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Review Article

Relationship between Prospective Memory Functioning and Self-Assessment of Mood among Patients with Chronic Respiratory Conditions

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Abstract

Prospective Memory (PM) is a group of processes and abilities thanks to which an individual is able to formulate purposes and intentions, to store them and implement them when the conditions are right. The concept of PM is highly practical and it is difficult to discuss it without referring to everyday life. The ability to use this kind of memory is of special importance in difficult situations, for example during chronic illnesses.

In order to function properly, an organism needs a constant supply of oxygen. Blood oxygen saturation is crucial to an organism's survival, and in humans it influences intellectual abilities. Limitations in oxygen transport to the brain result in brain atrophy. The process may then lead to degeneration in the hippocampus and frontal lobes, which are responsible for prospective memory functioning, among other things. How PM operates is also affected by somatic illnesses which directly or indirectly influence Central Nervous System (CNS).

The study's main goal was to describe the specificity of prospective memory functioning and its relationship with self-assessment of mood among persons who suffer from chronic respiratory diseases. Beck Depression Inventory and some memory tests were used. I examined 116 persons: patients suffering from Chronic Obstructive Pulmonary Disease (COPD), bronchial asthma, and allergic rhinitis, as well as healthy individuals. The results confirmed widespread mood disorders among participants with chronic respiratory conditions, which in turn disrupt one's cognitive functioning, prospective memory in particular. The potential overlap of depressive disorders with early symptoms of dementia was also pointed out.

Keywords: Drugs, Dementia, Chronic obstructive pulmonary disease; Memory; Mood; Central nervous system; Chronic respiratory conditions

Introduction

Prospective Memory (PM) is a group of processes and abilities thanks to which an individual is able to formulate purposes and intentions, to store them and implement them when the conditions are right. PM is a unique cognitive process, whose organization is highly specialized and influences everyday life situations. Thus it allows one to lead a satisfying life and is of fundamental importance to gaining self-reliance in one's behaviors. Prospective memory deficits hamper coping independently with everyday problems, either because one forgets about an important task, or indirectly by reducing the ability to strategically adapt to the dysfunction [1].

Making full use of PM requires understanding the current situation, predicting how it will evolve and interpreting relevant data. It is not only about recalling some information from the past, but also using it to perform a planned action. To use prospective memory means to be proactive, rather than only reactive in one's behaviors. There are two components that work together to make up prospective memory: the prospective aspect (implementing the intention) and the retrospective aspect (retrieving the intention). They directly reflect the specificities of PM disorders, which include, for example, difficulties in identifying a significant prospective memory cue, realizing what it stands for, or recalling the content of the intention. Prospective memory can be divided into two types, based on different kinds of memory cues: event based and time based. Event based prospective memory describes remembering to implement an action when a specific event takes place (e.g. go to the drugstore on your way home). Time based prospective memory describes remembering to perform an action at a specified time in the future (e.g. take your medicine at 8 a.m.) or after a specified time interval (e.g. repeat the test after 30 minutes). Due to these functions, the ability to use prospective memory becomes especially important in challenging situations, such as when one suffers from chronic illness [2].

The Commission on Chronic Illness defines chronic somatic conditions as "all impairments or deviations from normal which have one or more of the following characteristics: are permanent, leave residual disability, are caused by non-reversible pathological alteration, require special training of the patient for rehabilitation, and may be expected to require a long period of supervision, observation, or care".

This kind of disorders most often means heart and vascular diseases (e.g. coronary disease), respiratory conditions (e.g. bronchial asthma, Chronic Obstructive Pulmonary Disease (COPD)), cancers, and neuropathies [3].

Medical statistics reveal that the incidence of chronic diseases is growing rapidly across all age groups. So far, a methodical epidemiological research has not been conducted in Poland, however, it is estimated that these conditions affect 12%-20% of young population, and the incidence among adults depends on the type of disease (e.g. the frequency distribution of bronchial asthma is 6%-10%). In the latest reports it was suggested that about two million Polish adults suffer from COPD and about one and a half million from bronchial asthma-400 000 and 75 000 patients respectively are in advanced stages of their diseases. Moreover, these conditions currently cause about 45% of deaths worldwide including about 18% resulting from pulmonological diseases (such as COPD).

In order to function properly, an organism needs a constant supply of oxygen. Blood oxygen saturation not only influences human intellectual abilities, but is crucial to an organism's survival, as "physiological (not compensated) hypoxia is a pathological state which leads to an organism's death, irrespective of its direct cause". Limitations in oxygen transport to the brain result in brain atrophy. The process may then lead to degeneration of brain regions that are responsible for prospective memory functioning. How PM operates is also affected by somatic illnesses which directly or indirectly influence Central Nervous System (CNS) [4].

There is nothing surprising about the fact that bronchial asthma or COPD should co-occur with mental disturbances amongst adult patients. This co-occurrence increases mortality rates in both groups of patients, as depression may intensify severe (fatal) asthma attacks. Furthermore, low mood affects how asthmatic patients perceive their health status and illness, and how they understand health related and therapeutic behaviors. Persons suffering from depression do not follow medical recommendations, they forget to buy or take medicines, and their ratings of both physical and mental functions are worse. When depression symptoms coexist with a respiratory condition, patients score lower on cognitive tests.

The Goldberg's gradiental approach to cortical structures holds that the center of emotional control resides in the brain's frontal lobes, especially in the prefrontal cortex, and is laterally specialized. Focal left brain damage is associated with low mood, and the strength of this link depends on how far the injury is located from the left frontal lobe. Lesions to dorsal side regions of this lobe and to basal nuclei are often found to accompany depression. As Goldberg notices, frontal lobe injury may sometimes result in dementia masquerading as pseudo depression, or depression masquerading as pseudodementia. When this happens, relatively early symptoms of dementia (inability to make decisions regarding oneself, inability to make plans, excessive hesitation and dependence on others usually one's family) are confused with manifestations of low mood. Differentiating between dementia and depression still presents diagnostic problems, particularly when early signs of cognitive impairments result from injuries to the prefrontal cortex, as described above. Radziwiłłowicz remarks that global cognitive functioning among patients with diagnosed depression is similar to that of healthy persons any declines in memory efficiency may share characteristic features with or turn into dementia. In view of my own research one may expect that among patients with respiratory conditions depressive disorders and early symptoms of dementia do overlap [5].

The study's main goal was to describe the specificity of prospective memory functioning and its relationship with self-assessment of mood among persons who suffer from chronic respiratory diseases. This study was prompted by the results of other papers, some of which suggested that respiratory diseases significantly affect one's cognitive abilities. So far, little is known about the nature of memory deficits in patients from this group. My analyses focused on examining hypothetical links between respiratory, depressive and amnesiac symptoms. The reason for it was twofold: low mood is commonly found among patients suffering from severe respiratory conditions; also, depression has often been reported to influence an individual's memory efficiency [6].

Methods

The study was carried out in clinics, health care centers and allergy wards in the Pomeranian voivodeship, Poland. Prior to commencing the study, I obtained the approval issued by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk (no. 3/2010). The subjects gave their written consent to participate in neuropsychological testing, and each examination took 70-90 minutes on average. The patients were selected on the basis of information provided by their clinical history, medical documentation and spirometry results. The spirometry was performed on the day of the examination. Excluded were individuals with neurological disorders and mental disturbances diagnosed earlier than the pulmonological condition. Eventually I examined 116 patients who met the inclusion criteria; they were categorized into four clinical groups: two groups of patients with upper respiratory tract diseases and two control groups [7].

The participants' mean age was 52.4 years (SD=6.41), on average they completed 11.08 years' worth of education (SD=3.05). As far as these two variables are concerned: education levels ($F(3,112)=2.15$; $p=0.1$) and age ($F(3,112)=0.96$; $p=0.41$), no statistically significant intergroup differences were found. Only right handers were included in the study. The fact that participants were predominantly male was due to the specificity of COPD it affects men most often, consequently it is men who seek help in specialist clinics and health centers. Differences in sex ratios between all the groups were statistically insignificant ($\chi 2$ (3, $n=116)=1.08$; $p=0.78$).

Experimental Group 1 (Exp1) was made up of 32 individ-

uals with severe COPD (According to the GOLD classification, COPD is severe when FEV1/FVC<30% normal, or FEV1/FVC<50% normal combined with respiratory failure or with clinical symptoms of right sided heart failure) (average FEV1/FVC=35.81%, SD=7.72). The average duration of COPD was 8.19 years since the first symptoms began (SD=6.32). This disease rarely occurs alone, and the following are comorbidities of respiratory conditions in the examined groups (number of patients given in brackets): peptic ulcer (6), renal failure (3), kidney stones (3), atherosclerosis (3), endocarditis (2), atrial fibrillation (2), low blood pressure (2), varicose veins (4), type 2 diabetes (3), cholecystitis (3), appendicitis (3), and prostatic hypertrophy (4). Apart from that, 14 patients reported incidents of losing consciousness, probably as a result of dyspnea and/or hypoxia.

The second experimental group (Exp2) was made up of 30 persons suffering from atopic bronchial asthma. The average duration of illness was 13.47 years (SD=5.57) since the first symptoms started. At the moment of examination, the patients manifested upper respiratory tract disabilities. Excluded from the study were individuals whose medical records indicated a possibility of the overlap syndrome between bronchial asthma and chronic obstructive pulmonary disease [8].

The first control group (Ko1) was composed of 27 patients with chronic (all year round) symptoms of allergic rhinitis of moderate intensity. At the moment of examination, the patients manifested disease symptoms that impaired the functioning of the upper respiratory tract. The average duration of illness was 8.67 years (SD=5.47) since the first symptoms started. Most often diagnosed allergy types were moderate or severe allergic reactions to: house dust mites (20 patients), grass pollen (15), dander and fur of domestic animals (13), and mildew (11). Patients whose medical records reported symptoms of bronchial asthma or other somatic illnesses were excluded from the test. The second control group (Ko2) was made up of 27 healthy persons.

Prior to the examination proper, I asked each participant to recount his or her medical case history, and to assess the intensity of dyspnea he or she experienced. Then, tests were administered in a preset order: a task modelled on the method of clinical trials and following the clinical experimental approach by Kurt Goldstein (the Cambridge Prospective Memory Test; CAMPROMPT), Beck Depression Inventory, the Information WAIS-R subtest, and the Prospective Retrospective Memory Questionnaire (PRMQ).

Despite a wide array of memory tests that have been adapted to Polish conditions, a standardized method to examine one's prospective memory was still missing. To address this issue, I analyzed the literature on the subject, searching for a relevant tool, which could be easily adapted to Polish conditions. The features I was looking for were: simple method construction, short time of administration, and ecological validity. Whether the test was computer based was an additional exclusion criterion for some patients, especially the older ones, this could prove to be an insurmountable obstacle [9].

Following the above mentioned criteria, two relatively simple tests were chosen. They measured self-evaluation of PM (the PRMQ questionnaire) or objective PM functioning (the CAMPROMPT test, which I used to construct the clinical trial). The items in both tools refer to common everyday tasks and actions, which made it easier to adapt them to Polish conditions. The translation and adaptation process was conducted between February 2009 and April 2010.

The Prospective Retrospective Memory Questionnaire is a tool to measure an individual's self-assessment of both prospective and retrospective memory functioning. The tool consists of 16 items which cover small memory errors, ones that from time to time we all experience in everyday life situations. On a 5 point Likert scale, a subject is requested to assess how often such errors happen in his or her life. The higher the result, the lower the self-assessment of one's prospective memory, and the point range for the entire scale is from 16 to 80.

Because the test had no Polish standardization, a preliminary experimental adaptation was made for the purpose of this research. Eventually, I obtained a questionnaire that met general conditions for cultural adaptation, as outlined by Kądzielawa who defines them as "adapting the test to a given population's culture in such a way as to accomplish the purpose the test is supposed to serve; it retains formal characteristics of the test's structure, administration procedure, evaluation criteria, and interpretation of results; at the same time it takes into account the financial, social, normative, notional, and linguistic realities that are in the contents of the test."

In order to evaluate one's prospective memory, a clinical quasi experiment was set up, following the rules of the clinical experimental approach. It was based on the Cambridge Prospective Memory Test. CAMPROMPT is a standardized method for examining both aspects of prospective memory, and it joins environmental and laboratory approaches. During a 25 minute long test, a participant is asked to solve various puzzles, while at the same time he or she needs to remember to perform a few other tasks. The puzzles are intended only to distract the participant from the true memory test which is checking whether the participant performs six tasks he or she was supposed to remember to execute at the right moment or following a situational cue (as determined by the instructions). The participant's behavior is rated on a 6 factor scale. Verbal prompts are given if the participants fail to do a task correctly or do not respond at all [10].

If all the tasks are completed correctly and no prompts were needed, the participant receives the maximum number of points, namely 36. In my research, I compared the CAMPROMPT scores of the experimental group with the control group results, taking into account the estimated premorbid intelligence levels, calculated on the basis of the Information WAIS-R subtest.

Results

Mean scores obtained from self-assessment of severity of depression symptoms (among COPD patients with asthma and persons from the control groups) were compared ANOVA in conjunction with the post hoc Tukey's test was used. Data in this study reveal that the COPD patients with bronchial asthma scored higher than the control groups members ($F(3,112)=15.93$; $p<0.001$). Therefore, mood disorders are a relatively common problem among COPD patients.

Next, to clarify the epidemiology of mood disorders in the examined groups, the BDI scores were dichotomized. The results were converted into standard scores (z values), so the recalculated value indicated how much above or below the mean each observation was. The test was considered to be completed incorrectly when the result was at least 1.5 standard unit (z) lower than the results of the Ko2 group (healthy individuals). The procedure described and then repeated.

I adopted the following disorder criterion:

$z<1.5$: no mood disorders;

$z \geq 1.5$: mood disorders present;

Nearly 57% of patients from the Exp2 group displayed symptoms of mood disorders. On the other hand, 75% of patients within the Exp1 group manifested psychopathological symptoms.

The next stage of my analysis was a two way ANOVA in a 2 (clinical group: Exp1, Exp2) x 2 (the BDI score: no mood disorders, mood disorder present) design. In it, the dependent variables were different measure of prospective memory: the result obtained in the quasi experiment based on the CAMPROMPT test, the time and event based CAMPROMT subtests, self-evaluation of one's PM functioning (the overall PRMQ result), and the reproduction of the Rey-Osterrieth complex figure. The analysis was carried out separately for every test. The results of intergroup comparisons, together with statistical values and levels of significance for the differences between mean scores obtained in various PM tasks.

ANOVA performed on the CAMPROMPT test results revealed the effect main of the group ($F(1,58)=5.44$; $p<0.05$; $eta2=0.09$) and the main effect of mood ($F(1,58)=19.87$; $p<0.001$; $eta2=0.25$). The interaction model turned out not to be statistically significant. The profile of results indicated that persons with no depression scored higher on the CAMPROMPT test than the low mood individuals. Moreover, participants from Exp2 earned higher CAMPROMPT results than persons from the Exp1 group.

ANOVA performed on the time based score of the CAMPROMPT test revealed the main effect of the group ($F(1,58)=14.98$; $p<0.001$; $eta2=0.21$) and the main effect of mood disorders ($F(1,58)=28.33$; $p<0.001$; $eta2=0.33$). No interaction between group and depression was found here, either. Participants with no mood disorders scored higher on the time based CAMPROMPT subtest than people experiencing these disorders. Furthermore, the results of people with bronchial asthma were better than those earned by COPD patients.

On the other hand, for the event based CAMPROMPT tasks only the main effect of mood disorders was found ($F(1,58)=8.00$; $p<0.01$; $eta2=0.12$), i.e. people with no mood disorders scored higher than individuals with depression symptoms.

Next, a two way analysis of variance was performed on the data gathered in the Prospective Retrospective Memory Questionnaire: its prospective aspect, retrospective aspect, and total score. I found no statistically significant main effects of the group ($F(1,58)=1.44$; $p=0.23$) or of mood disorders ($F(1,58)=0.13$; $p=0.72$), and no interaction effect ($F(1,58)=2.15$; $p=0.15$) (Table 1).

Table 1: Selected demographic parameters of the participants and standard deviations

Disease condition	No.of Patients (n=116)	Average duration of illness	SD
Severe COPD	32	8.19 years	6.32
Atopic Bronchial Asthma	30	13.47 years	5.57
Control group-1 (Ko1)	27	8.67 years	5.47
Control group-2 (Ko2)	27	NA	NA

Discussion

In the light of the collected data, mood disorders appear to be a relatively common symptom among participants who suffer from respiratory failure (75% of COPD patients and 56.67% of those with asthma). According to various reports the incidence of depression in COPD patients varies from 10% to 79%, and its symptoms are most common in older patients, who were also diagnosed with cognitive impairments or dementia. When compared the results of low mood COPD patients with the results of individuals without these symptoms, it was clear that prospective memory tasks are completed worse and non-verbal long term memory functions worse in the first group. It can be argued that depression co-occurring with severe respiratory failure disrupts one's cognitive functioning, particularly prospective memory.

Earlier findings are not unambiguous. Some researchers claim that cognitive functioning in depression is characterized by processing information more slowly, and that this is particularly visible in memory tasks, including those that require prospective memory. According to other studies, disorders of attention and non-verbal long term memory affect how an individual evaluates his or her mood, and the measures of these types of memory most accurately reflect

the overall performance of one's cognitive processes in depression. Still others argue that mood disorders affect only the retrospective aspect of PM (one that refers to the content of the intention), the episodic memory (Tulving argues that both prospective and retrospective memory can be treated as kinds of episodic memory), the time based prospective memory, or only self-assessment of one's prospective memory. What is more, when disorders affect executive functions, processing speed or memory, then mood explains only 1%-2% of variance. In my own study, I found that patients with depression and chronic respiratory failure manifested non-verbal long term memory disorders, which partly confirms the assumption about deficits in the retrospective aspect of PM.

When compared to low mood individuals, participants with no depression symptoms fare better in PM tasks. This regularity became apparent in time based and event based tasks alike. Mood disorders explain a higher percentage of variance of the dependent variable for time based tasks (33%) rather than event based tasks (12%). Some surveys show an extremely strong negative effect of depression on memory in these situations a patient is unable to monitor the process of performing a time based PM task on the fly, not even to complete the instruction. However, fulfilling a PM task also depends on motivational factors, which can facilitate the performance. In my study, I observed differences in following the time based instructions for PM tasks between depressed and non-depressed participants: These differences are probably connected with the fact that individuals with no mood disorders more often monitor the passing of time. Such persons not only better remember about the task at hand, but also actively seek environmental cues and respond to them at the right time. Other studies showed that depressed patients have difficulties in solving problems in such a way that requires them to follow a previously established plan of action.

Albiński et al. arrived at different conclusions: They demonstrated that depression had a positive impact on the time based PM. They explained it with the analytical rumination hypothesis. Additionally, the authors did not confirm the relationship between depression and self-evaluation of one's memory. Wieczorek and colleagues (1996), on the other hand, suggested this link arguing that low mood individuals are very sensitive to even the slightest manifestations of cognitive impairments. Other papers were also published, however, and they denied the claim that mood disorders may lead to a risk of developing cognitive deficits nonetheless, in clinical practice measuring depression will always be a valuable source of information about the patient's behavior.

While it is true that depressive disorders do not explain the functioning of PM in persons with chronic respiratory condition in its entire complexity, the results I obtained in my study at least allow me to argue that there is a mutual spillover between mood disorders and prospective memory impairments in patients suffering from these conditions. Participants whose severe respiratory failure co-occurred with depression implemented fewer intentions than healthy individuals, and they tended to overestimate their memory abilities. In explaining why this is the case we should mention: insufficient perceptual sensitivity to prospective cues (which is probably connected with failing to seek them), only occasional use of auxiliary strategies, and significant difficulties with remembering the contents of the plans. Negative consequences of prospective memory deficits include not following medical advice (e.g. taking medicines irregularly) for individuals whose respiratory condition co-occurs with depression this is not only highly likely to happen, but also may bring about tragic results.

Conclusion

A significant conclusion from my study is confirming that mood disorders are widespread among patients with chronic respiratory conditions, which is disruptive to one's cognitive functioning, prospective memory in particular. The potential overlap of depressive disorders with early symptoms of dementia was also pointed out.

In the light of my own research, PM disorders appear to be an important clinical problem, and tackling it requires detailed neuropsychological diagnosis, as well as adapting the therapeutic process to the specificities of this group of patients. But the transfer of memory strategies is a necessary condition of restoring one's memory abilities.

The modern health paradigm holds that essential for people suffering from chronic diseases are their personal resources. Among other things, they affect one's motivation to protect and improve one's health condition, and once the disease sets in, they aid recovery processes. If the patients with respiratory failure received help in building their own personal resources, it would holistically improve their quality of life. In particular, this can be achieved by introducing ways of rehabilitating PM into remedial programs. One can also expect an adequately applied and competently performed prospective memory training to positively affect e.g. the regularity of drug intakes during pharmacotherapy this could contribute to an overall improvement of the patients' both physical and mental functioning.

Acknowledgment

None

Conflicts of Interest

No conflict of interest was declared.

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