

# WORKING MEMORY IN FEMALE VICTIMS OF DOMESTIC VIOLENCE

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*Key words:* posttraumatic stress disorder, psychomotor speed, visuospatial working memory

## SUMMARY

**Background.** *The purpose of this study was to evaluate selected cognitive functions in victims of domestic violence, and to examine the correlation between these functions and the intensity of symptoms of posttraumatic stress disorder (PTSD).*

**Material and methods.** *Psychomotor speed and visuospatial working memory were evaluated by the means of the Trail Making Test (TMT) A and B. The presence and intensity of PTSD symptoms were measured with Watson's PTSD Interview.*

**Results.** *PTSD symptoms of varying intensity were found in 97.8% of the female victims of domestic violence in the group examined. Extreme or severe intensity was found among half of the subjects. Psychomotor speed was impaired in 71.9%, while reduced visuospatial working memory (VWM) efficiency was found in 67.2% of the examined group. The intensity of PTSD symptoms significantly correlated with prolonged performance time on part B of the TMT. Age correlated with prolonged performance time in both parts B and A.*

**Conclusions.** *PTSD is commonly found among victims of domestic violence. Victims of domestic violence display deficits in working memory efficiency. Cognitive disorders are an essential element of the clinical picture of PTSD.*

## INTRODUCTION

Working memory is crucial for the proper functioning and integration of complex cognitive processes, the so-called executive functions. The latter include planning, conceptual thinking, problem solving, knowledge and decision making in complex situations. Working memory is indispensable for establishing an individual-environment relationship and forming social and

adaptational behaviors. This involves storing, retrieving, and processing information in short-term memory. The information may then be duly included in the mental analysis of the situation. The ability to base on experience and use new information is made possible by online processes, which control retrieving stored information and applying new methods of action. This constitutes the basis of psychological plasticity, which is required for good adaptation to changing circumstances (Borkowska 2006). Memory depends on various systems and neuroanatomical brain structures. Working memory is related to activity of the dorsolateral areas of the prefrontal cortex, which plays a vital role in the organization of complex mental functions. The competence of different types of working memory is connected with activities of other cortical centers (e.g. parietal lobe) and subcortical structures (e.g. hippocampus, thalamus and cerebellum). Each type of memory is affected by pathological factors in varying levels of intensity and is prone to efficiency loss in the course of many different diseases.

Under the influence of stress numerous changes in brain functioning can take place. Working memory is associated with episodic memory, whose neuronal mechanism requires the cooperation of cortical centers (mainly prefrontal cortex) and the hippocampus. The hippocampus is especially sensitive to the adverse effects of stress, and individuals with PTSD often display structural abnormalities of this form (McEwen 1999). Under the impact of stress there occurs a remodeling of brain functioning, such as prefrontal cortical atrophy and hippocampal atrophy or initial hypertrophy followed by atrophy of amygdala nucleus (Adolphs et al. 1995, Wood et al. 2003, Radley et al. 2006, Radley et al. 2004).

One of many sources of extreme stress is domestic violence, which can evoke Post-Traumatic Stress Disorder (PTSD). Studies on PTSD have revealed both changes in cognitive functions and in brain structure (Liston et al. 2003). A series of analyses has confirm the presence of deficits in declarative memory (Bremner 2006). The currently available results of many and diverse neuropsychological examinations of subjects with diagnosed PTSD report deficits in attention or short-term memory. Correlations have been found between the volume of the hippocampus and cognitive functions disorders among individuals with PTSD, indicating the limbic areas (Horner & Hamner 2002).

The methods of memory examination include the Trail Making Test A&B, which analyses visuospatial working memory and set-shifting ability after learning one procedural rule. This test of dot connecting has been used to evaluate cognitive function improvement among subjects treated for mental disorders (Borkowska & Rybakowski 2005), and to assess working memory in encephalitis (Juchnowicz et al. 2004). The present study applied the test to evaluate working memory in subjects with a history of traumatic experiences associated with domestic violence.

## METHODS

### ***Neuropsychological evaluation (Trail Making Test A and B, TMT).***

The TMT examines visuospatial or verbal working memory, set-shifting ability after learning one rule of procedure, and effectiveness in suppressing automated reactions. It evaluates the functioning of the frontal-temporal-parietal junction and the frontal lobes (right side especially). The test is comprised of two parts: A and B. During Part A, the task is to connect dots from 1 to 25 with a solid line in the correct order as quickly as possible. In part B, the subject is asked to connect numbers and consecutive letters alternately with a solid line in the following order: 1-A-2-B-3-C etc. Scoring is based on the number seconds needed to complete the tasks and the accuracy of performance.

The first part of the test evaluates psychomotor speed, while the second examines visuospatial working memory and set-shifting ability after learning a different rule of procedure. In order to do the test properly, one needs to have good visuomotor skills (eye-hand).

### ***Evaluation of the presence and intensity of PTSD***

The diagnosis of posttraumatic stress disorder and evaluation of its intensity were based on the PTSD Interview (PTSD-I) created by C. G. Watson (Watson et al. 1991). The PTSD-I is a self-evaluation scale based on the DSM-III diagnostic criteria for PTSD (APA 1980). The scale includes not only the evaluation of every symptom on a simple binary scale, present/absent, but also the intensity and frequency of each of the symptoms, which enables assessment of the presence and intensity of PTSD (Watson et al. 1991). It is characterized by reliability and conformity. Symptoms are grouped in three categories:

1. obsessive recollection of images and thoughts concerning a traumatic event (intrusion);
2. avoidance of any stimuli associated with the event,
3. overexcitement.

The reliability of the original scale measured by test-retest is  $r_{tt}=0.95$ , Cronbach = 0.94, sensitivity factor = 0.89, specificity = 0.94. The questionnaire has been adapted to suit Polish conditions (Koniarek et al. 2000). Internal conformity was calculated for the Polish version. Cronbach's alpha for individual scales was as follows:

- for the subscale measuring recollections (intrusion) 0.78;
- for the subscale measuring avoidance 0.74;
- for the subscale measuring overexcitement 0.87.

The internal conformity for the scale is 0.90. The subject evaluates the intensity and frequency of the 17 symptoms incorporated in posttraumatic stress disorder occurring after the most traumatic experience, if there has

been more than one such traumatic event. PTSD-I is the only tool analyzing the presence of PTSD with separate items significantly correlated with DSM-III, III-R, as well DSM-IV criteria. The scale's reliability is well documented, it is simple to administer and may be used by qualified interviewers. It can be applied to evaluate posttraumatic effects in various groups of victims.

The present study involved the use of an interpretation scale (Heitzman 2002), divided into parts from A to E. In part B of the interview, four questions pertain to symptoms related to recollection of memories (intrusion), in part C seven questions assess avoidance of any stimuli associated with an event, and in part D six questions are about overexcitement connected with a traumatic experience. The results of parts B, C and D were summarized. Additionally, there are two questions concerning the frequency of symptom occurrence and duration of PTSD (part E). Each symptom was evaluated using a 7-point scale of intensity, from "no, never" to "to the highest degree, always". PTSD criteria are met in a subject with a history of traumatic experience, if:

- in subscale B at least one answer is equal to or greater than 4;
- in subscale C at least three answers are equal to or greater than 4;
- in subscale D at least two answers are equal to or greater than 4;
- in part E both questions receive more than 1 point.

A total score from subscales B, C, and D greater than 24 points confirms the diagnosis of PTSD. The maximum possible score from the three subscales (B, C, and D) is 119 points. The level of intensity of PTSD was estimated according to the total amount of points awarded for the subscales:

- mild: 24-28 points;
- moderate: 49-73 points;
- severe: 74-98 points;
- extreme: 99-119.

### ***Study group***

The study group was comprised of 63 women who had been compelled to leave their homes and seek help in social welfare institutions due to domestic violence. The mean age in the group was 35.65 (SD=10.4), with a range between 17 and 55. All the subjects were residents of a hostel for victims of domestic violence, lived in a single mothers' home, or benefited from services at one or the other facility though not residing there. The period of time that had passed since the last traumatic event of domestic violence ranged from several months to several years among all of the victims; usually the event was more than 2 years in the past. Every one of the studied cases included victims of both physical and mental/emotional violence. The types of aggression expressed by the life partners of the victims varied, and consisted of:

- threatening to kill;
- attempting to strangle;
- beating with a heavy tool;

- threatening with a knife;
- threatening with an axe;
- pushing and knocking over;
- forcing sexual activity.

Most of the subjects emphasized that they had also been exposed to acute mental/emotional violence, such as:

- humiliation;
- verbal abuse;
- ridicule;
- circumscription of personal freedom;
- restrictions on the use of money;
- defrauding money;
- incurrance of debts.

In addition, the women endured particularly harsh mental/emotional suffering when compelled to witness their own children being abused by their partners. All these women were mothers with 1 to 4 children.

### **Statistical analysis**

The results of the examinations were submitted to statistical analysis. A set of statistical tests from SPSS for Windows, ver.13.0, was applied. The tests for independent variables were the t-test and Spearman's Rank Correlation Test.

## **RESULTS**

Almost all of the women in the study group (97.8%) with a history of traumatic events related to domestic violence displayed symptoms of posttraumatic stress disorder with varying levels of intensity (Table 1). Roughly half of them (48.9%) demonstrated extreme or severe intensity levels.

In the study group 71.9% of the subjects showed psychomotor speed impairment, and 67.2% reduced efficiency of visuospatial working memory. The dysfunctions were manifested at various intensity levels (Table 2). Moderate or severe psychomotor speed deficits were found in 29.8% of the subjects, and visuospatial working memory deficits in 32.7%.

The t-test for mean values revealed no statistically significant difference in

Table 1. Intensity level of PTSD in the research group (female victims of domestic violence)

Intensity level	Percentage
Extreme	6.1
Severe	42.8
Moderate	32.6
Mild	16.3
PTSD not diagnosed	2

Table 2. Percentage of individuals with psychomotor speed or visuospatial working memory impairments in relation to age standards

Degree of dysfunction	TMT A % subjects	TMT B % subjects
Normal	24.6	32.7
Mild disorder	28.0	21.8
Moderate disorder	14.0	12.7
Severe disorder	17.5	12.7
Deep deficits	12.3	20.0
Total function disorders	43.8	45.4
Total results below standards	71.9	67.2

the results from either part A or part B of the TMT among subjects with greater (moderate and severe) and lesser (mild and subclinical) intensity of PTSD (Table 3).

The intensity of PTSD symptoms correlated significantly ( $p=0.02$ ) with prolonged performance time on part B of the TMT (Table 4).

Older subjects performed worse on both parts of the TMT. Greater age correlated with prolonged performance time in both part A and part B when raw test results were taken into consideration (for both parts of the test). No significant correlation with age was found, however, after the results of the

Table 3. Mean values of TMT results in relation to intensity level and PTSD presence (t-test for mean values of independent variables)

Test	Moderate or severe Mean time (SD)	Mild or no symptoms Mean time (SD)	significance of difference p=
TMT A (sec.)	37.9 (21.8)	38.3 (24.9)	0.971
TMT B (sec.)	95.4 (69.7)	80.3 (54.7)	0.749

Table 4. Correlation between the intensity of PTSD symptoms and the results of both parts of the TMT (Spearman's Rank Correlation Test)

Test	Correlation coefficient	p	significance level
TMT A	0.175	0.228	-
TMT B	0.339	*0.02	0.05

Table 5. Correlation of TMT results with subjects' age (Spearman's Rank Correlation Test)

Results	Correlation coefficient	p =	significance level
TMT A			
Raw data	0.284	*0.032	0.05
Data adjusted for age	-0.253	0.058	-
TMT B			
Raw data	0.377	*0.005	0.01
Data adjusted for age	-0.248	0.068	-

Table 6. Mean values of TMT performance time results (time in seconds) in the younger and older group of subjects (T-test for mean values of independent variables)

Test	≥35 years old mean (SD)	< 35 years old mean (SD)	difference p =
TMT A	42.3 (23.9)	33.9 (19.6)	0.159
TMT B	104.8 (75.7)	78.4 (47.7)	0.119

test were adapted to age group standards (Table 5).

Among women above 35 years of age the mean performance time in both parts of the TMT, and especially in part B, was longer than among women younger than 35, though the difference was still not significant (Table 6). More advanced age was typically associated with sustained violence.

## **DISCUSSION**

More than two-thirds (67.2%) of the investigated female victims of intimate partner violence had difficulties in completing part B of the test correctly due to the lack of set-shifting abilities. It could be hypothesized on this basis that they suffered from severe impairment of subcortical centers, since a considerable part of subjects had already had serious difficulties in the first part of the test, where they scored below standards (71.9% of subjects below standards). 21.8% of the subjects displayed severe and deep deficits.

Recent research on working memory efficiency in humans suggests that it becomes less efficient with age, with impairment beginning at the age of 35-49 (Swanson 1999). In the investigated group, subjects older than 35 performed worse on the tests than younger individuals. Although the difference in performance was not significant, the performance time on both parts of the test correlated significantly with age. Other studies have also recorded a correlation between the results and the subjects' age - there was a real drop in performance in parts A and B of the Trail Making Test among individuals with a history of brain infection (Juchnowicz et al. 2004).

Current research demonstrates that working memory disturbances appear among individuals with mental and neurological disorders, or even constitute an essential element of their clinical picture (Borkowska 2006).

Neurocognitive changes among domestic violence victims remain permanently related to PTSD symptoms. Their improvement in the course of treatment is only as great as the reduction of PTSD symptoms (Foa 2004). Working memory disorders are crucial pathogenic and clinical elements in mental diseases such as schizophrenia, affective disorders, and also in post-traumatic stress disorder resulting from a history of traumatic experience of domestic violence. Neuropsychological testing can play a vital role in post-traumatic stress disorder diagnosis. However, it has not been definitely determined whether cognitive deficits are characteristic of PTSD, whether they develop as a consequence of stress, independently of PTSD symptoms, or if

genetic factors lead to analogous effects. The results of this study confirm that there is a relation between cognitive deficits and PTSD symptom intensity. The results revealed a correlation between PTSD symptom intensity and prolonged performance time on part B of the TMT, which evaluates visuospatial working memory and set-shifting ability after learning one rule of procedure.

## CONCLUSIONS

1. Posttraumatic stress disorder is commonly found among victims of domestic violence.
2. Victims of domestic violence display working memory disturbances.
3. The results of the present study suggest that cognitive disorders may be essential elements of the clinical picture of PTSD.

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RECEIVED: 12 June 2007

ACCEPTED: 28 November 2007