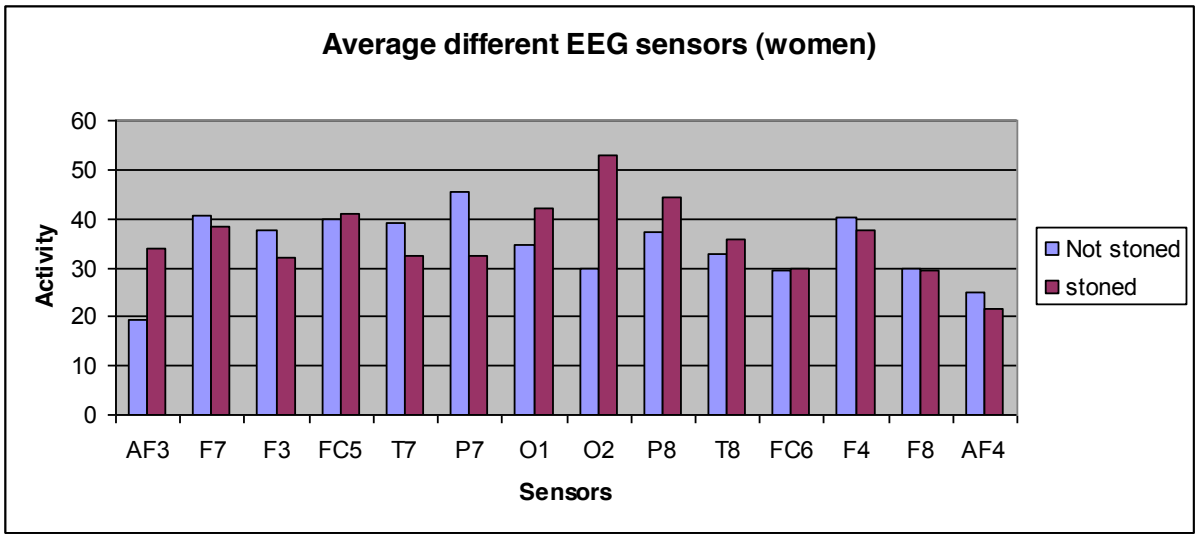




Although these graphs do not show a similar pattern, Tony and Kevin do seem to have an overall increase in brain activity during the shock while not stoned. However, Guido does not show this increased brain activity at that time point. Since there is a big difference between the graphs of stoned and non-stoned men but also between men overall and women, this might indicate that there is a difference between the reaction of men and women to shock.

To see which brain areas where involved with an increased activity in the brain, these four graphs show the average brain activity per location on the brain measured by the EEG:





The graphs show that there is indeed a difference between the brain activity of stoned women compared to that of stoned men. Although the men show less brain activity when stoned compared to when not stoned on the different locations on the head, the women show an increased brain activity when stoned compared to not stoned on the different locations on the head.

Moreover, the locations P7 and O2 in both men and women show an increased brain activity compared to other locations. However, at location O2 men show this difference when not stoned while women show this difference when stoned. This indicates that men react differently to shock while being stoned than girls.

Location P7 stands for the left part of the occipitotemporal where colour and forms are perceived. Since they were most of the time doing a colour blindness test, this might explain why this area has an overall increased activity. Moreover, O2 stands for the right side of the parastriate, which is an area of the occipital lobe, concerned with vision (visual cortex). The peeks at O2 can be explained by the sudden display of a terrifying image during the research. The moment when the picture is displayed is absolutely unexpected for the subjects. Therefore the visual cortex is extremely stimulated and this will increase the average brain activity in sensor O2.

Conclusion

It has been scientifically proven that marijuana usage affects the mental state of an individual, however not many research has been done on the effects of marijuana on the experience of fear. We therefore used EEG technology to research whether the use of marijuana effects brain activity when experiencing fear triggered by a shock. Our aim was to explore whether there is a significant difference in the experience of anxiety due to shock when having used marijuana compared to when being sober.

We examined twelve participants who were asked to participate in a 'fake' colour perception test, hereby preventing any bias in the experiment to occur since any knowledge of our experiment could alert the subjects and dampen their reactions, which would result in less effective results. We divided the participants into two groups of which six used marijuana while the other six were sober while taking the test. Furthermore, we kept the gender ratio in both groups equal to avoid any bias.

We triggered the shock reaction by showing the participants a short clip, which started with a colour blindness test but ended with a frightening image and a sudden sound of a girl screaming. Since by using this clip all participants were shocked after the same amount of time, we focused mainly on this shock reaction in the data analysis.

We found out that there is a difference between stoned men and stoned women, overall the stoned women showed an increased brain activity while the men showed a decreased brain activity when being stoned compared to being sober. Furthermore, the non-stoned men did not show a pattern compared to the girls.

The most active electrodes were 02 and P7. Electrode O2 was measuring the area of the brain responsible for visual perception and processing and Electrode P7 represents the part of the brain where colours and forms are processed. Considering the nature of the test these findings are not surprising..

Discussion

Our research project proves to be a success but further improvements could still me made. The most significant improvement factor would be a larger group of test subjects, giving us a more accurate representation of the actual effects. We saw in our test results that some of the data was inconsistent particularly in the case of male test subjects.

Another major improvement would be to have test subjects with the same tolerance to marijuana. We were able to determine that test subjects had different experiences with marijuana because of results from the interviews with each subject which we conducted before the EEG test. This data showed a clear difference between people who were not used to smoking marijuana and those that regularly smoke marijuana. Furthermore, it seems as if the men were perhaps less affected by the marijuana than the women, most likely due to the fact that they have a larger BMI and also are more tolerant. For further research it might therefore be necessary to measure the BMI of the test subjects and chose test subjects with similar BMI's in order to prevent this difference.

The results could be more conclusive if more advanced device was used, the EEG device is limited, and can only measure certain parts of the brain. The EEG was not able to measure any reading from the Amygdala, the areas of the brain generally responsible for anxiety and shock. A more advanced device may be better able to measure this area and would give more accurate results.

Lastly we should take into account the stimulus which was used to scare test subjects. We noticed in our research that some male test subjects were not scared at all. In contrast females were terrified and we could also see that from their reaction (they started shouting). For further research it might be interesting to research whether there is a difference in the experience of shock by girls compared to that of boys. It might be that overall women are more easily scared than men.

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