Abstract. – Introduction and Aim: Heroin abuse can lead to organic damage of cerebral structures, including sequels in cognitive and affective sphere, which are in positive relation with the duration of substance usage. Memory is one of the cognitive functions which is highly sensitive to opiate toxic effects. The aim of this research was determination of heroin impact on the visual memory of addicts, as well as the existence of specific relation of potential deficiencies in visual memory with the duration of substance use.

Methods: The research included 90 examinees, divided into three groups, depending on the duration of heroin intake. We used questionnaire for basic socio-demographic and addictological traits of examinees; Wechsler’s scale for the assessment of the intelligence and Visual Memory Test (TVP), for the assessment of the visual memory.

Results: The achievements of heroin addicts with different duration of the substance abuse differ significantly ($F = 1.83; df = 12; p < 0.05$). Total number of errors examinees make in the first series of TVP (immediate visual memory) grows, almost linearly in the function of the duration of heroin abuse ($p < 0.05$), but in neither of groups meets criteria for the visual memory impairment. Deficiency of the delayed visual memory occurs in examinees who use heroin for one (total number of errors = 6.46; participation of typical organic errors = 31.7%) and longer than five years (total number of errors = 7.66; participation of typical organic errors = 26.7%). Univariate covariance analysis separates the average daily dosage of heroin as the most significant variable that contributes to the expression of the aforementioned deficiencies ($F = 4.21; df = 2; p < 0.05$).

Conclusion: Heroin abuse leads to damage of delayed visual memory, whereby for the observed effect intake of the substance for a period longer than one year is necessary.

Key Words: Visual + memory, Heroin, Disorders.

Introduction

Organic damage of cerebral structures, correlating with the broad spectra of deficiencies in different domains of mental functioning, often interdependable and intertwined, is found within the range of harmful consequences caused to the body by the use of heroin. Numerous works from the domain of neuropsychology indicate that most vulnerable to the effects of heroin are neurons of frontal and prefrontal cortex, philogenetically youngest brain structures, responsible for control, planning and programming of all higher mental and motor functions. Memory is cognitive function highly sensitive to the toxic effects of opiates. Patients with the prefrontal cortex damage manifest quite specific memory disorders. Enhanced sensitivity to the influence of interfering stimuli and inability for the release from the proactive inhibition are the main features of the frontal amnestic syndrome.

Long-term abuse of heroin stands out as the most significant factor contributing to the development and severity of neuropsychological sequels, including memory impairments. Speaking about mnestic deficiencies, bibliography provides different positions on the length of exposure to opiates required for the mentioned deficiencies to manifest, while the critical periods range from two to five years.

Davis et al. point also to the necessity of differentiation between the transitory changes from the permanent ones, stressing that “recovery” of cognitive functions is possible during the periods of abstinence. Latest research confirm these findings, with an addition that the partial improvement of cognitive functions comes about during the early stages of abstinence, after the withdrawal symptoms reach their peak, since cogni-
tive deficiencies during the early abstinence are related to the neural dysregulation in the prefrontal cortex induced by the withdrawal syndrome, and are partially transitory.6

Severe mnestic deficiencies do not appear as a result of heroin action on central nervous system. Literature provides mainly works speaking about the impairment of the short-term, i.e. working memory.7-9. There are no consistent works that would speak in favour of the impairment of the long-term memory caused by the influence of heroin. Since the multicomponent system of the working memory is inseparably connected with the attention system, in other words that inferent stimuli cause rapid turn off of memory traces,10 mnestic deficiencies are often described together with attention disorders.

Several Authors cite poorer achievements, meaning significantly larger number of errors, on the Benton Visual Retention Test in the group of heroin addicts compared to the control group of healthy examinees.11-13. It is known that the aforementioned test is used as an instrument for the assessment of the short-term visual memory, but accomplishments on it largely depend on the preservation of visual perception and motorics, i.e. coordination.14 Interestingly, as far as the achievement on the aforementioned test is concerned, there is no statistically significant difference between the groups of heroin addicts and multiple drug users.11

Pathak et al. bring up a hypothesis that heroin addicts have disadvantages in processing visual information on the iconic level, but not on the deeper levels of the mnestic process.

In line with the above stated data from bibliography, the aim of this research was the determination of psychiatric-psychological consequences of the heroin abuse, in terms of the impairment of the visual memory, as well as of the existence of specific relation of possible deficiencies in visual memory with the duration of the use of the substance. Within the series of examinations, the aim was to separate those parameters that are significantly related to manifest deficiencies, which would help in defining predictors of the visual memory impairments in heroin addicts.

Subjects and Methods

Research was conducted as a prospective study, which was conducted at the Institute of Psychiatry of the Clinical Centre Vojvodina in Novi Sad during the year 2008.

The sample included 90 examinees, selected based on the clearly defined including and excluding criteria. Including criteria were: diagnosis of opiate dependency in accordance with ICD 10,16 abstinence from opiates for more than three weeks, male gender, age 19-28. In order to exclude other potential agents that could contribute to the visual memory impairment, following excluding criteria were defined in the selection of the sample: sustained craniocerebral trauma, existence of a diagnosed endocranial tumour, diagnosed temporal epilepsy, presence of a psychotic disorder, current affective disorders, presence of the mental deficiency syndrome, diagnosis of some other addiction disorder, neurological and neuromuscular impairments, abstinence from opiates longer than 1/6 of the using period, severe liver impairment.

Examinees were divided into three groups of 30 examinees, according to the duration of the substance abuse:

Group – examinees using heroin up to 1 year
Group – examinees using heroin 1-5 years
Group – examinees using heroin longer than 5 years.

Following instruments were used for the data collection:

Questionnaire, specially designed for the needs of this research, which regarded basic sociodemographic and addictological traits of examinees. The questionnaire included the following items: age of examinees, duration of the substance abuse, average daily dose of heroin within the last three months, route of heroin administration during the last three months, age at the time of the first contact with any psychoactive substance, age at the time of the first contact with the heroin, frequency in discontinuations in heroin intake, presence of substance related disorder in the family.

VITI (Wechsler Individual Test of Intelligence) standard version of Wechsler Adult Intelligence Scale (WAIS), the primary clinical instrument used to measure adult and adolescent intelligence. VITI is a combination of WAIS and WAIS/R (revised version) forms. WAIS is the basis, while the test is given in the manner taken from WAIS/R. The instrument estimates different aspects of intellectual functioning. Three different scores are ob-
tained: total intelligence quotient (TIQ) or intelligence quotient of the whole scale, verbal intelligence quotient (VIQ) and performance intelligence quotient (PIQ). Verbal and performance IQ scores are based on the means of larger number of different functions. Table of pondered scores corresponding to age groups is used for the calculation of normative values for examinee in question.

Indicators of intellectual functioning of examinees have been introduced in the research as confounding variables, that are believed to have potential to significantly influence examinees’ achievement on the test for the verbal memory assessment. General intelligence is the foundation of the memory and a requirement for an individual to solve different tasks at more or less same level of efficiency. Memorizing of verbal material is in direct and positive relations with the “verbal aspect” of intellectual abilities.

Potential impact of both verbal and practical IQ scores on the verbal memory function has been considered in the analysis of results, since the basic VITI partition to verbal and non-verbal part only partially corresponds to subtests’ factorial determinateness, and significant functional overlapping of the two scales is hence believed to be inevitable.

Visual Memory Test – It is a visual retentive test, which is used for examining of figural perception, immediate and delayed memory and graphomotoric reproduction. The test is comprised of two figural series: Series I for examining immediate and Series II for examining delayed memory. Errors in these operations, depending on the frequency, type and arrangement, are related to organic dysfunctions. Qualitative analysis of the test is based on coding of errors and identification of “typically organic errors”, which declines an entire set of differential diagnostic errors and increases the reliability of the test.

Statistical Analysis – Within the statistical data processing covariance analysis was used, in cases where dependent variables are achievements on psychological tests; categorical variable of groups (duration of abuse), and controlling (interfering) variables: age of examinees, age at the time of the first contact with heroin and psychoactive substances, average daily dose of heroin, route of administration and number of discontinuations in abuse, as well as measures of intellectual efficacy, where necessary. Variables followed normal distribution, meeting thus the conditions for conducting this analysis. This method, in multivariate analysis, enables determination of the overall model, and then in univariate analysis significance of independent agent (group) impact on each of dependent variables, whereby the co-variables are kept under control. Significance of differences between dependent variables’ means, in subgroups created based on independent factors proven to be significant in the previous analysis, was tested by Scheffe’s comparison.

Obtained data have been processes in appropriate PC statistical program Statistic for Windows version 7.0 (SPSS Inc., Chicago, IL, USA), while the graphic displays were made in Microsoft Office Excel 2007.

Results

Sociodemographic and Addictological Traits of Examinees

The sample included examinees aging 19-24. At the overall sample level, average age of examinees was 24.5 (M=24.51, SD=3.05). With the analysis of variance, it was identified that examinees with different heroin abuse duration differ significantly with regard of their current age as well (F=27.919; df=2; p=0.000).

Examinees in this research have had the first contact with any of psychoactive substances at, averagely, 15 years (M=15.57; SD=1.88). Relative to the stated criterion, difference between examinees with different duration of addiction is at the marginal level of significance (F=2.637; df=0.078).

Examinees report that their first contact with heroin was around the age 19 (M=18.9; SD=2.49). Examinees with longer duration of addiction started with heroin abuse at younger age (F=4.716; df=0.012).

Average heroin dose that examinees take daily was, on the level of the total sample, approximately 1.5 g (M=1.40; SD=0.87). Analysis of variance shows that it can be claimed with high reliability that examinees from different groups systematically differ in respect to the average daily dose of heroin intake (F=2.631; p=0.000).

There is statistically significant connection between the duration of heroin abuse and the way of administration. Addicts with longer abuse duration use heroin intravenously considerably more often (χ^2=18.086; df=2; p=0.000).

It was determined by analysis of variance that addicts who use heroin for longer period of time also have more discontinuations in drug abuse (F=9.550; df=2; p=0.000). Results of multiple
comparisons tested with Scheffe’s test show that the systemic difference is maintainable between the first and the second \( (p=0.002) \) and the first and the third group \( (p=0.001) \), while the difference between the first and the third group \( (p=0.994) \) is not maintained.

**Indicators of Intellectual Functioning**

Intellectual abilities of examinees in this research are within the range of average values for the age. Analysis of variance has not identified statistically significant difference between examinees with unlike heroin abuse duration \( (F=6.024; df=0.12) \).

**Visual Memory Test**

Achievements of heroin addicts with unlike duration of substance abuse on the Visual Memory Test, seen as a whole, differ significantly (Table I). Neither of the stated control variables interferes with the mentioned effect.

**Immediate Visual Memory**

Total number of errors in the first series of the test \( (\text{immediate visual memory}) \) grows almost linearly in the function of the abuse duration, which is not the case with organic specific errors (Figure 1).

Percentage of typical organic errors in all three groups of examinees exceeds 20\%, therewith that ratio is highest in the group of examinees with average abuse duration one to five years (Figure 2).

<table>
<thead>
<tr>
<th>Table I. Multivariate covariance analysis for TVP as entire model.</th>
</tr>
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<tbody>
<tr>
<td>TVP F</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Dose</td>
</tr>
<tr>
<td>Route of administration</td>
</tr>
<tr>
<td>Age-PAS</td>
</tr>
<tr>
<td>Age-heroin</td>
</tr>
<tr>
<td>No of discontinuations</td>
</tr>
<tr>
<td>MIQ</td>
</tr>
<tr>
<td>GIQ</td>
</tr>
<tr>
<td>Group</td>
</tr>
</tbody>
</table>

TVP – Visual Memory Test; MIQ – manipulative (practical) intelligence quotient; GIQ – global intelligence quotient; n.s. (non significant) – no statistical significance; s * (significant) – \( p<0.05 \); s. ** (significant) – \( p<0.01 \).

Table II shows differences in examinees’ achievement in the part of the Visual Memory Test referring to the assessment of the immediate visual memory. Duration of heroin abuse stands in significant relation only with the total number of errors on this part of the test, while examinees from the tree groups with different abuse duration don’t differ in respect of the number of organic specific errors and ratio of total and organic specific errors.

**Delayed Visual Memory**

Significant increase of the total number of errors in the function of the abuse duration is noted in the part of the test referring to the delayed visual memory (Figure 3).

Percentage of typical organic among total errors is lower than 20% in examinees who use heroin less than one year, while the highest percentage has been registered in the group of examinees using heroin in duration one to five years (Figure 4).

Even in the part of the test measuring delayed visual memory, statistically significant difference between examinees with differing duration of abuse is obtained only in the total number of errors (Table III).

Testing of the differences on the level of individual group couples with Scheffe’s test shows that the significance of the difference between the second and the third group of examinees is dissolving (Table IV).

**Discussion**

Total number of errors examinees are making in the first series of the test \( (\text{immediate visual memory}) \) grows almost linearly with the increase of the abuse duration, and accordingly, the difference between the three groups of heroin addicts with unlike abuse duration is statistically significant \( (p<0.05) \). Results show that examinees abusing heroin for less than one year make fewer errors from the determined standard (2.9 errors), while examinees with abuse duration longer than one, i.e. five years, make more errors than standard values (4.96 and 6.06 in second and third group of examinees, respectively). However, achievement of examinees’ in neither of the mentioned groups exceeds the expected performance by two errors, which is one of indicators of prob-
Figure 1. Average number of errors in the first series of the Visual Memory Test (TVP).

Figure 2. Relation of the number of total and organic specific errors in the first series of Visual Memory Test (TVP).

Table II. Univariate covariance analysis with indicators of immediate visual memory as dependent variables.

<table>
<thead>
<tr>
<th></th>
<th>Total no of errors</th>
<th>Organic errors</th>
<th>Relation of errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>F</td>
<td>p</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>0.15</td>
<td>n.s.</td>
</tr>
<tr>
<td>Dose</td>
<td>1</td>
<td>0.03</td>
<td>n.s.</td>
</tr>
<tr>
<td>Route of administration</td>
<td>1</td>
<td>0.06</td>
<td>n.s.</td>
</tr>
<tr>
<td>Age-PAS</td>
<td>1</td>
<td>0.92</td>
<td>n.s.</td>
</tr>
<tr>
<td>Age-heroin</td>
<td>1</td>
<td>0.31</td>
<td>n.s.</td>
</tr>
<tr>
<td>No of discontinuations</td>
<td>1</td>
<td>0.78</td>
<td>n.s.</td>
</tr>
<tr>
<td>MIQ</td>
<td>1</td>
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</tr>
<tr>
<td>GIQ</td>
<td>1</td>
<td>2.70</td>
<td>n.s.</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>3.04</td>
<td>*&lt;p&lt;0.05</td>
</tr>
</tbody>
</table>

MIQ – manipulative (practical) intelligence quotient; GIQ – global intelligence quotient; n.s. (non significant) – no statistical significance; *<p<0.05; **<p<0.01.
The impact of heroin on visual memory

able impairment of visual memory function. Average number of organic errors ranges from 0.76 (first group of examinees) to 1.63 (second group of examinees), and in protocols with low number of total errors (as is the case with examinees in this research) does not suggest impairment of the immediate visual memory.

If we take a look at the next criterion for the diagnosis of the visual memory impairment, the ratio of the number of typical organic errors among total errors, we see that it exceeds 20% (marginal tolerable value) in all three groups, but not with significant deviation regarding examinees with the shortest (+4.5%) and longest (+3.3%) abuse duration. Deviation from the marginal value in the group with abuse duration one to five years is somewhat higher (+12.3%), and such a result can be understood in the context of poorer intellectual achievements in the mentioned group of examinees, since there is high correlation between the TVP results and intellectual abilities (r=0.76) 17.

Summarising results from the part of the test referring to immediate visual memory, we can deduce that no deficiencies in the mentioned function are registered in heroin addicts, although the performance of examinees at some segments of the test decrease significantly with the increase of the abuse duration. Decrease of the performance is in no segment sufficient to in-

Figure 3. Average number of errors in the second series of the Visual Memory Test (TVP).

Figure 4. Ratio of the number of total and typical organic errors in the second series of the Visual Memory Test (TVP).
dicate potential impairment of the immediate visual memory.

Results of this research are opposed to the findings of Penk, who establishes that heroin has negative effects on immediate visual memory, using as an instrument Benton’s Visual Retention Test, which would be a correlate of the Visual Memory Test.

In the second series of the Visual Memory Test (delayed visual memory) examinees using heroin less than one year make fewer errors than in the immediate visual memory test, and the number of errors is below standard value for the age. Also, the ratio of the number of organic specific and total number of errors in the abovementioned group of examinees is below 20% (16.3%), and we can deduce that the heroin abuse for less than one year gives no effect on the function of the delayed visual memory.

On the other side, examinees abusing heroin longer than one, i.e. five years, averagely achieve 1.5 errors more on the test of delayed visual memory than on the test of the immediate visual memory, which is not a feature of unimpaired examinees. Deviance from the expected score (4.07 errors) is in both groups higher than two errors. Participation of typical organic in the number of total errors exceeds 20% (31.7% in the second group and 26.7% in the third group). Comparison of the groups of examinees regarding parameters of the delayed visual memory indicate that there is no significant difference between the addicts using heroin longer than one year and longer than five years.

It can be concluded from the given results that the heroin abuse leads to the deficiency in delayed visual memory, whereby for the observed effect intake of the substance for a period longer than one year is necessary, which is consistent with results Prosser et al obtained. Contrary to that, Pathak et al identify that heroin abuse impairs processing of visual information on the sensory memory level (iconic level), but not in the deeper levels of processing.

Out of agents that were assumed to might contribute to potential impairment, average daily dose was isolated, whose increase is related to the higher level of the delayed visual memory impairment.

As with the verbal modality, immediate and delayed visual memory are inseparably related to the functioning of the attention and concentration system, and it would thus be desirable for the mentioned deficiencies to also be analysed in the context of the attention system dysfunctions.

<table>
<thead>
<tr>
<th>Group</th>
<th>Delayed memory-total errors p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>s.***</td>
</tr>
<tr>
<td>1-3</td>
<td>s.***</td>
</tr>
<tr>
<td>2-3</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

n.s. (non significant) – no statistical significance; s.*** (significant) – p<0.001.
Conclusion

Heroin abuse leads to impairment of delayed visual memory, whereby for the observed effect intake of the substance for a period longer than one year is necessary. The most significant factor, contributing to the intensity of the mentioned mnemonic deficiencies, is the average dose of daily taken heroin.

References