Is Clinical Insight Associated with Working Memory Components in Schizophrenia and Schizoaffective Disorder?

Selim TÜMKAYA[1], Ezgi HANCI YENİGÜN[2], Osman Zülkif TOPAK[3], İbrahim ŞENDUR[4], Neşe ÖZTÜRK ATKAYA[5], Osman ÖZDEL[6]

SUMMARY

Objective: Previous studies suggest that the level of clinical insight in schizophrenia patients is related to working memory functions. However, these studies were not specifically concerned with the components of working memory and had not focused in detail on working memory functions. For this reason, the current study investigated the relationship between clinical insight and working memory components in patients with schizophrenia and schizoaffective disorder.

Method: The patient group was evaluated by using the Scale for Assessment of Negative Symptoms, the Scale for Assessment of Positive Symptoms, and the Scale to Assess Unawareness of Mental Disorder to measure clinical insight. Moreover, all participants underwent a "Situation Awareness" test in order to measure working memory functions. Based on published data, the first stage of this test was accepted to measure the "visual spatial sketchpad" component of working memory, and the second stage was accepted to measure the "episodic buffer" (bound information storage) component. The functions of these components were measured separately as top-down and bottom-up cognitive processes.

Results: The episodic buffer function (managed by the bottom-up cognitive process) was related with clinical insight. This relationship also continued after correcting for the effect of positive symptoms on insight. The patients performed worse than the controls in terms of visual spatial sketchpad function, which was managed by both top-down and bottom-up cognitive processes. The patients performed worse than the controls in terms of both top-down and bottom-up cognitive processes and visual spatial sketchpad function. Furthermore, the patients were also worse than the controls in terms of episodic buffer function (managed by top-down cognitive processes).

Conclusion: Clinical insight may be associated with binding function (associated with episodic buffer function) managed by bottom-up cognitive processes in patients with schizophrenia and schizoaffective disorder. Further studies are necessary to confirm this novel finding.

Keywords: Schizophrenia, clinical insight, working memory, episodic buffer, visual spatial sketchpad, binding function

INTRODUCTION

Schizophrenia is a chronic disease that causes significant loss of function and courses with positive, negative, and cognitive symptoms. Published data has shown that 50-80% of schizophrenic patients have decreased insight (Sartorius et al. 1972). Insight is defined as a patient's awareness of his/her own illness, symptoms of the illness, effects of the illness, and need for treatment (David 1990). Reduced insight is associated with treatment non-compliance as well as poorer outcome and functioning in schizophrenia (Buckley et al. 2007, Lincoln et al. 2007). For these reasons, it is important to elucidate the underlying mechanisms of reduced insight, which may lead to the development of new treatment methods that can be used to improve insight. Both positive and negative

Received: 30.07.2017 - **Accepted:** 14.02.2018

[1]Assoc Prof., [6]Prof., Pamukkale University, Department of Psychiatry, Denizli, [2]MD., Sultan Abdülhamid Han Hospital, Department of Psychiatry, İstanbul, [3]MD., Samandağ Government Hospital, Department of Psychiatry, Hatay, [4]MD., Denizli Government Hospital, Department of Psychiatry, Denizli, [5]MD., Çarşamba Government Hospital, Department of Psychiatry, Samsun, Turkey.

e-mail: *selimtumkaya@gmail.com*

https://doi.org/10.5080/u22878

symptoms as well as impaired cognitive function may be associated with reduced insight in schizophrenia (De Hert et al. 2009, Ritsner and Blumenkrantz 2007, Stefanopoulou et al. 2009). A meta-analysis by Nair et al. (2014) reported memory and executive function disorders to be associated with clinical insight in psychotic patients. Working memory can be defined as the temporary storage of information and the active use of information to manipulate behaviors. Although there have been conflicting published results (Upthegrove et al. 2002, Simon et al. 2009), studies have generally shown a relationship between the level of clinical insight and working memory functions in schizophrenia patients (Pegoraro et al. 2013, Sapara et al. 2014, Shad et al. 2007). However, these studies have typically focused on working memory functions, and have not been concerned with the individual components of working memory. According to Baddeley (2012), visual working memory consists of three parts, including the visual-spatial sketchpad, the episodic buffer, and the central executive. The visual-spatial sketchpad is responsible for temporarily storing visual or spatial information. The episodic buffer binds and actively stores information from the visual spatial sketchpad or long-term memory. A semantic representation may also be formed when the episodic buffer binds this information. The episodic buffer is also responsible for storing the properties of the visual objects (e.g., color, shape, location, etc.) in an active manner (i.e., bound to each other). This binding function increases the storage capacity of the episodic buffer, as it allows many features to be stored as a single representation. The central executive allows other working memory sections to communicate with each other and is responsible for concentrating or for distracting attention during a task. Recently, the episodic buffer has been defined as a separate entity from the other parts of the working memory. Although it had been previously reported that the episodic buffer is responsible for the active binding of information about the properties of objects (entirely under the management of the central executive), later studies have suggested that the episodic buffer is responsible for the storage of automatically-bound information (i.e., passive binding). The episodic buffer is important because it has the highest storage capacity and it transfers instantly-processed information to the long-term memory (Baddeley 2012).

One of the most important features that distinguishes the episodic buffer from the visual-spatial sketchpad is that the episodic buffer has the ability to store information in a bound manner. Luck and Vogel (Nature, 1997) first reported the binding properties of visual objects. Using colorful moving objects, they demonstrated that subjects having difficulty storing the single visual properties of more than 4 objects could store 16 pieces of information, such as color, size, difference, and the location of 4 objects, at the same time in their working memory. Moreover, when the subjects were asked about the above four characteristics of the objects all together, they had almost the same number of correct responses as they did when they were asked about a single feature of these objects. Based on these results, the authors reported that visual working memory capacity tests should focus on the measurement of bound visual properties rather than a separate single visual property. Currently, standardized tests are available that investigate verbal episodic memory; however, there is no standardized test for the investigation of visual episodic buffer function. To measure visual episodic buffer function, there are tests that typically question subjects about the binding features of still objects, such as color and shape, to each other (Nobre et al. 2013). However, the majority of objects in our daily and social lives are in motion, and therefore, there is a need for an accurate evaluation of many moving visual warnings, such as people's behaviors and facial expressions, in order to interpret events around us. One of the tests that measures one's ability to track objects is the "multiple-object tracking" test. The purpose of this test is to determine the final positions of moving objects over time (Pylyshyn and Storm 1988). During the test, a person constantly renews information about the position of many objects by dividing his/her attention. Another form of this test, which is called the "multiple identity tracking" test, asks the test-taker to identify the object in a specified location after watching the screen. This task requires storing bounded information of the identity and location of the objects. Therefore, it has been suggested that multiple object-tracking tasks are suitable for measuring the function of the visual spatial sketchpad, and multiple identity-tracking tasks are suitable for measuring the episodic buffer (Oksama and Hyona 2008). Kelemen et al. (2007) reported that the multiple object tracking test results of schizophrenia patients were worse than those of a control group, and that their performances were related to spatial working memory.

On the basis of the findings discussed above, the current study utilized a visual tracking test called the Situational Awareness Test (SAtest) to determine the relationship between clinical insight and working memory in schizophrenia patients. A visual working memory test was chosen to be used because it allowed the measurement of episodic buffer function, which involves binding properties. The SAtest was first used to test visual working memory in patients with obsessive-compulsive disorder, and these patients performed worse in the first two stages of the test than a group of normal controls (Tumkaya et al. 2013). A very recent study revealed that the SAtest performance of healthy subjects was associated with serotonin transporter gene polymorphisms, which are known to be associated with schizophrenia (González-Giraldo et al. 2017). The first stage of the SAtest has several similarities with multiple object tracking tests, and the second stage has several similarities with multiple identity tracking tests. In the first stage (SA1) of

the SAtest, the participants are asked to identify the locations of moving objects. In the second stage (SA2), participants are asked to identify the object that was previously displayed in a given location on the screen. Therefore, in the current study, we assumed that the SA1 measures visual spatial sketchpad function and that the SA2 measures episodic buffer function. Moreover, our SAtest can measure these functions (visual spatial sketchpad vs episodic buffer) separately as top-down and bottom-up cognitive processes. This enables measurement of both the active and passive binding function, especially in the SA2 (episodic buffer stage). Top-down cognitive processes are those processes that are used when a situation is simpler and more pronounced. In general, participants know where to direct their attention during top-down processes. However, bottom-up processes are used when a large number of stimuli need to be evaluated, and in cases when the cognitive task is unclear. During these bottom-up processes, the participant often does not know where to direct his/her attention, since the task is unclear. It has been hypothesized that bottom-up cognitive processes are used very actively in our complicated and mobile daily lives, which involve several visual objects (Perruchet et al. 1990).

Based on the above studies regarding the relationship between working memory and insight, the current study's hypothesis was that the SAtest performances of the schizophrenia/schizoaffective disorder patients would be associated with clinical insight. We believe that the results of this study will elucidate the relationship between clinical insight and working memory components in these patients. Importantly, the elucidation of the relationship between working memory components and insight may lead to novel treatment interventions.

METHODS

Participants

A total of 48 patients, 40 diagnosed with schizophrenia and 8 with schizoaffective disorder on the basis of DSM-5 criteria (American Psychiatric Association 2013) as they consecutively consulted Pamukkale University Psychiatric Hospital Psychotic Disorders Polyclinic, were included in this study. The control group consisted of 41 healthy individuals, generally chosen from hospital staff, their relatives, or neighbours, and matched with the patient group in terms of age, gender and education level. The exclusion criteria comprised being over the age of 60, mental retardation, significant neurological or medical illness, alcohol or drug use disorders, and/or vision loss. Prior to participation in the study, all participants were informed about the study and provided informed consent. This study was conducted in accordance with the Helsinki declaration and was approved by the Ethics Committee of Pamukkale University.

Measurement instruments

All clinical and demographic data were collected during a psychiatric interview conducted by an experienced psychiatrist. Diagnosis of schizophrenia, schizoaffective disorder, mental retardation, and alcohol or drug use disorder were made during this interview according to DSM-5 criteria (American Psychiatric Association 2013). Severity of negative and positive symptoms were assessed using the Scale for Assessment of Negative Symptoms and the Scale for Assessment of Positive Symptoms (Andreasen 1990, Erkoç et al. 1991a, Erkoç et al. 1991b). Both of these 6-point scales that have been used in comparative studies are scored by the interviewer. Higher scores indicate symptom severity. The Scale to Assess Unawareness of Mental Disorder was used to measure the patients' insight levels. This scale is a Likert scale that is filled-out by the clinician. The first 3 items of that scale question the patient's awareness of his/her illness, the treatment effects, and social outcomes of the illness on a 1 to 5 scale, and the scale's total score is obtained with sum of these scores (Amador et al. 1994, Bora et al. 2006).

After undergoing the psychiatric interviews and completing the scales, the participants were taken to a quiet room and given the SAtest, which was obtained from the Psychology Experiment Building Language (PEBL) test battery (Mueller 2010). The SAtest was performed on a computer with an LED monitor of 21.5 inches and 1920X1080 resolution.

The SAtest is a dynamic visual tracking test that was developed on the basis of the Situation Awareness Global Assessment Technique (Endsley et al. 2000) (Mueller et al. 2014, Tumkaya et al. 2013). Those taking the test are asked to observe the locations, identities, and movements of 5 constantly moving creatures. These creatures/targets are divided into 2 groups (e.g., insects and lizards). The insect group consists of an ant, a fly, and a spider, while the lizard group consists of 2 lizards (one turquoise and one yellow). The lizards follow an insect previously selected as a target by the computer program. The computer program determines a specific location as a destination for each insect. For each loop, the targets are directed at an angle 12.5° away from both sides of the destination, and the targets move at a speed of 100 pixels/second. If the lizard catches the target insect, the lizard "eats" the insect, and then tries to catch a new insect. During this simulated motion (ranging between 2500 and 4000 ms), all of the creatures disappear from the screen at certain time intervals, and questions designed to test one of the three stages of situation awareness are displayed on the screen. To test SA1, the participants are asked the locations of all targets, and to test SA2, the participants must identify which two targets were previously in two circled locations on the screen. The SA2 stage requires the use of both target localization and target identity. To test SA3, the participants are asked in what direction a specific target was going. The SAtest consists of four blocks, with the exception

of the practice section. In the practice section, the test is introduced by asking the participant sample questions about SA1, SA2, and SA3. The next 3 blocks consist of 15 simulations each, and related questions are asked for SA1, SA2, and SA3 in each respective block. In these 3 blocks, participants watch the simulations, already knowing which question they will have to answer following the simulations. The final block consists of 15 simulations taken from each of the previous 3 blocks in mixed order. As participants watch the simulations in the 4th block, they are unaware of the question to follow. Thus, the first 3 blocks are "goal-driven," as the subject's attention is directed to the target, while the last block is "data-driven," as it is driven by environmental cues. The 3 stages of the SAtest are also evaluated separately based on the accuracy and the time parameters of these two blocks, namely, 'goal-driven' and 'data-driven'. The lower the score (calculated via logarithms of the values related to accuracy) the higher the level of situation awareness indicated (Figure-1, https://www.youtube.com/watch?v=zfFRQqFTC-Q). The third stage of the SAtest (SA3) asks the participant to identify the direction in which the object on the screen is moving. This test was used in 3 stages in a previous study, although the authors of that study indicated that the third stage had no distinctive characteristics due to its excessive difficulty (Tumkaya et al. 2013). The third stage (SA3) is very distracting during bottom-up cognitive processes. We have chosen to utilize the SAtest in the current study because this test is a natural visual tracking test that can provide meaningful results, thereby facilitating the monitoring of the test (Mandzia et al. 2004, Staresina et al. 2009).

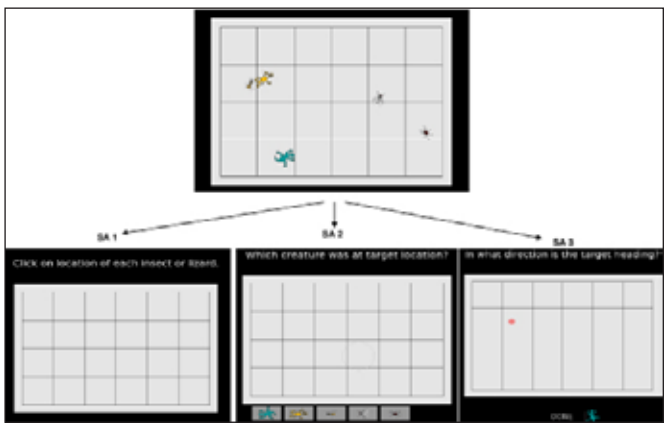

Figure 1. The PEBL Situation Awareness Task. Participants must track a dynamic simulation in which predators (lizards) track prey (insects). Every few seconds, the tracking is interrupted, and one of three probes is given, requiring participants to indicate (1) SA1, the locations of the tracked targets; (2) SA2, the identity of two tracked targets; and (3) SA3, the direction targets were moving in.

Data analysis

Statistical analysis was conducted using the SPSS-22 (The Statistical Package for Social Sciences) for Windows. The sociodemographic characteristics of the groups were compared using t-tests, and categorical variables (i.e., gender and marital status) were compared using the X2 test. The base 10 logarithms of situational awareness scores were used in all calculations. Situational awareness scores of the groups were compared using a MANOVA, controlling for age and education duration. Moreover, differences between the groups were calculated using Cohen's d test. Correlations between situational awareness scores and clinical assessment scale scores were assessed using partial correlation analysis, controlling for age and educatıon duration (due to their possible confounding effects).

RESULTS

Comparison of the groups with respect to sociodemographic characteristics is shown in Table 1. The patient and the control groups did not differ significantly in terms of age, gender, education level, and marital status. Mean disease duration

Table 1. Sociodemographic properties of the groups

	Controls (n=41)	Patients (n=48)	Test statistic	df	p
Age mean±sd (min-max)	34.95±8.87 (23-57)	37.95±10.10 (19-62)	t=1.479	87	0.268
Gender					
Woman n(%)	20 (48.8)	20 (41.7)	χ^2=0.452	1	0.501
Male n(%)	21 (51.2)	28 (58.3)			
Marital status					
Married n(%)	25 (61)	23 (47.9)	χ^2=1.518	1	0.218
Single n(%)	16 (39)	25 (52.1)			
Duration of education mean±sd (min-max)	10.80±4.24 (5-17)	10.44±3.76 (5-16)	t=-0.432	87	0.666

The data shown as mean±standard deviation (sd), minimum-maximum (min-max) or number of cases (%).

Table 2. The medications patients used and their mean doses

	n
Antipsychotics	
One antipsychotics	16
Two antipsychotics	18
Three antipsychotics	13
Four antipsychotics	1
Antidepressant	10
Valproic acid	4
Lithium	1
Medications	**Mean dose**
Olanzapine	15.38 mg/day
Risperidone	3.5 mg/ day
Paliperidone	9 mg/ day
Amisulpiride	627.27 mg/ day
Qetiapine	336.66 mg/ day
Aripiprazole	10.29 mg/ day
Clozapine	250 mg/ day
Zuclopenthixol depot	200 mg/2 week
Flupenthixol depot	20 mg/2 week
Haloperidol depot	90 mg/month
Paliperidone depot	91.55 mg/month
Risperidone depot	41.66 mg/ 2 week

in the patient group was 11.27 (± 7.49; 1-30) years. All of the patients included in this study were taking medication which, together with the mean doses, are shown in Table 2. The clinical evaluation scores of the patient group and a comparison between the SAtest scores of the patient and control groups are presented in Table 3. Our data indicate that the SA1 scores of the patients (managed by both top-down and bottom-up cognitive processes) were significantly worse than those of the controls. Likewise, the SA2 scores of the patients (managed by top-down cognitive process) were also significantly worse than those of the controls. On the other hand, there was no significant difference between the patient and control groups in terms of SA2 scores managed by a bottom-up process ($p>0.05$). However, Cohen's d revealed a small effect ($d=0.2-0.5$) between the SA2 scores of the patients and controls (managed by bottom-up process). There was no significant difference between the results of the patients and the controls at the SA3 stage.

In the patient group, mean duration of disease did not correlate with insight and the SAtest scores ($p>0.05$). However, there was a correlation between age and SA1 scores ($r=0.341$, $p=0.018$) and between education duration and SA3 scores ($r=-0.308$, $p=0.033$). There was no relationship between SA2 and age or education duration ($p<0.05$). The results of the correlation analyses in the patient group are presented in Table 4. According to these analyses, both the SA2 stimulus driven performance (controlling for the effects of age and education level) and severity of positive symptoms were correlated with insight. In addition, we found that insight had a relationship with SA2 stage scores (managed by bottom-up process) independent of positive symptoms. This was true when we considered the effect of insight while controlling for positive symptoms, and then considering the effect of positive symptoms while controlling insight ($r=0.476$, $p=0.001$). When considering insight as a covariate, there was no relationship between the severity of positive symptoms and the SA2 stage performance ($r=-0.098$, $p=0.511$). In the control group, age and duration of education correlated with SA1 (managed by both top-down and bottom-up processes) and with SA2 and SA3 (both managed by top-down processes) ($p=0.002-0.045$, $r=0.667-0.315$, respectively).

Table 3. Scores of clinical evaluation scales and SAtest-accuracy of the groups

		Controls (n=41) Mean±SD	Patients (n=48) Mean±SD (Range)	F	p	Cohen's d
	SANS	-	28.16±19.23(3-75)	-	-	
	SAPS	-	10.06±10.51(1-44)	-	-	
	SUMD	-	4.54±2.33(3-12)	-	-	
	SAtest					
SA1-Visuospatial sketchpad	Top-down process	-0.307±.0109	-0.218±0.158	7.35	0.008	0.655
	Bottom-up process	-0.232±0.086	-0.150±0.081	18.53	0.000	0.981
SA2-Episodic buffer	Top-down process	-0.168±0.068	-0.129±0.058	6.35	0.014	0.617
	Bottom-up process	-0.145±0.064	-0.128±0.058	1.62	0.206	0.278
SA3	Top-down process	1.816±2.02	1.851±2.05	1.33	0.251	0.017
	Bottom-up process	1.830±1.97	1.854±2.07	1.18	0.280	0.011

Degree of freedom (Df)=1, SAtest: Situation Awareness Test, SANS: The Scale for Assessment of Negative Symptoms, SAPS: The Scale for Assessment of Positive Symptoms, SUMD: The Scale to Assess Unawareness of Mental Disorder

Table 4. The correlations in between the scores of SAtest-accuracy and clinical evaluation scale

		SANS		SAPS		SUMD	
		r	p	r	p	r	p
	Age	-	-	-	-	0.038	0.798
	Education	-	-	-	-	0.197	0.179
	SANS	-	-	-	-	0.150	0.308
	SAPS	-	-	-	-	0.292	0.044
	SAtest*						
SA1-Visuospatial sketchpad	Top-down process	0.112	0.459	0.028	0.853	0.174	0.248
	Bottom-up process	-0.096	0.524	-0.139	0.355	0.236	0.115
SA2-Episodic buffer	Top-down process	0.116	0.445	0.061	0.687	0.098	0.519
	Bottom-up process	0.208	0.166	0.061	0.687	0.475	0.001
SA3	Top-down process	-0.020	0.895	0.163	0.280	0.197	0.189
	Bottom-up process	0.030	0.846	-0.034	0.821	0.114	0.451

*:The correlations assesed using to partial correlation analyses, controlling for age and duration of education. SAtest: Situation Awareness Test, SANS: The Scale for Assessment of Negative Symptoms, SAPS: The Scale for Assessment of Positive Symptoms, SUMD: The Scale to Assess Unawareness of Mental Disorder

DISCUSSION

The results of the current study suggest that the clinical insights of patients with schizophrenia and schizoaffective disorder may be associated with episodic buffer function, in which the properties of objects are stored by binding with a bottom-up process. Matussek (1987) argued that patients with schizophrenia process objects around them separately from their context without integration, and therefore, these patients cannot make enough sense of the events occurring in their environment. Although one study reported that there are some disorders related to episodic buffer-binding function in schizophrenic patients (Luck et al. 2010), to our knowledge, the current study is the first to investigate the relationship between insight and episodic buffer-binding. In our opinion, poor clinical insight in schizophrenia is associated with lack of storage, and these patients cannot compare their disease symptoms with previous experiences (long-term memory) using working memory. Therefore, schizophrenic patients cannot realize that their current symptoms are unusual experiences and symptoms of their disease (Cooke et al. 2005, Raffard et al. 2009). This point of view also suggests that episodic buffer function, which enables the connection between working memory and long-term memory, plays a role in the development of reduced insight in schizophrenia. However, we are curious as to why insight correlates only with binding function (mediated by bottom-up process), but not with top-down process. The results of the current study, specifically the presence of a relationship between insight and binding function with bottom-up cognitive process, may be explained by a model developed by Markova and Berrios (1995). According to the first stage of their model, uninterpreted raw experiences revealed by pathological brain signals are unconsciously compared with previous experiences. If there is an inconsistency in this first stage, the information becomes conscious, being managed by bottom-up processing. Then, following this stage, attention is focused on information, and this unusual/strange experience is thus subjected to conscious cognitive processing. In this way, this unusual experience can be perceived as a symptom of the disease. On the other hand, in cases where an unusual experience cannot be properly compared with past experiences, there will be no inconsistencies, and therefore, insight cannot be developed (Markova and Berrios 1995). Literature reveals that these bottom-up cognitive processes may be associated with reduced insight through distorted feelings known as "subjective experiences" and "self-disorders." These feelings, which are shown to be associated with reduced insight, are considered to emerge with bottom-up cognitive processes (Laroi et al. 2004, Henriksen and Parnas 2014, Uhlhaas and Mishara 2007). Considering these feelings, which are often thought to be permanent features of schizophrenia, as variables in further studies may provide a better explanation of the relationship between insight and the bottom-up cognitive processes used in visual integration (Parnas 2012, Nelson et al. 2008). These bottom-up cognitive processes have been found to be associated with abstraction, which has previously been reported to play an important role in development of insight (Drake and Lewis 2003) (Reber 1989, Chiu et al. 2005). Some authors believe that abstraction comes from the integration of visual findings (Hommel and Colzato 2009). Thus, the ability to perform abstraction might be an intermediate step in the development of insight. We believe that it may be useful to test this hypothesis in future studies. Finally, a few neurophysiological studies support the results of the current study. These studies have shown that early perceptual neurophysiological disorders (related to hearing in psychosis) may be associated with insight disorders (Pallanti et al. 1999, Sumich et al. 2006). However, to our knowledge, there has been no evidence, until the data presented here, to show that a relationship existed between early perceptual neurophysiological findings related to vision and insight. Future studies conducted

using neurophysiological measurements during the process of binding visual features of moving objects (without focusing directly on bottom-up attention) may help to elucidate the neurophysiological bases of insight.

With the exception of the current study, majority of the studies investigating cognitive functions in schizophrenia have concentrated on goal-driven top-down processing (Kietzman 1991, John and Hemsley 1992, Stratta et al. 1998, Stratta et al. 1999). Moreover, many studies have reported that disorders in cognitive abilities with a top-down mechanism are related to insight (Monteiro et al. 2008, Keshavan et al. 2004). However, a meta-analysis reported that the psychoeducational approaches used to develop insight might fail in schizophrenic patients, suggesting that strategies aiming to increase top-down learning fail to develop insight. The authors concluded that the use of bottom-up learning strategies may have positive effects on insight (Lincoln et al. 2007). Since the current study did not focus on traditional cognitive functions, the results presented should not be taken to indicate lack of relationship between traditional cognitive abilities and insight. Implementation of methods aiming to develop bottom-up cognitive processes and therefore to develop insight may also increase the effectiveness of other top-down psychoeducational interventions. Both the model of insight by Markova and Berrios (1995) described above and the idea that lower cognitive functions may affect higher cognitive functions (Javitt 2009) supports this suggestion. In the current study, there was no significant difference between the patients and controls in terms of SA2 scores associated with bottom-up cognitive processes or SA3 scores associated with both bottom-up and top-down cognitive processes. The observed lack of difference between the groups may be due to the extreme difficulty of this part of the test. The control group responded with a wrong answer 72% of the time in SA2 with a bottom-up process, and this rate rose to 80%, even if random responses were given in this test of 5 choices. Not observing a significant difference between the patient and control groups might be due to a floor effect. Also, the high mean angular deviation (69.6 degrees) of the controls in the SA3 suggests a floor effect. Therefore, the use of a 4-target version rather than a 5-target version of the SAtest may reduce workload and increase sensitivity in future studies. Poor performance of the schizophrenia patients at the SA1 stage in our current study as compared to the controls suggests that the patients have poor visual-spatial sketchpad functions. This finding was also emphasized by Kelemen et al. (2007) in a study which used multiple object tracking tests.

Recent studies on visual cognitive functions in schizophrenia have focused on magnocellular and parvocellular pathways in the brain. It is thought that the magnocellular pathway (where-pathway) provides a rough assessment of visual phenomena and is effective in determining the location of moving objects over time, while the parvocellular pathway (what-pathway) provides a more detailed assessment and is effective for determining the identity of the objects. The magnocellular pathway extends from the primary visual field to the parietal cortex, and the parvocellular pathway extends from the primary visual field to the temporal cortex. Previous studies conducted on schizophrenia patients have reported disorders in both pathways (Bennett et al. 2016, Butler and Javitt 2005). Likewise, our current findings suggest that insight may be associated with the cooperation of these two pathways. Indeed, studies investigating the brain structures that may be associated with clinical insight in schizophrenia have shown that insight disorder is associated with a more general disorder involving the parietal and temporal regions, rather than with a single brain structure (Xavier and Vorderstrasse 2016).

One limitation of the current study was that we did not perform an intelligence level measurement which has been reported to be associated with insight in previous studies (Nair et al. 2014). However, we believe that this limitation did not affect our results, because not only did the study exclude individuals with clinical mental retardation but also the statistical analyses were controlled for education level. Another limitation of this study is that all of the patients were taking medication. This may be important, as it is known that medications may have mild effects on cognitive functions (Schreiber and Newman-Tancredi 2014). Finally, the results are based on a low number of participants. For these reasons, our findings need to be confirmed using larger sample groups of patients who are not taking medication.

In conclusion, results of this study, which need to be supported by future studies, suggest that the insight of patients with schizophrenia and schizoaffective disorder may be associated with binding function that is mediated by episodic buffer bottom-up cognitive processes.

REFERENCES

Amador XF, Flaum M, Andreasen NC (1994) Awareness of illness in schizophrenia and schizoaffective and mood disorders. Arch Gen Psychiatry 51: 826-36.

American Psychiatric Association (2013) Diagnostic and Statistical Manual of Mental Disorders -5th ed. American Psychiatric Publishing, Washington DC.

Andreasen NC (1990) Methods for assessing positive and negative symptoms. Mod Probl Pharmacopsychiatry 24: 73-88.

Baddeley A (2012) Working memory: theories, models, and controversies. Annu Rev Psychol 63: 1-29.

Bennett D, Dluzniak A, Cropper SJ et al (2016) Selective impairment of global motion integration, but not global form detection, in schizophrenia and bipolar affective disorder. Schizophr Res 3: 11-4.

Bora E, Özdemir F, Özaşkınlı S (2006) Akıl hastalığına içgörüsüzlük ölçeğinin kısaltılmış Türkçe formunun geçerlilik ve güvenilirliği. Türkiyede Psikiyatri 8: 74-80.

Buckley PF, Wirshing DA, Bhushan P et al (2007) Lack of insight in schizophrenia: impact on treatment adherence. CNS Drugs 21: 129-41.

Butler PD, Javitt DC (2005) Early-stage visual processing deficits in schizophrenia. Curr Opin Psychiatry 18: 151-7.

Chiu MJ, Liu K, Hsieh MH et al (2005) Dual-modality impairment of implicit

learning of letter-strings versus color-patterns in patients with schizophrenia. Behav Brain Funct 1: 23.

Cooke MA, Peters ER, Kuipers E et al (2005) Disease, deficit or denial? Models of poor insight in psychosis. Acta Psychiatr Scand 112: 4-17.

David AS (1990) Insight and psychosis. Br J Psychiatry. 156: 798-808.

De Hert MA, Simon V, Vidovic D et al (2009) Evaluation of the association between insight and symptoms in a large sample of patients with schizophrenia. Eur Psychiatry 24: 507-12.

Drake R, Lewis S (2003) Insight and neurocognition in schizophrenia. Schizophr Res 62: 165-73.

Endsley MR, Garland DJ (2000) Situation Awareness Analysis and Measurement. Lawrence Erlbaum Associates, Mahwah, NJ.

Erkoç Ş, Arkonaç O, Ataklı C et al (1991) Negatif semptomları değerlendirme ölçeğinin güvenilirliği ve geçerliliği. Düşünen Adam 4: 16-9.

Erkoç Ş, Arkonaç O, Ataklı C et al (1991) Pozitif semptomları değerlendirme ölçeğinin güvenilirliği ve geçerliliği. Düşünen Adam 4: 20-4.

González-Giraldo Y, González-Reyes RE, Mueller ST, Piper BJ, Adan A, Forero DA (2017) Situation Awareness Performance in Healthy Young Adults Is Associated With a Serotonin Transporter Gene Polymorphism. Psychol Rep.

Henriksen MG, Parnas J (2014) Self-disorders and schizophrenia: a phenomenological reappraisal of poor insight and noncompliance. Schizophr Bull 40: 542-7.

Hommel B, Colzato LS (2009) When an object is more than a binding of its features: Evidence for two mechanisms of visual feature integration. Vis Cogn 17: 120-40.

Javitt DC (2009) When doors of perception close: bottom-up models of disrupted cognition in schizophrenia. Annu Rev Clin Psychol 5: 249-75.

John CH, Hemsley DR (1992) Gestalt perception in schizophrenia. Eur. Arch. Psychiatry Clin. Neurosci 241: 215-21.

Kelemen O, Nagy O, Matyassy A et al (2007) How well do patients with schizophrenia track multiple moving targets? Neuropsychol 21: 319.

Keshavan MS, Rabinowitz J, DeSmedt G et al (2004) Correlates of insight in first episode psychosis. Schizophr Res 70: 187-94.

Kietzman ML (1991) Information processing and schizophrenia. In: Steinhauer SR, Gruzelier JH, Zubin J et al Handbook of Schizophrenia vol. 5: Neuropsychology, Psychophysiology and Information Processing. Elsevier, Amsterdam s. 227-39.

Laroi F, Barr WB, Keefe RSE (2004) The neuropsychology of insight in psychiatric and neurological disorders. In: Amador X, David A, editors. Insight and Psychosis; Awareness of Illness in Schizophrenia and Related Disorders. Oxford, Oxford University Press.

Lincoln TM, Lüllmann E, Rief W (2007) Correlates and long-term consequences of poor insight in patients with schizophrenia. A systematic review. Schizophr Bull 33: 1324-42.

Lincoln TM, Wilhelm K, Nestoriuc Y (2007) Effectiveness of psych-oeducation for relapse, symptoms, knowledge, adherence and functioning in psychotic disorders: a meta-analysis. Schizophr Res 96: 232-45.

Luck SJ, Vogel EK (1997) The capacity of visual working memory for features and conjunctions. Nature, 390: 279-81.

Luck D, Danion JM, Marrer C et al (2010) Abnormal medial temporal activity for bound information during working memory maintenance in patients with schizophrenia. Hippocampus 20: 936-48.

Mandzia JL, Black SE, McAndrews MP et al (2004) fMRI differences in encoding and retrieval of pictures due to encoding strategy in the elderly. Hum Brain Mapp 21: 1-14.

Markova IS, Berrios GE (1995) Insight in Clinical Psychiatry: A New Model. J Nerv Ment Dis 183: 743-51.

Matussek P (1987) Studies in delusional perception. Translated and condensed In Cutting J, Sheppard M. Clinical Roots of the Schizophrenia Concept. Translations of Seminal European Contributions on Schizophrenia. Cambridge, UK: Cambridge University Press. s. 87-103.

Monteiro LC, Silva VA, Louza MR (2008). Insight, cognitive dysfunction and symptomatology in schizophrenia. Eur Arch Psychiatry Clin Neurosci 258: 402-5.

Mueller ST (2010) A partial implementation of the BICA cognitive decathlon using the Psychology Experiment Building Language (PEBL). İnt J Mach Conscious 2: 2273-88.

Mueller ST, Piper BJ (2014) The psychology experiment building language (PEBL) and PEBL test battery. J Neurosci Methods 222: 250-9.

Nair A, Palmer EC, Aleman A et al (2014). Relationship between cognition, clinical and cognitive insight in psychotic disorders: a review and meta-analysis. Schizophr Res 152: 191-200.

Nelson B, Yung AR, Bechdolf A et al (2008) The phenomenological critique and self-disturbance: implications for ultra-high risk ("prodrome") research. Schizophr Bull 34: 381-92.

Nobre ADP, Rodrigues JDC, Sbicigo JB et al (2013) Tasks for assessment of the episodic buffer: A systematic review. Psychol Neurosci 6: 331.

Oksama L, Hyönä J (2008) Dynamic binding of identity and location information: A serial model of multiple identity tracking. Cogn Psychol 56: 237-83.

Pallanti S, Quercioli L, Pazzagli A (1999) Effects of clozapine on awareness of illness and cognition in schizophrenia. Psychiatry Res 1999 86: 239-49.

Parnas J (2012) The core Gestalt of schizophrenia. World Psychiatry 11: 67-9.

Pegoraro LF, Dantas CR, Banzato CE et al (2013) Correlation between insight dimensions and cognitive functions in patients with deficit and nondeficit schizophrenia. Schizophr Res 147: 91-4.

Perruchet P, Gallego J, Savy I (1990) A critical reappraisal of the evidence for unconscious abstraction of deterministic rules in complex experimental situations. Cogn Psychol 22: 493-516.

Pylyshyn ZW, Storm RW (1988) Tracking multiple independent targets: Evidence for a parallel tracking mechanism. Spat Vis 3: 179-97.

Raffard S, Bayard S, Gely-Nargeot MC et al (2009) Insight and executive functioning in schizophrenia: a multidimensional approach. Psychiatry Res 167: 239-50.

Reber AS (1989). Implicit learning and tacit knowledge. J Exp Psychol 118: 219.

Ritsner MS, Blumenkrantz H. (2007) Predicting domain-specific insight of schizophrenia patients from symptomatology, multiple neurocognitive functions, and personality related traits. Psychiatry Res 149: 59-69.

Sapara A, Birchwood M, Cooke MA et al (2014) Preservation and compensation: the functional neuroanatomy of insight and working memory in schizophrenia. Schizophr Res 152: 201-9.

Sartorius N, Shapiro R, Kimura M et al (1972) WHO international pilot study of schizophrenia. Psychol Med 2: 422-5.

Schreiber R, Newman-Tancredi A (2014) Improving cognition in schizophrenia with antipsychotics that elicit neurogenesis through 5-HT 1A receptor activation. Neurobiol Learn Mem 110: 72-80.

Shad MU, Keshavan MS, Tamminga CA et al (2007) Neurobiological underpinnings of insight deficits in schizophrenia. Int Rev Psychiatry 19: 437-46.

Simon V, De Hert M, Wampers M et al (2009). The relation between neurocognitive dysfunction and impaired insight in patients with schizophrenia. Eur Psychiatry 24: 239-43.

Staresina BP, Gray JC, Davachi L (2009). Event congruency enhances episodic memory encoding through semantic elaboration and relational binding. Cereb Cortex 19: 1198-207.

Stefanopoulou E, Lafuente AR, Saez Fonseca JA et al (2009) Insight, global functioning and psychopathology amongst in-patient clients with schizophrenia. Psychiatr Q. 80: 155-65.

Stratta P, Daneluzzo E, Bustini M et al (1998) Schizophrenic deficits in the processing of context. Letter. Arch Gen Psychiatry 55: 186-7.

Stratta P, Daneluzzo E, Bustini M et al (1999) Schizophrenic patients use context-independent reasoning more often than context-dependent reasoning as measured by the Cognitive Bias Task (CBT): a controlled study. Schizophr Res 37: 45-51.

Sumich A, Harris A, Flynn G et al (2006) Event-related potential correlates of depression, insight and negative symptoms in males with recent-onset psychosis. Clin Neurophysiol 117: 1715-27.

Tumkaya S, Karadag F, Mueller ST et al (2013) Situation awareness in obsessive-compulsive disorder. Psychiatry Res 209: 579-88.

Uhlhaas PJ, Mishara AL (2007) Perceptual anomalies in schizophrenia: integrating phenomenology and cognitive neuroscience. Schizophr Bull 33: 142-56.

Upthegrove R, Oyebode F, George M et al (2002) Insight, social knowledge and working memory in schizophrenia. Psychopathol 35: 341-6.

Xavier RM, Vorderstrasse A (2016) Neurobiological basis of insight in schizophrenia: A systematic review. Nurs Res 65: 224-37.