

# Biological Correlates of P300 and Extraversion Relationship

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## ABSTRACT

*Because of the great sensitivity of P300 determined in prior research, the aim of this study was to investigate the mediate impact of some biological determinants of P300 on its relationship with extraversion. The sample consisted of 54 female psychology students, right-handers, in the age range of 19–23 years. The P300 was measured by visual oddball paradigm in two trials using EMG/EP device Medelec/TECA Sapphire<sup>II</sup>, 4E. Results showed that those subjects who had glasses, drink coffee, do not take any medications and do not smoke showed significant negative correlation between P300-latency and extraversion. Only those subjects who had glasses showed significant negative correlation between P300-amplitude and extraversion. Also, there were differences between those group subjects in P300-amplitude regarding measuring trial. So, it was concluded that findings have confirmed expected great sensitivity and variability in P300 that mediate its relationship with extraversion and should be controlled in future studies.*

**Key words:** visual P300, biological determinants, extraversion, students

## Introduction

Evoked potentials (EPs) or event-related potentials (ERPs) present voltage fluctuations that are associated in time with some physical or mental occurrence<sup>1</sup>. In contrast to the spontaneous EEG waves, ERPs are time-locked, i.e. they appear in a precisely determined period after the given stimulus<sup>2</sup>. There are two EP-groups: evoked (sensory or exogenous) potentials (those who follow the external physical stimuli) and emitted (cognitive or endogenous) potentials (those who are connected with the processes of preparing for some cognitive or motor activity)<sup>3</sup>.

The well-known and mostly investigated is P300. It presents big positive wave with latency of 250–600 msec, and appears while subject is actively focused on given stimulus and/or when novel or surprising stimulus appears in any kind of modality. It is related with attention allocation and changes in working memory. P3-generators are located within several brain regions: parietal and frontal associative cortex, thalamus, hippocampus and other limbic structures<sup>4</sup>, so generally show fronto-parietal activation<sup>5–6</sup>. P300 is often elicited by oddball paradigm in visual/auditory modality – the task of simple stimuli discrimination. During such a task the subject listens (looks) to a sequence of tones (visual stimuli),

where one tone (visual stimulus) is usually the target. The subject's task is to press the button on hearing (seeing) the target stimulus<sup>6</sup>. In this study visual oddball paradigm has been used to measure P300 in two trials.

## Biological Determinants of P300

There has been a numerous studies that have been investigated the significant influence of natural, induced and constitutional factors on P300<sup>7–9</sup>, and their mediate impact on relationship of P300 with other psychological variables.

### *Natural P300-determinants*

It has been determined that circadian somatic changes indirectly influenced on P300 through the physiological measures: during day body temperature and heart rate mildly increased, and then slowly decreased toward evening hours. So, P300-latency is shorter in subjects with higher body temperature and in those with faster heart rate<sup>10</sup>. Experimental studies determined clear 90-minutes ultradian fluctuations in P300-latency<sup>11</sup>. Repetitive use of audio oddball paradigm has caused decre-

ase in P300-amplitude and increase in P300-latency<sup>12,13</sup>. Lin and Polich study while started measuring P300 in two different timings, showed that determined ultradian fluctuations in P300-wave have had inverse phases in two different subject groups: Uppers started from phase of increasing in EEG and P300 and Downers who started from phase of decreasing in P300<sup>14</sup>. These findings implicated that described fluctuations in nervous electrophysiological activity reflected changes in the arousal level that also had effect on P300-wave. Besides, studying P300 within season alteration showed that P300-amplituda significantly increased in spring and summer when there was more sunlight<sup>15,16</sup>. Those changes were more prominent in females than males<sup>17</sup>. Furthermore, even findings concerning the relationship between food taking and P300 were inconsistent, because some of them have showed no significant connection<sup>18</sup>, and most of them have determined significant increase in P300-amplitude after regular food intake<sup>5</sup>, it was thought that there was a significant connection but not on the direct level<sup>19</sup>. There were no determined connection between menstrual cycles and P300<sup>20</sup>, but while being exposed to the emotional stimuli (pictures of naked men and babies) it was determined significant increase in P300-amplitude in women who has ovulating<sup>21</sup>.

### *Induced P300-determinants*

Studies of induced biological determinants of P300 such as physical activity and exercising, regular one or not, have showed significant increase in P300-amplitude and even more in visual P300 at subject who were involved in some sports in the long term, and also decreased P300-amplitude and shorter P300-latencies during exercise<sup>22–24</sup>. Other studies have showed significant connection between decreased P300-amplitude and longer P300-latencies and fatigue and sleep deprivation<sup>25–28</sup>. Furthermore, what was relevant for this study, other studies have determined the significant impact of caffeine on amplitude increase and latency decrease only in conditions of subject's fatigue<sup>29–30</sup>. After just two smoked cigarettes, nicotine induce latency and amplitude increase<sup>31</sup>, but in the long term latency and amplitude decrease and only in older smokers<sup>32–33</sup>. Young smokers have showed longer P300-latencies in difference to older ones<sup>34</sup>. Experiments of effect of immediate alcohol drinking on P300 have showed decreased P300-amplitudes and prolonged P300-latencies, while in social drinking there were no long term effects on P300<sup>5</sup>. But, significantly lower P300-amplitudes have been found in alcoholics regarding sex<sup>35–37</sup> and prolonged visual P300-latencies<sup>38</sup>. Psychopharmacological studies have showed decreased P300-latencies in subject's group which took aspirin (acetilsalic acid)<sup>39</sup>. Besides, Polich has determined decrease in P300-amplitude in occasionally cannabis consummates, but without any changes in chronic drug users<sup>6</sup>.

### *Constitutional P300-determinants*

P300-morfology has been changed with age, i.e. parallel with maturation changes of nervous system. But, these changes were not the same in children and adults: during cognitive development linear latency decrease and amplitude increase with age has been observed<sup>40–43, 7–8</sup> in age range from 6 to 25 years. But in subjects aged from 20 to 80 years, ERP-studies found longer latencies and amplitude decrease<sup>44–46, 7, 8, 47–49, 43</sup>. Empirical findings of hemispheric asymmetries showed that right hemisphere was more active during classic oddball task. In both modalities, audio and visual, P300-amplitudes were higher over right hemisphere primary on anterior-medial locations (F3, F4, C3 and C4) for target and non-target signals<sup>50–54</sup>, with no differences in P300-latency. Behavioural-genetic studies have showed significant genetic determination of P300<sup>55–58</sup>, where estimated meta-heredity for amplitude was 60% and for latency 51%. Considering sex differences in P300, men have shown lower amplitudes than women<sup>16, 54, 55</sup> what has explained by the fact that men had smaller proportions of corpus callosum than women<sup>59</sup>. But, sex differences vary according numerous factors such as age, season, the type of task used, tape of stimuli used, etc. P300 has been widely used as an indicator of many psychopathological states and neurological illness, where generally showed lower amplitudes and prolonged latencies<sup>7</sup>. Finally, in ERP-research of intelligence negative correlation between intelligence and latency has been consistently found regardless modality of oddball task or intelligence test used<sup>60–67</sup>.

### *P300 and extraversion*

On the basis of arousal theory, it was expected and confirmed in numerous studies that introverts who had higher sensory reactivity on physical stimuli of moderate intensity and higher levels of cortical arousal than extraverts would show higher P300-amplitudes in both modalities<sup>68–75, 62</sup>. But, controlling and measuring variables such as attention and habituation in same studies, differences have disappeared<sup>76–78</sup> or extraverts showed significantly higher P300-amplitudes than introverts<sup>79–83</sup>. These findings have been explained by the observation that extraverts had faster habituation and faster decline in task performance that needed attention allocation<sup>82</sup>. Considering the fact that classic oddball task had a tendency to evoke monotony, it was presumed that introverts would be better in maintaining their attention to the task. Besides task conditions all previous described biological determinants have showed in how many ways not just P300 but also its relationship with other psychological variables such as extraversion could be affected.

So, the first aim of this study was to examine the relationship between latency and amplitude of P300 measured by visual oddball task and its biological determinants: age, use of glasses/contact lenses, consumption of coffee, cigarettes, medications, alcohol, and illegal drugs and occupation with sports. Previous research showed statistically significant relationship between those factors and P300<sup>5</sup>. Second, this study was aimed to investi-

gate the mediate role of those factors within the relationship of P300 and extraversion that was analysed separately<sup>84</sup>. It was expected that visual P300 would be affected by sight problems and, regarding the two measuring trials, that it would also be affected by other biological determinants although in different ways. Finally, it was expected that the relationship between P300 and extraversion would be mostly affected by those determinants significantly correlating with either extraversion or P300 (age, sight problems, coffee, cigarettes, and medications). Those relationships would be studied separately for the P300-amplitudes measured in the first and second trial, and also for the each electrode separately.

## Method

### Subjects

A total of 54 female subjects ( $\bar{X}$ =20.5 years, SD=1.28, range:19–23) were selected from a preliminary sample of 91 undergraduate students from the Department of Psychology in Rijeka. They were all right-handed, naive to electrophysiological studies, and reported no visual or neurological/psychiatric problems. The subjects received course credit for their participation in the study.

### Questionnaires

The data on various biological determinants were collected by the General Data Questionnaire, and extraversion was measured by the Eysenck Personality Questionnaire (EPQ-R). First questionnaire collected data about sight problems, drinking coffee, using any kind of medications, smoking, drinking alcohol, using drugs in last 15 days and involvement in any kind of sports. EPQ-R besides other dimensions measured extraversion. This subscale consisted of 23 items on which subjects answer by choosing YES or NO. In this study the level of reliability Cronbach alpha for this subscale was satisfactory ( $r=0.89$ ) and even higher from the one gained in validation study:  $r=0.85$ <sup>85</sup>.

### Apparatus and procedure

After the general instruction and filling out of the described questionnaires, each subject underwent a measuring visual P300 in two trials. All recordings were made in the course of four months, always on Wednesdays and always at the same time – noon. P300-responses were elicited by the standard visual oddball paradigm, chosen because of its smaller monotonous effect on the subjects. A Medelec/TECA Sapphire<sup>II</sup> 4E device<sup>86</sup> with five Ag/AgCl disc electrodes was used. The active electrodes were placed on O<sub>1</sub>, O<sub>2</sub>, P<sub>3</sub> and P<sub>4</sub> (according to 10–20 system), and referred to Fz. The electrode impedance was kept below 5k $\Omega$  and the filter bandpass was 0.1–50 Hz. A pattern reverse binocular full-field stimulation was performed in a dark, quite room using a checkerboard pattern, 70 cm away from the nasion, with 1Hz frequency and 100% contrast. Fifteen percent of stimuli were rare (target) checkerboards (consisting of the small

quadrangles), whereas the remaining ones were frequent (nontarget) checkerboards (consisting of the big quadrangles), presented in the random order. Subjects were instructed to look at the red circle in the centre of the monitor and to react to the target stimuli by pressing the pen.

The marking of the amplitudes and latencies of the P300 component was performed manually, using a cursor, by the same medical technician for both trials. In the first trial, the first major positive peak between 300–600 msec for the rare stimuli was identified as the P300 response and was marked. To avoid the effect of the latency jitter<sup>87–88</sup>, and to make evoked potentials more stable over trials, in the second trial they were marked by their same latencies as the one from the first trial. Therefore, for each subject there was the same P300-latency (as measured only in one trial) in both trials but different P300-amplitude.

## Results and Discussion

### Biological determinants

22 students (40.7%) wear glasses or contact lenses and 32 of them not (59.3%). 32 students (59.3%) usually drink coffee on regular basis, and 22 of them not (40.7%). 15 students (27.8%) said that regularly use some medications (Claritin, tooth antibiotics, ibuprofen, antihistaminic, contraceptives (cilest, triquilar), iron pills, pills against menstrual pain (caffetin, nalgesin), pills for muscle relax (andol), pills against pain (voltaren) and pills for gastritis. 39 (72.2%) of them said that did not use any kind of medication. 16 students smoke (29.6%) and 38 of them not (70.4%). 38 (70.4%) students drinks alcohol at least once a week, and 16 of them not or not at all (29.6%). 4 students (7.4%) said that used illegal drugs in the past 15 days, and 50 of them not or not at all (92.6%). Finally, 20 students (37%) were involved in different kind of sports and 34 of them were not (63%).

### Extraversion and P300 results

The group averages were calculated for extraversion ( $\bar{X}$ =15.48; SD=5.44; Range:1–23) and for latency and amplitude of P300. P300-latency measured on O<sub>1</sub> electrode was ( $\bar{X}$ =412.80, SD=42.88), on O<sub>2</sub> electrode ( $\bar{X}$ =413.72, SD=44.32), on P<sub>3</sub> electrode ( $\bar{X}$ =389.07, SD=65.47) and on P<sub>4</sub> electrode ( $\bar{X}$ =388.76, SD=65.67). P300-amplitude was measured in two trials: in first trial on O<sub>1</sub> electrode was ( $\bar{X}$ =4.51, SD=2.91), on O<sub>2</sub> electrode ( $\bar{X}$ =4.56, SD=3.21), on P<sub>3</sub> electrode ( $\bar{X}$ =9.25, SD=6.92) and on P<sub>4</sub> electrode ( $\bar{X}$ =9.25, SD=7.28); and in second trial on O<sub>1</sub> electrode was ( $\bar{X}$ =3.75, SD=3.19), on O<sub>2</sub> electrode ( $\bar{X}$ =3.54, SD=2.68), on P<sub>3</sub> electrode ( $\bar{X}$ =8.91, SD=6.79) and on P<sub>4</sub> electrode ( $\bar{X}$ =9.05, SD=6.99). All given measures were in excepted range of values. The basic principle for marking the EP-waves in the first trial block was the peak amplitude, and each ERP-component was marked one by one as described in Method. Due to the technical limitations of the device used, a possibility of a latency jitter could

not be avoided by using the Woody filter method, and therefore the P300-latencies were made constant over trial blocks and used for marking all EP-waves in the second trial block. Although a lot of valuable information has been lost in this way, the additional reason for using this method was the evidence of a very small impact of habituation on P300-latencies and<sup>12,14,89</sup>, especially when pauses between the trial blocks were very short (1–2 minutes).

*Correlation analysis of P300, extraversion and biological determinants*

Correlation analysis of extraversion and measured biological determinants showed only one significant relationship (Table 1). Those students who regularly drink alcohol showed also significantly higher level of extraversion ( $r=-0.34$ ,  $p<0.05$ ). This finding was expected considering the well-known framework of Eysenck’s drug postulate: alcohol is frequently used as an example for a depressant drug that should shift a person’s position on the extraversion-introversion axis in the direction of lower arousability<sup>90,91</sup>. Also, some recent studies what have investigated drinking motives and personality determined that habitual drinking was associated with higher involvement in social events and with enhancement motives that was highly correlated with sensation seeking – personality trait which was suppressed in extraversion<sup>92,93</sup>.

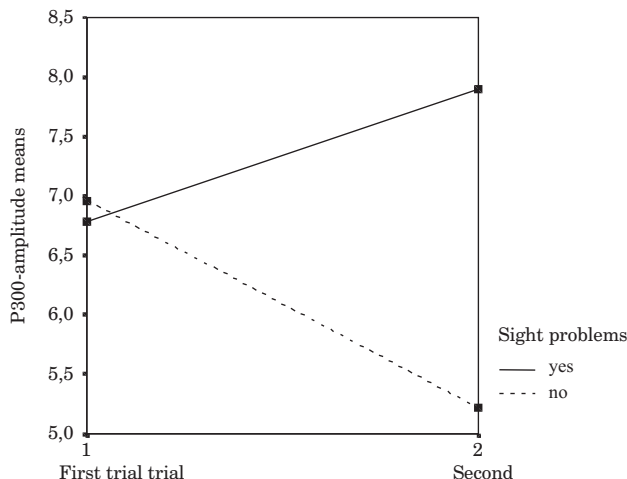


Fig. 1. P300-amplitude in function of measuring trial and sight problems.

Analysing the relationship between biological determinants and P300 in first trial it could be seen that subjects with glasses had significantly shorter P300-latencies measured on occipital electrodes (Table 1), e.t. the same students showed shorter time for evaluation and categorisation of target stimuli. Besides, P300-amplitude had been highly affected by continuity and duration of visual task, so it was significantly negative connected with sight problems but only in second trial. ANOVA was per-

**TABLE 1**  
CORRELATION MATRIX OF BIOLOGICAL DETERMINANTS, P300 LATENCIES AND AMPLITUDES MEASURED ON 4 ELECTRODES (O<sub>1</sub>, O<sub>2</sub>, P<sub>3</sub> AND P<sub>4</sub>) IN FIRST TRIAL, P300-AMPLITUDES IN SECOND TRIAL AND EXTRAVERSION (N=54)

	P3-L na O <sub>1</sub>	P3A na O <sub>1</sub>	P3-L na O <sub>2</sub>	P3A na O <sub>2</sub>	P3-L na P <sub>3</sub>	P3A na P <sub>3</sub>	P3-L na P <sub>4</sub>	P3A na P <sub>4</sub>	Extra
Age	0.12	-0.03 -0.24	0.13	-0.02 -0.42*	0.02	-0.04 -0.08	0.01	-0.01 -0.13	0.09
Sight	0.31*	0.02 -0.28*	0.32*	0.08 -0.40*	0.11	0.02 -0.23	0.10	-0.01 -0.26	0.04
Coffee	0.14	0.16 0.25	0.14	0.10 0.32*	0.22	0.13 -0.02	0.23	0.12 0.07	-0.10
Smoke	0.14	0.26 0.02	0.17	0.20 0.04	0.26	0.20 -0.34*	0.26	0.10 -0.27*	-0.01
Medic.	-0.03	-0.08 0.02	-0.02	-0.01 -0.18	0.16	0.11 -0.11	0.16	-0.05 -0.31*	0.04
Alcohol	0.14	0.11 0.00	0.13	0.13 0.04	0.15	0.06 0.10	0.15	-0.01 0.03	-0.34*
Drugs	0.02	0.04 -0.17	0.06	0.06 0.07	0.13	0.19 -0.10	0.15	0.09 0.14	-0.14
Sport	-0.02	-0.08 -0.17	-0.07	-0.03 -0.22	0.05	0.16 0.13	0.05	0.22 0.04	-0.16
Extra	-0.19	-0.10 0.00	-0.20	-0.10 -0.09	-0.31*	0.03 0.10	-0.31*	0.04 0.08	

\*p<0.05; \*\*p<0.01

P3-L: P300-latency; P3-A: P300-amplitude; Extra: Extraversion; P300-amplitudes in second trial are showed in second rows within same boxes

formed to examine significant correlation. So, determined significant interaction effect of measuring trial and sight problems ( $F_{(1,54)}=5,29$ ,  $p=0.03$ ) indicated to different directions in P300-amplitude changes: those subjects with glasses showed significant increase in P300-amplitude in second trial, but those who did not have glasses significant decrease in second trial (Figure 1). In the first trial there were no significant differences in amplitude between those two groups. So, these two findings concerning sight problems and latency and amplitude of P300-wave could be explained by facilitating role of glasses on perceiving and detecting visual signals, what has been ensured by the fact that given correlations have been determined on occipital electrodes which reflected neuroanatomical location of visual pathways in brain<sup>44</sup>. Also, it was interesting to analyse the relationship between extraversion and P300-amplitude in group who had glasses and the one without them. Only first group showed significant negative correlation between extraversion and P300-amplitude what has favored the hy-

pothesis about higher amplitudes in introverts. But, this finding was only on one electrode and not so high, so his reliability is in question.

Considering second trial, significant correlation has been determined between lower P300-amplitude and older subjects, those who did not have glasses, those who drink coffee, those who did not take any medications and those who did not smoke. Determined negative correlation between age and P300-amplitude confirmed previous findings of P300-changes with age<sup>46</sup>, but because it was only on one electrode and did not showed significant result in ANOVA, it was observed on a tendency level so the subject sample was defined as age homogenous. So, it was recommended to use samples with smaller age ranges.

Several studies showed that drinking coffee or other products that contains caffeine affected on mild increase of P300-amplitude and significant decrease of P300-latency<sup>29-30</sup>, because it works as a stresor<sup>94</sup>. But, in studies where fatigue and arousal were experimentally manipulated it was determined that arousal level had major me-

TABLE 2  
CORRELATION MATRIX OF P300 LATENCIES AND AMPLITUDES MEASURED ON 4 ELECTRODES (O<sub>1</sub>, O<sub>2</sub>, P<sub>3</sub> AND P<sub>4</sub>) IN TWO TRIALS, AND EXTRAVERSION IN 8 GROUPS

P300		Extraversion							
		Sight problem		Coffee		Medications		Smoking	
		yes N=22	no N=32	yes N=32	no N=22	yes N=15	no N=39	yes N=16	no N=38
P300-latency	O <sub>1</sub>	-0.44*	-0.07	-0.24	-0.10	0.08	-0.29	-0.26	-0.17
		0.04	0.71	0.18	0.66	0.78	0.07	0.33	0.31
	O <sub>2</sub>	-0.44*	-0.10	-0.28	-0.08	0.08	-0.31	-0.28	-0.18
		0.04	0.60	0.12	0.74	0.76	0.06	0.30	0.29
	P <sub>3</sub>	-0.41	-0.25	-0.46**	-0.08	-0.19	-0.36*	-0.24	-0.34*
		0.06	0.17	0.01	0.73	0.49	0.02	0.36	0.05
	P <sub>4</sub>	-0.41	-0.25	-0.46**	-0.08	-0.19	-0.36*	-0.26	-0.34*
		0.06	0.17	0.01	0.73	0.49	0.02	0.33	0.04
1. trial	O <sub>1</sub>	-0.15	-0.06	0.08	-0.24	-0.03	-0.12	-0.01	-0.12
		0.51	0.76	0.65	0.29	0.93	0.45	0.97	0.46
	O <sub>2</sub>	-0.32	0.07	0.02	-0.20	-0.15	-0.08	-0.08	-0.11
		0.15	0.70	0.92	0.37	0.58	0.62	0.78	0.52
	P <sub>3</sub>	-0.02	0.08	0.30	-0.21	0.15	-0.04	0.19	-0.01
		0.93	0.67	0.09	0.35	0.59	0.81	0.47	0.93
	P <sub>4</sub>	-0.02	0.11	0.28	-0.20	0.29	-0.07	0.07	0.03
		0.92	0.56	0.12	0.37	0.29	0.68	0.79	0.84
P300-amplitude	O <sub>1</sub>	-0.22	0.20	0.28	-0.25	-0.26	0.09	0.31	-0.09
		0.33	0.28	0.12	0.26	0.35	0.58	0.25	0.59
	O <sub>2</sub>	-0.46*	0.29	0.25	-0.33	-0.44	0.06	0.21	-0.18
		0.03	0.11	0.17	0.13	0.10	0.69	0.43	0.27
	P <sub>3</sub>	-0.16	0.28	0.13	0.06	-0.13	0.19	0.16	0.08
		0.48	0.12	0.49	0.78	0.64	0.26	0.54	0.65
	P <sub>4</sub>	-0.13	0.22	0.10	0.06	-0.34	0.22	0.16	0.04
		0.56	0.24	0.57	0.80	0.22	0.17	0.56	0.83

\* $p<0.05$ ; \*\* $p<0.01$

mediate role within the relationship between P300 and coffee<sup>29,30</sup>. Furthermore, analysis of different findings in group of subjects who drink coffee and in the one where did not showed changes within the relationship between extraversion and P300-latency in the first one (Table 2). So, drinking coffee had significant mediate role in studied relationship, what has confirmed previous findings where coffee had been shown to produce different changes in mood, cognitive performance and physiology<sup>95</sup>, especially on cortical arousal. This finding partially confirmed previous findings where drinking coffee affected on obtaining significant differences in cognitive speed between introverts and extraverts<sup>94</sup>.

Concerning taking different medications in the last month, those subjects who reported that have been used some of them have showed higher P300-amplitudes. Because there were very different kind of medications mentioned earlier, it was possible of their indirect impact on amplitude which has not been studied within previous ERP-research. In Stenberg's research<sup>83</sup> subjects reported of using contraceptive pills what showed not to be correlated with P300. So, because this was a one lonely finding (just on one electrode) it could be concluded that maybe this was the result of different physiological variations. Still, analysing group of those subject who reported that have been used some medications and the of those who reported not being used any kind of medication, it could be seen (Table 2) that relationship between extraversion and P300-latency has been changed in the first one and remained the same in the second. This could be the result of the significant impact of hormones, neurotransmitters and other neurobiochemical factors that have been studied in previous research – the variables that could not be controlled in this study<sup>96</sup>.

Finally, on marginal level it was determined that those students who smoked more often showed shorter P300-latencies on one parietal electrode in difference to those who did not smoke ( $r=0.264$ ,  $p=0.053$ ). This result of shorter P300-latencies in smokers has been previously determined<sup>5</sup>. Smoking included nicotine intake what evoked immediate pharmacological effect on bodily functions and chronic such as addiction. Frequently confirmed findings of better performance on cognitive tasks after smoking have been attributed to nicotine induction of increased arousal level<sup>97,32</sup>, what has been determined in electrophysiological studies too<sup>98,99</sup> where abstinence induced slower alpha waves and increase of theta activity – state that presented fatigue or drowsiness. But, this connection between smoking and arousal level indexed by P300 was mediated by age<sup>34</sup>, type of task used, modality and intensity of stimuli, and CO-level before and after smoking<sup>100</sup>. Also, one study determined significant difference in P300-amplitude between instant smokers and non-smokers, and no significant relationship between chronic smokers and non-smokers in P300-amplitude measured by visual oddball paradigm<sup>33</sup>. In this study, students who smoked showed higher P300-amplitudes on both parietal electrodes. But this finding was not so simple. Further ANOVA analysis showed significant in-

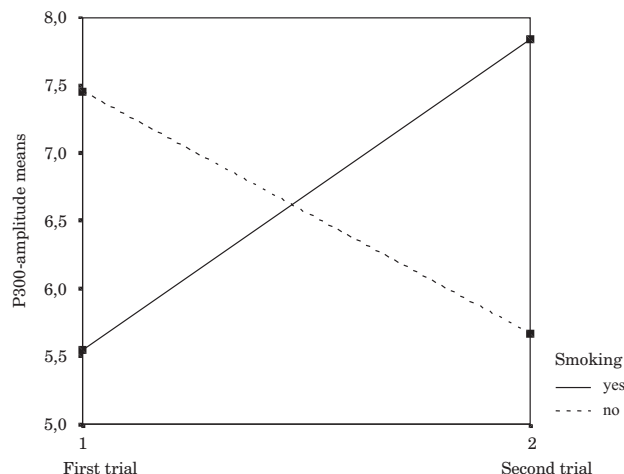


Fig. 2. P300-amplitude in function of measuring trial and smoking.

teraction effect of measuring trial and smoking on P300-amplitude (Figure 2). In the first trial, students who have smoked showed significantly lower P300-amplitudes than those who have not smoked. But, in the second trial, those students who have smoked showed significantly higher P300-amplitudes than those who have not smoked, what implicated on indirect connection between smoking and P300-amplitude according to the given task continuity. It was obvious that smoking influenced on vigilance maintenance that could be explored by manipulating task time and number of trials, and that P300-amplitude as an index of cortical arousal increased in smokers and decreased in non-smokers.

Separate correlational analysis of P300 and extraversion showed that in smokers group there was no any significant relationship between studied variables (Table 2), but in non-smokers group previous negative correlation between extraversion and P300-latency has been confirmed. So, it could be concluded that smoking significantly has affected on the relationship between P300-latency and extraversion, because this significant relationship has been found only in non-smokers group. Evidently, P300 was very sensitive on different physiological changes which have been more or less successfully controlled in this study.

## Conclusion

To conclude, separate correlation analysis of P300 and extraversion concerning previously described biological factors showed that only those students who had glasses, drink coffee, did not take any medications and did not smoke have confirmed previously determined significant negative correlation between P300-latency and extraversion. According to relationship between P300-amplitude and extraversion which was not significant in the whole sample, but in the group of subject who had glasses it was determined that more extraverted students showed decreased P300-amplitudes. Two interac-

tion effects have been determined which confirmed the presumption of complex nature of studied relationships between P300-amplitude and measuring trial concerning factors of sight problems and smoking. These findings have confirmed expected significant sensitivity and variability of latency and amplitude of P300, which should be taken into account within any ERP-research of personality. So, it was important for future studies to use auditive oddball paradigms to avoid heterogenous samples con-

cerning sight problems, to find heterogenous subjects concerning a wider range of personality dimensions, and finally to conduct separate analysis concerning biological determinants such as smoking and consumption of coffee. Also, using more trials, more complex tasks within different oddball paradigms and more adequate electrophysiological apparatus could be guidelines for improving an ERP-research.

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## **BIOLOŠKI KORELATI ODNOSA IZMEĐU P300 I EKSTRAVERZIJE**

### **SAŽETAK**

Zbog visoke osjetljivosti P300-vala koja je utvrđena u prijašnjim istraživanjima, cilj ovog rada je bio ispitati medijatorski utjecaj nekih bioloških korelata P300 na njegov odnos s ekstraverzijom. Uzorak se sastojao od 54 studentice psihologije, sve dešnjakinje, u dobi od 19 do 23 godine. P300 je izmjeren zadatkom jednostavne diskriminacije vidnog podražaja u dvije serije mjerenja pomoću EMG/EP aparata Medelec/TECA Sapphire<sup>II</sup>, 4E. Rezultati su kod studentica koje nose naočale, piju kavu, ne uzimaju nikakve lijekove i ne puše pokazali značajnu negativnu korelaciju između P300-latencije i ekstraverzije. Značajna negativna korelacija između P300-amplitude i ekstraverzije utvrđena je samo kod onih studentica koje su nosile naočale. Također, utvrđene su značajne razlike između pojedinih grupa studentica u P300-amplitudi s obzirom na seriju snimanja. Stoga je zaključeno da su nalazi potvrdili očekivani značajnu osjetljivost i varijabilitet kod P300-vala, koji imaju medijatorski utjecaj na njegovu povezanost s ekstraverzijom, što bi svakako trebalo kontrolirati u budućim istraživanjima.