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THE ASSESSMENT OF ATTENTION LEVEL CHANGES AFTER SINGLE CAFFEINE CONSUMPTION

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ABSTRACT

Introduction: Caffeine is probably the most widely consumed and socially accepted central nervous system stimulant. Nowadays the number of coffee consumption increased, a lot of adults consume caffeine containing products daily to enhance or maintain performance. Caffeine in low and moderate doses improves vigilance and reaction time for rested individuals.

Aim: The objective of the present study was to evaluate changes of attention level after single caffeine consumption in young healthy adults by using Neurosky Attention algorithm.

Methods: We evaluated the changes of attention level in young healthy adults, who normally do not use products containing high levels of caffeine (energy drinks, strong coffee). A task requiring attention was given to the participants. During the task EEG activity, attention level, duration of the task was recorded. For recording we used a frontal lobe EEG from a single-channel dry-sensor recording MindWave® device. The meaning of attention is presented in a scale from 0 to 100.

Results: In this study, we examined 19 participants (n=19): 13 women and 6 men. The average age of all subjects is 23,47 ± 0,90 years. The duration of the task was 8,19 ± 1,53 minutes before caffeine consumption, while the duration of the task after caffeine consumption was 7,20 ± 1,24 (p=0,005). The overall duration of the task after caffeine consumption was shorter for 15 participants and only for 4 participants the task time increased. The average mean of attention during the examination before caffeine consumption was 55,72 ± 6,83, while the average mean of attention during the examination after caffeine consumption was 57,64 ± 10,79 (p>0,05).

Conclusions: Single caffeine consumption had increased the attention level and significantly shortened the overall duration of the task for most participants. The caffeine functioning peak for attention has short-term effects. After single caffeine consumption, there was observed a significant increase of the blood pressure.

Keywords: *attention, caffeine, electroencephalography*

Introduction

Caffeine is a central nervous system stimulant, which is probably the most widely consumed and socially accepted psychoactive substance [1]. Nowadays the number of coffee consumption increased, according to the International Coffee Organization published data at January 2017, World total coffee consumption from 2012 to 2015 has increased 1,9 %, a lot of adults consume caffeine containing products daily to enhance or maintain performance [2].

For most adults, consumption of up to 400 mg of caffeine a day appears to be safe [3]. A daily intake of 110–345 mg caffeine may be considered a moderate amount for most adults and appears to be associated with a neutral to potentially beneficial effect on health [4]. Additionally, caffeine in low and moderate doses improves vigilance and reaction time for rested individuals [5,6]. Habitual consumers of coffee perform better on tests where cognitive performance is needed [7].

After oral consumption, caffeine is quickly absorbed and the highest blood concentration are reached after 30-60 minutes [8]. It is distributed throughout the body, including the brain, and exerts its influence as an adenosine receptor antagonist and has multiple systemic effects. Performance benefits include physical endurance, reduction of fatigue, and enhancing mental alertness and concentration [1].

In this study we will focus on the effects of caffeine on neuropsychiatric system and we have attempted to evaluate the changes of attention level after single caffeine consumption, to find out whether the increasing caffeine containing products consumption is based on real impact for the attention or there are no significant difference, maybe usage of caffeine just have psychological effects.

Objective

The objective of the present study was to evaluate changes of attention level after single caffeine consumption in young healthy adults by using Neurosky Attention algorithm.

Methods

The research was carried out with the authorization (No.BEC-MF-35) of the department of social sciences and humanities.

We evaluated the changes of attention level in young healthy adults, who normally do not use products containing high levels of caffeine (energy drinks, strong coffee). They were selected randomly from the students of Lithuanian University of Health Sciences. They were free of disability, medical disease or neurological deficit. Participants were required to avoid products containing caffeine one day before examination. The night before examination they were required to go to sleep early. The measurements were made in a relaxed atmosphere in a quiet place in the hospital in the first half of the day.

All the participants completed questionnaire about the caffeine consumption habits. The questions were about consumption of products containing caffeine, the frequency, quantity and the reasons why participants consume these products.

Before all the measurements, the participants were asked to sit for ten minutes. After this period, by non-invasive way the blood pressure, heart rate and saturation were measured.

A task requiring attention was given to the participants. They had to do an increasing composition (matrix) of the numbers from 0 to 99, which were randomly spread over the table. During the task EEG activity and attention level were recorded. Additionally, we recorded the duration of the task.

For recording we used a frontal lobe EEG from a single-channel dry-sensor recording MindWave® device. The meaning of attention is presented in a scale from 0 to 100. The attention level was categorized into five levels which were: 1-19 (very poor attention), 20-39 (poor attention), 40-59 (neutral), 60-79 (good attention) and 80-100 (great attention) [9].

After this step, for the participants were given a tablet of food supplement containing 200 mg of caffeine (equivalent about 2 cups of roasted ground coffee). After a consumption of food supplement containing caffeine, the participant resting and waiting for further examination

for 30 minutes.

After 30 minutes, by non-invasive way the blood pressure, heart rate and saturation were measured. Participants were asked to do the same task requiring attention. During the task EEG activity, attention level and the duration of the task were recorded.

The results were analysed by considering the smallest value of mean and standard deviation.

Results

In this study, we examined 19 participants (n=19): 13 women and 6 men. The average age of all subjects is 23,47 ± 0,90 years.

Most of the participants were taking small quantities of caffeine containing products in their everyday life. 2 participants answered do not consuming coffee or caffeine containing products at all, 12 – consume coffee not every single day, 3 – consume 1-2 times a day and 2 participants consume coffee from 3 to 4 times a day. Subjects has identified consuming weak (n=6), moderate (n=8) and strong coffee (n=3). 10 participants answered that after coffee consumption their general condition significantly do not changed, 3 said that they feel much more better and 2 participants do not feel any effect. Majority of the participants do not consume (or consume less than once a month) other products containing caffeine.

In the questionnaire participants were asked what attention level subjectively is needed in their everyday activities, 12 participants answered that they need high attention level, 6 - neutral attention level and only one participant said that his everyday activities require low attention level. Participants were asked to assess what attention level is needed to complete the given task before and after caffeine consumption, 12 participants answered that the given task require high attention level.

For the participants, we have evaluated the changes of the blood pressure, systolic blood pressure before caffeine consumption was 117,74 ± 9,39, after – 121,58 ± 9,77 (p=0,009), diastolic blood pressure before caffeine consumption was 75,79 ± 8,42, after – 81,32 ± 5,44 (0,001). No statistically significant changes were found between heart rate and saturation before and after caffeine consumption.

The duration of the task was 8,19 ± 1,53 minutes before caffeine consumption, while the duration of the task after caffeine consumption was 7,20 ± 1,24 (p=0,005). The overall duration of the task after caffeine consumption was shorter for 15 participants and only for 4 participants the task time increased.

The average mean of attention during the examination before caffeine consumption was 55,72 ± 6,83, while the average mean of attention during the examination after caffeine consumption was 57,64 ± 10,79 (p>0,05).

The task time we divided into three equal sections. The attention of all participants was very similar in all sections. Before caffeine consumption, in the first section the average mean of attention was 58,16 ± 7,69, in the second – 56,29 ± 7,90, and in the third section – 52,72 ± 8,22. After caffeine consumption, respectively was 60,00 ± 17,75, 58,66 ± 11,66 and 54,26 ± 10,79. If we compare the results, the higher level of attention was reached after caffeine consumption in all three sections, the results are given in Table 1.

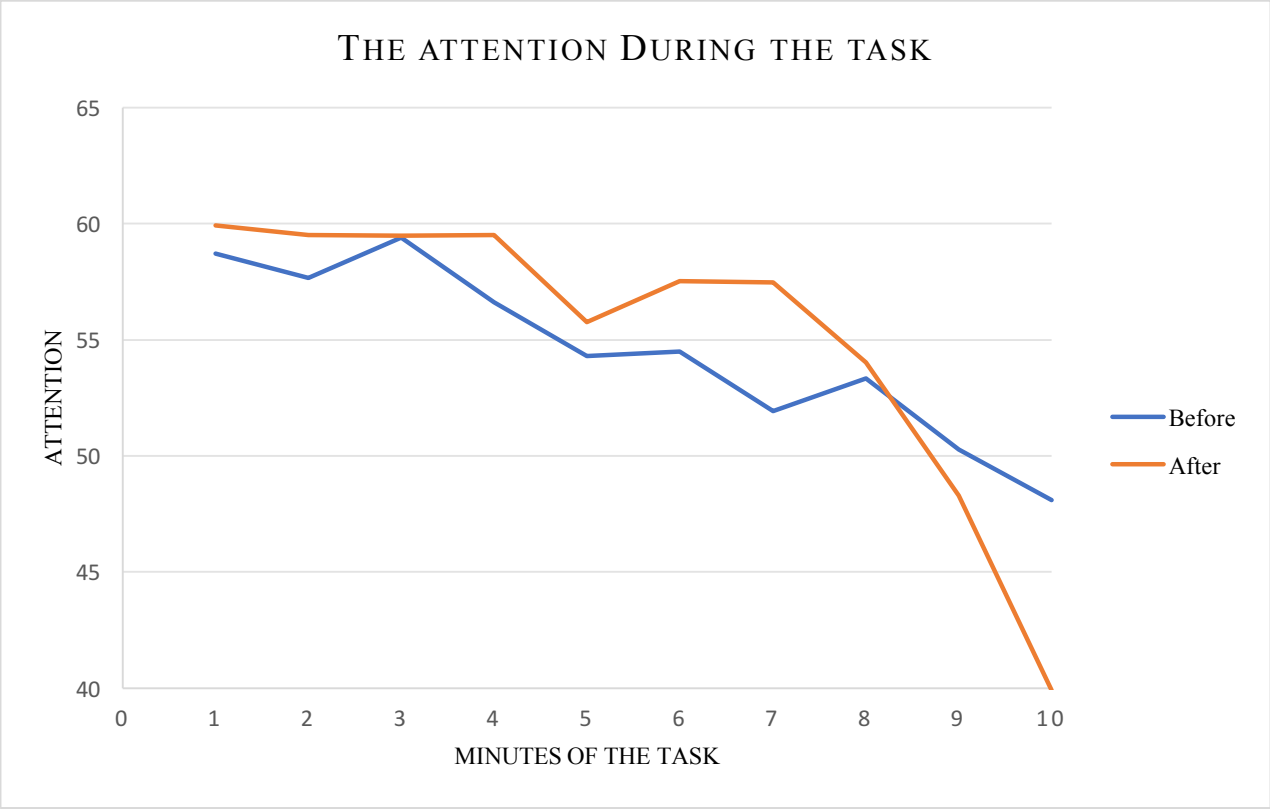
Variable	Attention		
	Before	After	p value
I section of the task	58,16 ± 7,69	60,00 ± 17,75	0,277
II section of the task	56,29 ± 7,90	58,66 ± 11,66	0,334
III section of the task	52,72 ± 8,22	54,26 ± 10,79	0,445

Table 1: Attention in different sections of the task before and after caffeine consumption

However, analysing the average mean of attention in every minute of the task, we have noticed that during the task the attention was not constant. If we compare the same minute before and after caffeine consumption, after caffeine consumption in every minute of the task was reached the higher average mean of attention till 9 minute. In 9 minute the average mean of attention decreased, before caffeine consumption was 50,28 ± 9,61, while after caffeine consumption - 48,28 ± 13,65 ($p>0,05$). Consequently, for those, who needed more time to complete the task, the attention eventually run out, while for participants, who completed the task faster, the average of attention was continuous increasing every minute of the task. Results are given in Table 2 and Graph 1.

Minute	Attention				
	Before	SD	After	SD	p value
1 min	58,71	7,38	59,92	21,69	0,684
2 min	57,67	8,36	59,52	17,78	0,960
3 min	59,40	5,85	59,47	18,21	0,960
4 min	56,61	10,74	59,52	11,87	0,960
5 min	54,30	11,32	55,76	12,00	0,983
6 min	54,48	8,55	57,53	14,34	0,622
7 min	51,93	8,87	57,48	11,53	0,038
8 min	53,33	9,33	54,04	12,29	0,729
9 min	50,28	9,61	48,28	13,65	0,747

Table 2: The attention in every minute of the task before and after caffeine consumption



Graph 1: The changes of attention during the task before and after caffeine consumption

The attention level was categorized into five levels, we measured the duration of the task in each level before and after caffeine consumption, results are given in Table 3. It is interesting that overall duration of the task was shorter after caffeine consumption, but if we compare the task before and after, participants after caffeine consumption stayed for a longer period of time in higher attention levels, for example, 14 participants stayed longer in 80-100 attention level, they could reach and maintain the higher attention for a longer time after caffeine consumption (p=0,025).

Attention level	Duration before caffeine consumption	Duration after caffeine consumption	p value	After caffeine duration shortened (n=19)	After caffeine duration extended (n=19)
Overall duration	8,38 ± 1,90	7,41 ± 1,41	0.005	15	4
01-19	0,13 ± 0,18	0,18 ± 0,38	0.189	11	8
20-39	1,13 ± 0,82	0,93 ± 1,05	0.014	13	6
40-59	3,54 ± 1,19	2,28 ± 0,68	0.072	17	2
60-79	2,98 ± 1,09	2,73 ± 1,01	0,748	10	9
80-100	0,62 ± 0,50	1,07 ± 0,74	0,025	5	14

Table 3: The duration of the task in different attention levels before and after caffeine consumption

Conclusions

Single caffeine consumption could increase the attention level. For majority of the participants general attention was higher and they stayed for a significantly longer period of time in great (80-100) attention level.

Single caffeine consumption significantly shortened the overall duration of the task for most participants.

The caffeine functioning peak for attention has short-term effects, for participants, who needed more time to complete the task, was observed the exhaustion of attention.

After single caffeine consumption, there was observed a significant increase of the blood pressure.

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Disclosures

Authors declare that there is no conflict.

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