

Examination of the Relationship Between the Theory of Mind, Neurocognitive Functions and Thought-Language Features in the Schizophrenia and Bipolar Affective Disorder I Groups



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ABSTRACT

Objective: In this study, it was aimed to examine the relationship of ToM with face-emotion recognition, executive functions and thought disorders in the schizophrenia (SC) and bipolar affective disorder I (BAD I) groups.

Method: 40 SC, 40 BAD I and 40 healthy control groups were included, matched for age, gender, and educational status. Dokuz Eylül Theory of Mind Scale (DEToMS) and Reading Mind in Eyes (RMET) test, Benton face recognition test (BFRT), Ekman emotion recognition battery, Wisconsin Card Sorting Test (WCST), Stroop test, Thought and Language Index (TLI) were used. Positive and Negative Symptoms Rating Scale (PANNS) in the SZ group, Young Mania Rating Scale (YMRS) in the BAD I group were used.

Results: The number of perseverative responses in WCST was higher in the SC group than the BAD I group. Recognition of the fearful expression scores, DEToMS total and subscale scores except irony were higher and scores of TLI were lower in healthy controls more than patients group. Recognition of the fearful expression scores, DEToMS total and subscale scores except irony were higher and scores of TLI were lower in BAD I group more than SC group. There was no difference between SC and BAD I groups between BFRT, emotion recognition except fearful expression and RMET scores. The best predictors of DEToMS were executive functions and TLI total score in the SC group and was emotion recognition in the BAD I group. The best predictors of the RMET score were executive functions and emotion recognition for both groups.

Conclusion: Our findings suggest that social cognition remains a biomarker in patients with SZ and BAD I.

Keywords: Schizophrenia, bipolar disorder, theory of mind, emotion recognition

INTRODUCTION

Schizophrenia (SZ) and Bipolar Affective Disorder (BPAD) I are similar in terms of age of onset, lifetime risk, worldwide prevalence, risk of suicide, and genetic predisposition (Berrettini 2003). The diagnostic overlap for these two diseases has been showed in family studies conducted in recent years (Lichtenstein et al. 2009). Molecular connectivity studies suggest that some loci of susceptibility may be common to both diagnostic classes (Berrettini 2000). Similar structural anomalies have been shown, particular in white and gray matter structures in the temporal and frontal regions (Anderson et al. 2013). Dopamine dysregulation is observed in both diseases and antipsychotic treatment is, again, used

for both. Therefore, there is increasing evidence that SZ and BPAD I should be considered as two classes that lie along the continuum of psychotic disorders (Tamminga et al. 2014).

Social cognition has been defined as the mental processes underlying perception, interpretation of, and response generation for the behavior, dispositions, and intentions of others during social interactions (Green and Leitman 2008). The most studied areas of social cognition in SZ are social knowledge, emotion recognition, theory of mind (ToM), and attribution style (Green et al. 2005). ToM is defined as the ability of understanding and interpreting the intentions, thoughts, wishes, beliefs and behaviors of others (Green et al. 2005). While social-cognitive ToM is about making inference

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about the beliefs of others, social-perceptual ToM is about making inference about the feelings of others (Shamay-Tsoory et al. 2009). In literature, there are many studies that confirm ToM disorders in patients with SZ (Brüne 2005, Harrington 2007, Sprong 2007). In most studies, it has been shown that there are ToM impairments in the remission period of SZ, as well as in the acute psychotic periods (Bora 2009), and that there are also ToM impairments in the prodromal phase of the disease before the acute symptoms begin, and in individuals with associated risk of SZ (Bora and Pantelis 2013). In BPAD, it was reported that ToM impairments are seen in patients in remission period but more severely during acute mood episodes (manic, depressive) and even in the first degree relatives of patients (Bora et al. 2016, Samamé et al. 2012). There are studies showing that while there are social-cognitive ToM impairments in BPAD, social-perceptual ToM is not different from healthy controls (Shamay-Tsoory et al. 2009, Barrera Á et al. 2013, Montag C et al. 2010), however, some other studies show that there are impairments in both ToM areas (Lahera et al. 2007, Bora et al. 2005).

Another aspect of social cognition is the emotion recognition. The emotion recognition from facial expressions is a component of non-verbal communication, and several studies in SZ have reported a relationship between social competence and emotion recognition skills, and it is emphasized that it predicts later professional functioning and ability to live independently (Mueser et al. 1996). In studies on facial-emotion recognition skills in patients with SZ and BPAD, it was found that patients with SZ had difficulty recognizing angry facial expressions compared to patients with BPAD, and both patient groups labeled angry facial expressions as expressions of fear compared to healthy controls (Goghari and Sponheim 2013), and it was reported that in the acute psychotic period, patients with BPAD I had deficiencies in recognizing happy and sad expressions, while patients with SZ have deficiencies in recognizing sad expressions (Daros et al. 2014). It was reported that patients with SZ and BPAD with psychotic features incorrectly label the visually neutral facial expressions as negative compared to patients with BPAD without psychotic features and healthy controls (Thaler et al. 2013b).

It has been stated that the thought disorder seen in SZ is caused by a disorder in the thought process rather than a disorder in the content of thought (Goldberg et al. 1998). No difference between SZ and BPAD I manic episodes in terms of positive formal thought disorder (FTD) was reported, while in the euthymic period, there is more positive FTD in SZ and negative FTD is higher in SZ (Jamadar et al. 2013). FTD has been associated with executive functions and sustained attention (Nagels et al. 2016). In a study conducted with patients with SZ and healthy controls, false belief tests and understanding irony were found to be negatively

associated with positive FTD and metaphor comprehension and executive functions disorders were found to be negatively correlated with negative FTD (Langdon et al. 2002).

It is known that cognitive symptoms persist during the remission period of SZ (Green et al. 2004). It is accepted as an endophenotype as similar disorders are found in the first degree relatives of patients with SZ and in the prodromal period of the disease (Heinrichs and Zakzanis 1998). Even though, several studies found more impairment especially in verbal episodic memory, executive functions (Heinrichs and Zakzanis 1998) as well as processing speed (Dickinson et al. 2007), a general neurocognitive disorder in SZ was found in most studies (Hill et al. 2004). In BPAD, neurocognitive disorder was found in areas similar to SZ but quantitatively less so. (Vöhringer et al. 2013). While BPAD patients were found to be comparable to SZ patients in terms of impairment in the social-cognitive ToM, it was reported that there was a general ToM impairment in SZ patients, and when neurocognitive functions were controlled, the impairment was significant only in SZ patients (Konstantakopoulos et al. 2020). Again, when basic emotion recognition skills and neurocognitive functions were controlled in BPAD patients, deficiency only in advanced ToM functions was reported (Bora et al. 2005).

The relationship between ToM disorders, neurocognitive functions and other social cognitive functions remain unclear for SZ and BPAD I. In this sense, it is important to define interaction patterns and to determine the differences in different mental areas.

This study aims to examine the patients with SZ, BPAD I and healthy controls in terms of social cognitive functions (ToM, emotion-face recognition), neurocognitive functions and thought-language characteristics. First, we directly compared ToM, face-emotion recognition, neurocognitive functions, and thought-language features in SZ and BPAD I groups, and healthy controls. Secondly, the relationship between ToM and neurocognitive functions, face-emotion recognition, and thought-language features in patients with SZ, BPAD I groups and healthy controls was examined and thirdly the factors that help predict the ToM functions in patients with SZ and BPAD I.

METHOD

Sample

In this study, 40 patients with SZ, 40 patients with BPAD I and 40 healthy controls were diagnosed and included by using the Structured Clinical Interview Form for DSM-IV Axis I Disorders (SCID I) who were selected from follow-up patients and were in the remission phase, close to discharge in the inpatient service of Bolu Abant İzzet Baysal University and Bolu Mental Health and Diseases Hospital, and from the

patients who were not in the acute phase and followed up in the outpatients clinic of the hospital. The exclusion criteria for SZ and BPAD I group were determined as the presence of neurological (head trauma, epilepsy, cerebrovascular disease, intracranial tumor, head trauma) or physical diseases that affect cognitive functions, having a history of substance abuse, presence of mental disabilities (mental retardation, blindness, deafness) that prevented them from completing the scale, and illiteracy. The exclusion criteria in the healthy control group were identified as having a history of psychiatric treatment and a relatively with a diagnosis of SZ or BPAD I in addition to other criteria for the SZ and BPAD I groups.

Evaluation Tools: To evaluate mania symptoms, the BPAD I group was administered the Young Mania Rating Scale (YMRS), which was developed by Young et al. (Young et al. 1987) and whose Turkish validity and reliability study has been conducted (Karadag et al. 2001). For BPAD I, YMRS <7 was considered as euthymia. To assess severity in the SZ group, the Positive and Negative Syndrome Scale (PANSS) by Kay et al. was administered (Kay et al. 1987). Turkish validity and reliability study of the scale had been conducted (Kostakoglu et al. 1999).

Thought-Language Index (TLI): TLI consists of two main categories; namely, thought impoverishment and thought disorganization composed of a total of 8 items. The category of impoverished thought consists of such items as poverty of speech, weakening of goal and perseveration and the category of disorganized thought consists of other items such as looseness, peculiar use of words, peculiar sentence construction, peculiar logic and distractibility. The test material consists of 8 picture tests selected from the Thematic Apperception Test (TAT) in a fixed order. The person is asked to speak about a minute for each picture and this one-minute free response phase continues with the investigation phase where the person is asked to explain any unusual responses of theirs. The entire application is recorded and evaluated according to the protocol developed by Liddle (2002) (Liddle et al. 2002). Turkish validation and reliability study was conducted for TAT (Ulaş et al. 2007).

Neuropsychological Evaluation

Wisconsin Card Sorting Test (WCST): The test was developed for evaluating executive functions and the final version was created by Heaton (Heaton 1981). Its Turkish validity and reliability study was conducted by Karakas et al. (Karakas et al. 1998). In this study, WCST:CV4 Scoring Program was used. This test measures the ability to change behavior, in other words, the cognitive flexibility according to feedbacks. The study evaluates the number of perseverative answers and completed categories.

Stroop Test: The test, which measures sustained and concentrated attention, requires the ability to suppress intrusive inappropriate stimuli. Its Turkish validity and reliability study had been conducted (Karakas et al 1998). The test includes 4 cards. There are color names written in black on a white background on the 1st card, color names written in different colors on the 2nd, circles in different colors on the 3rd and neutral names written in different colors on the 4th. The duration and the number of errors for each card were recorded. For Stroop 5, patients are asked to state the color of the text written on the 2nd card which the names of colors are written in different colors. The most important feature for the Stroop Test is the disruptive effect (Stroop 5). In this study, the duration and the number of errors in the Stroop Test were evaluated.

Dokuz Eylül Theory of Mind Index (DEToMI)

DEToMI, which is developed to measure the ability of theory of mind in adults, consists of tasks of 7 stories and 3 pictures. In story tasks, the individual is asked to answer the story-related questions that will be asked throughout the story. Five of the story tasks require only one skill (first and second degree false belief, irony, metaphor, and faux-pas), but the remaining two stories evaluate various aspects of the theory of mind skills (empathy, irony, 1st and 2nd-degree false belief and metaphor) with different questions within the same story. In one of these story tasks which include the evaluation of different theory of mind skills, four control questions were placed between the story and the questions, thus checking whether the participant remembered the story or not. Scoring is 1 point for the correct answer and 0 point for the wrong answer, according to the answer key. Control questions were not included in the scoring and were also taken as control points. One can score in the range of 0-15 in these story tasks. Picture tasks consist of 3 pictures that tell a story, and require choosing a 4th picture from two other pictures that would be appropriate with the storyline. Each picture evaluates a different feature: 1st degree false belief, 2nd degree false belief, and empathy. In scoring, the correct choice is 1 and the wrong choice is 0 points. One can score between 0 to 3 in the picture task. The total one can score with this scale is between 0-18 points. In addition, the application takes about 15-20 minutes. The validity and reliability study of the scale was previously conducted (Degirmencioglu et al. 2017).

Reading Mind in the Eyes Test (RMET)

Developed by Baron-Cohen et al. (Baron-Cohen et al. 2001), this test consists of 36 photographs showing only the eyes of actors and actresses. The participant is asked to choose the option that best describes the mental state of the person in the picture from the 4 options given. These options do not only include the 5 basic emotions, i.e. fear, sadness,

anger, happiness and disgust, but because they are built on complex emotions and intentions, the test is accepted as an indicator of the ability of theory of mind, not as emotion recognition. The Turkish validity and reliability study of the test was conducted by Yildirim et al. (Yildirim et al. 2011). The Turkish form consists of 32 items for 4 items that have low internal consistency were removed.

Benton Face Recognition Test (BFRT)

Developed by Benton et al. (Benton et al. 1993) BFRT consists of a spiral-bound book of 22 A4-size pages with a face on each page. The answers are also recorded. Its standardization in our country was carried out by Cahit Keskinilic in 2008 (Keskinilic 2008). The total score is the indicator of the test performance of the subject. The maximum one can score in the test is 27 in the short form and 54 in the long form. The minimum score of the test is 0.

Ekman Facial Emotion Recognition Battery

In our study, 56 photographs of 8 models (4 male, 4 female) created by P. Ekman and W.V. Friesen were used. This set of photos consist 6 emotion expressions of happiness, sadness, fear, anger, surprise,disgust, and neutral expression. The first seven of these 56 photographs were introduced to the patients and they were expected to know the next 49 pictures. The photos were pictures of people renown in the society by over 90%. The photographs were shown to the patients on a computer screen and they were asked to respond within 5 seconds.

Statistical Analysis Methods

The descriptive statistics were obtained by presenting the descriptive data of each three groups using frequency analysis. It was tested by Kolmogorov Smirnov whether continuous numeric data was normally distributed or not. When comparing the three groups (SZ, BPAD I and healthy controls), DEToMI, RMET, BFRT, Ekman emotion recognition test, WCST, Stroop, and TLI ANOVA was applied for normally distributed continuous variables whereas Kruskal-Wallis test was applied for non-normally distributed continuous variables. For groups with variations, Tukey correction was used for Post-hoc tests in ANOVA to determine from which groups the difference came, and in Kruskal-Wallis, each group was compared with the Mann Whitney U test. Since there were more than two groups, Bonferroni correction was applied and it was determined as $p:0.05/3: 0.017$. Pearson correlation analysis was used to determine whether DEToMI and RMET have a correlation with BFRT, Ekman emotion recognition battery, TLI, WCST, and Stroop test. Bonferroni correction was used because multiple correlations were examined. Stepwise linear regression analysis was performed

to determine the predictive factors for DEToMI and RMET, which were shown to differ between the groups. All statistical analyzes were carried out with SPSS 22.0 analysis.

RESULTS

Age, gender, educational status and employment data for all three groups participating in the study are given in Table 1. The mean duration of the disease of the SZ group was 14.7 ± 1.6 (years), the number of hospitalizations was 5.6 ± 0.6 , and the total length of hospitalization was 7.9 ± 1.2 (months). In the BPAD I group, the duration of the disease was 15.5 ± 1.4 (years), the number of hospitalizations was 4.8 ± 0.6 , and the total length of hospitalization was 6.5 ± 1.1 (months). While 37 patients in the BPAD I group had psychotic episodes during the illness, 3 patients did not. There was no statistical difference between the SZ and BPAD I patient groups in terms of duration of the disease, the number of and length of hospitalizations. While the use of antipsychotic (AP) equivalent to chlorpromazine was 356 ± 27.5 mg in patients with SZ, it was 201.2 ± 26.4 mg in BPAD I patients. SZ patients had a significantly higher dose of AP use equivalent to chlorpromazine than BPAD I patients ($Z:4.22$; $p<0.05$). In the SZ group, 11 patients had one AP, 22 patients had two APs, and 3 patients had more than 2 APs. There was MS (mood stabilizer) use in 1 patient and antidepressant use in 2 patients. In BPAD I group, 20 patients were on lithium, 17 used valproic acid, and 6 patients used both lithium and valproic acid. In the SZ group, 18 patients used one AP, 17 used two, and 2 patients used more than 2 APs. Only one patient was on antidepressants, and 1 patient used 2 APs without MS. In the SZ group, the mean PANSS positive score was 10.8 ± 0.5 , the mean PANSS negative score was 19.6 ± 0.7 , and the mean PANSS general symptomatology score was 28.8 ± 0.7 . The mean YMRS score of the BPAD I patient group was 1.1 ± 0.3 (Table 1).

Neuropsychological Tests

In the study, the number of perseverative responses and the number of categories were evaluated in the WCST test. While the number of perseverative responses was significantly higher in the patient groups, the number of completed categories was lower in patient groups than the healthy controls. The number of perseverative responses was higher in patients with SZ than in patients with BPAD I. There was no difference between the two groups in terms of the number of completed categories.

In Stroop Test, the duration of Stroop 5, the number of errors and corrections were evaluated. Patient groups took longer to complete and made more errors than healthy controls. There was no difference between the patient groups diagnosed with SZ and BPAD I (Table 1).

Table 1. Sociodemographic and Clinical Characteristics of SZ, BPAD I, and Healthy Control Groups

	SZ	BPAD I	Healthy Control	F/X ²	p	
Age	40.2±1.6	39.2±1.6	37.0±1.3	F: 1.850	P: 0.309	
Gender	16 (40%)	22 (55%)	19 (48%)	X ² : 1.805	P: 0.406	
Female/Male %	24 (60%)	18 (45%)	21 (58%)			
Education (Year)	9.6±0.6	10.3±0.7	11.0±0.5	X ² : 2.236	P: 0.327	
PANSS Positive	10.8±0.5					
PANSS Negative	19.6±0.7					
PANSS General	28.8±0.7					
PANSS Total	59.3±1.6					
YMRS		1.1±0.3				
TLI Total Score	8.7±0.5	5.6±0.4	1.2±0.1	93.85	<0.001	SCZ>BPADI>HC
WCST PRN	51.3±5.0	38.1±3.5	17.9±1.5	45.61	<0.001	SCZ>BPADI>HC
WCST Category	2.5±0.5	2.2±0.3	6.8±0.4	44.59	<0.001	SCZ=BPADI<HC
Stroop 5 Duration	38.6±2.9	33.6±2.2	24.7±0.9	22.61	<0.001	SCZ=BPADI>HC
Stroop 5 Error	1.5±0.4	1.4±0.3	0.3±0.9	7.94	0.019	SCZ=BPADI>HC
Stroop 5 Correction	2.4±0.3	2.5±0.3	1.5±0.2	7.10	0.029	SCZ=BPADI>HC

SZ: Schizophrenia; BPAD I: Bipolar Affective Disorder I; PANSS: The Positive and Negative Syndrome Scale; YMRS: Young Mania Rating Scale; TLI: Thought Language Index; WCST: Wisconsin Card Sorting Test PRN: Perseverative Response Number

Dokuz Eylül Theory of Mind Scale (DEToMI) - Reading Mind in the Eyes Test (RMET)

The patients with SZ and BPAD I had lower DEToMI total scale scores and subscale scores of First-Degree False Beliefs Test (FDFB), Second Degree False Beliefs (SDFB), irony, empathy, recognizing faux-pas compared to the healthy control group and the patients with BPAD I scored lower on all subscales except for the irony subscale. While no difference was found between the SZ and BPAD I groups in the RMET test, the patients in both groups experienced difficulties in the test compared to healthy controls (Table 2).

Benton Face Recognition Test (BFRT) - Ekman Emotion Recognition Battery

While there was no statistical difference between the patient groups diagnosed with Z and BPAD I in terms of BFRT, both patient groups had difficulty compared to healthy controls (SZ=BPAD I<HC). In the Ekman Emotion Recognition Test, patient groups had difficulty in recognizing happy, sad, fearful, angry, disgusted, and neutral facial expressions compared to healthy controls. Patients with SZ had difficulty in recognizing fearful facial expressions compared to patients with BPAD I (Table 2).

Correlation Analysis

With SZ patients, the total score of DEToMI was found to have a moderate correlation with the recognition of happy, surprised, neutral facial expressions and the number of completed categories of WSCT; a weakly positive

correlation with the score of recognition of Ekman angry facial expression; a moderate negative correlation with TLI total score, Stroop 5 duration and number of errors, and a weak negative correlation with the number of perseverative responses of WSCT. It has been found that in SZ patients, the RMET has a moderate correlation with the score of the recognition of happy, surprised, disgusted, and neutral facial expression, a weakly positive correlation with BFRT total score, Ekman angry facial expression recognition score and the WCST category number; a moderate negative correlation with Stroop 5 duration and TLI total score, and a weak negative correlation with the number of Stroop 5 errors (Table 3).

It was found in the BPAD I patient group, that the DEToMI had a moderate positive correlation with Ekman happy, sad facial expression recognition score and WCST category number, and a weak positive correlation with Ekman angry, disgusted, neutral facial expression recognition; DEToMI had a weak negative correlation with the number of Stroop 5 errors and the total score of TLI. Also, a moderate correlation with the score of recognition of Ekman sad, surprised facial expression and WCST category number, a weakly positive correlation with Ekman angry, neutral facial expression recognition was found with RMET; RMET had a moderate negative correlation with Stroop 5 duration and number of errors (Table 4).

In the healthy control group, it was found that DEToMI total score had a moderate correlation with WCST category number and a weak negative correlation with the TLI total score. The total score of RMET had a weakly positive correlation with

Table 2. Comparison of SZ, BPAD I and Healthy Control Groups in Terms of Theory of Mind, Face-Emotion Recognition Features

	SCZ	BPAD I	Healthy Control	F/X ²	p	
RMET	16.2±0.8	17.9±0.8	23.7±0.5	44.46	0.00	SCZ=BPADI<HC
DEToMI Total Score	8.3±0.5	11.7±0.4	15.5±0.2	74.54*	0.00	SCZ<BPADI<HC
FDFB	1.5±0.1	2.2±0.1	-	58.58	0.00	SCZ<BPADI<HC
SDFB	1.5±0.1	2.0±0.1	2.8±0.1	33.63	0.00	SCZ<BPADI<HC
Irony	0.9±0.2	1.5±0.2	2.1±0.2	14.67	0.01	SCZ=BPADI<HC
Metaphor	0.7±0.1	1.0±0.1	1.5±0.1	25.02	0.00	SCZ<BPADI<HC
Empathy	3.6±0.2	4.3±0.1	4.9±0.5	30.77	0.00	SCZ<BPADI<HC
NFP	-	0.2±0.1	0.6±0.1	38.85	0.00	SCZ<BPADI<HC
Benton Face Recognition	20.9±0.4	20.8±0.3	23.3±0.2	32.34	<0.001	SCZ=BPADI<HC
Ekman Happy	6.7±0.1	6.8±0.9	-	4.07	0.019	SCZ=BPADI<HC
Ekman Sad	3.8±0.3	4.0±0.3	5.2±0.3	17.56	<0.001	SCZ=BPADI<HC
Ekman Fear	2.2±0.2	2.9±0.2	3.7±0.2	17.45	<0.001	SCZ<BPADI<HC
Ekman Angry	4.9±0.3	5.5±0.2	6.5±0.9	13.45	<0.001	SCZ=BPADI<HC
Ekman Surprise	5.5±0.3	6.0±0.2	6.6±0.1	7.13	0.001	SCZ=BPADI<HC
Ekman Disgusted	4.7±0.4	4.6±0.3	6.0±0.1	7.11	0.001	SCZ=BPADI<HC
Ekman Neutral	4.6±0.4	5.7±0.3	6.6±0.1	11.06	<0.001	SCZ=BPADI<HC

SCZ: Schizophrenia; BPAD I: Bipolar affective disorder I; RMET: Reading the Mind in the Eyes Test; DEToMI: Dokuz Eylül Theory of Mind Index; FDFB: First-degree false belief; SDFB: Second-degree false belief; NFP: Noticing the faux-pas (p<0.05)

Table 3. Correlation of DEToMI and RMET Total Score with Benton Face Recognition, Ekman Emotion Recognition Battery, WCST Category Number, WCST Perseverative Response Number, Stroop Duration, and Error Number in the SZ Group

		Benton Total	EH	EF	ES	ED	EN	WCST Category	WCST P R N	Stroop 5 duration	Stroop 5 error	TLI Total
DEToMI	r	0.289	0.509*	0.375	0.487*	0.282	0.535**	0.511**	-0.372	-0.535*	-0.453	-0.539*
	p	0.071	0.001	0.017	0.001	0.078	0.000	0.001	0.018	0.000	0.003	0.000
RMET	r	0.333	0.618*	0.350	0.462	0.466	0.464	0.399	-0.150	-0.589**	-0.341	-0.444
	p	0.036	0.000	0.027	0.003	0.002	0.003	0.011	0.354	0.000	0.031	0.004

DEToMI: Dokuz Eylül Theory of Mind Index; RMET: Reading the Mind in the Eyes Test; EH: Ekman Happy; EF: Ekman Fear; ES: Ekman Surprise; ED: Ekman Disgust; EN: Ekman Neutral; WCST: Wisconsin Card Sorting Test; PRN: Perseverative Response Number TLI: Thought Language Index

Ekman surprised facial expression recognition; a moderate negative correlation with TLI total score, and a weak negative correlation with Stroop 5 duration (Table 5).

Regression Analysis

In order to understand which variables predicted the DEToMI total score in the patient group with SZ, family history of psychiatric disease, BFRT total score, Ekman happy, fearful, angry, disgusted, surprised, neutral, TLI total score, WCST correct number, number of completed categories, number of perseverative answers were included in the linear regression model as variables. The stepwise linear regression analysis showed that the total TLI score, the number of categories completed in the WCST, and the number of Stroop 5 corrections explained 56% of the variance (Table 6). When the same variables were included in the linear regression

model, it was shown that Ekman happy and the duration of Stroop 5 test explained 51% of the variance for the total RMET score (Table 7).

In the BPAD I patient group, for the predictor factors of DEToMI and RMET total score, family history of psychiatric disease, Benton total score, Ekman happy, fearful, angry, surprised, disgusted, neutral, TLI total score, WCST correct number, number of perseverative answers, number of completed categories, Stroop 5 duration, and Stroop 5 number of corrections were included in the regression model. The stepwise linear regression analysis showed that for the total score of DEToMI, Ekman happy and neutral explained 31% of the variance (Table 8), for the total score of TLI, the number of WCST completed categories, Ekman surprised, and Stroop 5 duration explained 45% of the total variance (Table 9).

Table 4. Correlation of DEToMI and RMET Total Score with Benton Face Recognition, Ekman Emotion Recognition Battery, WCST Category Number, WCST Perseverative Response Number, Stroop Duration, and Error Number in BPAD I Group

		Benton Total	EH	ES	EF	ES	ED	EN	WCST Category	WCST P R N	Stroop 5 duration	Stroop 5 error	TLI Total
DEToMI	r	0.118	0.437	0.411	0.320	0.087	0.368	0.359	0.406	-0.243	-0.291	-0.346	-0.351
	p	0.470	0.005	0.008	0.044	0.595	0.019	0.023	0.009	0.131	0.068	0.029	0.026
RMET	r	0.228	0.048	0.417	0.353	0.429	0.291	0.374	0.501*	0.076	-0.483*	-0.611**	-0.164
	p	0.157	0.768	0.008	0.026	0.006	0.069	0.018	0.001	0.639	0.002	0.000	0.313

DEToMI: Dokuz Eylul Theory of Mind Index; RMET: Reading the Mind in the Eyes Test; EH: Ekman Happy; ES: Ekman Sad; EF: Ekman Fear; ES: Ekman Surprise; ED: Ekman Disgust; EN: Ekman Neutral; WCST: Wisconsin Card Sorting Test; PRN: Perseverative Response Number; TLI: Thought Language Index

Table 5. Correlation of DEToMI, RMET Test Scores, WCST Category Number, WCST Perseverative Response Number, Stroop 5 Duration and Stroop 5 Error Number, TLI Total Score in the Healthy Control Group

		Ekman Surprise	WCST Category	WCST P R N	Stroop 5 duration	Stroop 5 error	TLI Total
DEToMI	r	0.204	0.500**	-0.273	-0.250	-0.105	-0.373
	p	0.206	0.001	0.089	0.120	0.519	0.018
RMET	r	0.324	0.562**	-0.333	-0.385*	-0.081	-0.508**
	p	0.041	0.000	0.036	0.014	0.618	0.001

DEToMI: Dokuz Eylul Theory of Mind Index; RMET: Reading the Mind in the Eyes Test; ES: Ekman Surprise; WCST: Wisconsin Card Sorting Test; PRN: Perseverative Response Number; TLI: Thought Language Index

Table 6. Regression Analysis of the Predictors of DEToMI Total Score in the SZ Group (N:40)

Variable	B	SEB	β	95 CI%		p
				Lower Limit	Upper Limit	
Model 1						
Constant	13.845	1.472		10.866	16.824	0.000
TLI Total Score	-0.628	0.159	-0.539	-0.950	-0.305	0.000
Model 2						
Constant	15.302	1.382		12.501	18.102	0.000
TLI Total Score	-0.590	0.142	-0.506	-0.878	-0.302	0.000
Stroop 5 Correction Number	-0.730	0.221	-0.404	-1.177	-0.283	0.002
Model 3						
Constant	12.883	0.147		9.884	15.881	0.000
WCST Completed Category Number	0.429	0.140	0.360	0.144	0.714	0.004
Stroop 5 Correction Number	-0.724	0.199	0.400	-1.129	-0.320	0.001
TLI Total Score	-0.439	0.138	0.377	-0.718	-0.160	0.003

Model 1 R²: 0.290 ; F:15.54

Model 2 R²: 0.452 ; F: 10.94

Model 3 R²: 0.565 ; F: 15.59 ; P<0.001 CI: Confidence Interval, DEToMI: Dokuz Eylul Theory of Mind Index; WCST: Wisconsin Card Sorting Test; TLI: Thought Language Index

DISCUSSION

In this study, it was shown that patients with both SZ and BPAD I had weaker ToM skills compared to healthy controls. While no difference was found between patients with SZ and BPAD I in terms of RMET test, it was shown that patients with SZ were weaker in terms of first- and second-degree false belief, understanding metaphor, empathy skills, and

recognizing faux-pas, which are the subscales of DEToMI. There was no difference between the two groups in terms of recognition of irony. While literature distinguishes between social-perceptual ToM and social-cognitive ToM it was reported that false belief tests represented social-cognitive ToM, and faux-pas recognition and irony comprehension represented social-perceptual ToM (Shamay-Tsoory et al. 2007). In our study, finding no difference in the RMET

Table 7. Regression Analysis of the Predictors of RMET Total Score in the SZ Group (N:40)

Variable	B	SEB	β	95 CI%		p
				Lower Limit	Upper Limit	
Model 1						
Constant	-20.278	7.562		-35.587	-4.969	0.011
Ekman Happy	5.444	1.124	0.618	3.169	7.720	0.000
Model 2						
Constant	-5.723	8.236		-22.410	10.965	0.492
Ekman Happy	3.950	1.118	0.448	1.683	6.216	0.001
Stroop 5 duration	-0.118	0.037	-0.399	-0.193	-0.042	0.003

Model 1: R²:0.382; F: 23.4Model 2: R²:0.512 ; F:19.3 p<0.001 CI: Confidence Interval RMET: Reading the Mind in the Eyes Test**Table 8.** Regression Analysis of the Predictors of DEToMI Total Score in the BPAD I Group (N:40)

Variable	B	SEB	β	95 CI%		p
				Lower Limit	Upper Limit	
Model 1						
Constant	-1.411	4.412		-10.343	7.521	0.751
Ekman Happy	1.935	0.647	0.437	0.626	3.245	0.005
Model 2						
Constant	-3.963	4.229		-12.531	4.605	0.355
Ekman Happy	1.912	0.603	0.432	0.691	3.134	0.003
Ekman Neutral	0.475	0.183	0.353	0.104	0.846	0.014

Model 1 R²:0.191; F:8.96Model 2 R²:0.315; F:8.52 p<0.001 CI: Confidence Interval BPAD I: Bipolar Affective Disorder I; DEToMI: Dokuz Eylul Theory of Mind Index**Table 9.** Regression Analysis of the Predictors of RMET Total Score in the BPAD I Group (N:40)

Variable	B	SEB	β	95 CI%		p
				Lower Limit	Upper Limit	
Model 1						
Constant	15.379	0.980		13.395	17.364	0.000
WCST Completed Category Number	1.159	0.325	0.501	0.502	1.816	0.001
Model 2						
Constant	9.301	2.641		3.949	14.653	0.001
WCST Completed Category Number	0.986	0.313	0.426	0.351	1.620	0.003
Ekman Surprise	1.080	0.440	0.332	0.189	1.972	0.019
Model 3						
Constant	14.126	-3.167		7.703	20.549	0.000
WCST Completed Category Number	0.706	0.315	0.305	0.067	1.345	0.031
Ekman Surprise	1.037	0.413	0.319	-1.875	-0.199	0.017
Stroop 5 duration	-0.118	0.048	-0.328	-0.020	-0.216	0.019

Model 1 R²: 0.251; F: 12.75Model 2 R²: 0.356; F: 10.23Model 3 R²:0.448; F: 9.74 p<0.001 CI: Confidence Interval, BPAD I: Bipolar Affective Disorder I; RMET: Reading the Mind in the Eyes Test; WCST: Wisconsin Card Sorting Test

test and the irony comprehension task, which is one of the DEToMI subtasks, indicates that there was no difference in social-perceptual ToM. There was a difference between the two groups in the task of recognizing faux-pas, but it was reported in literature, that this task represents two mental states; the cognitive component (understanding that the person speaking should not say it) and the perceptual component (empathic understanding that the hearer will feel humiliated or upset) (Frith and Frith CD 2003). Therefore, the findings of our study can be interpreted as there is no difference between BPAD I and SZ in terms of social-perceptual ToM, and the SZ group experienced more difficulties in terms of social-cognitive ToM. In a study, neurocognitive skills, social-perceptual, social-cognitive ToM, and attribution style were examined in patients with SZ and BPAD, and it was shown that patients with BPAD had a social-perceptual ToM impairment comparable to SZ, while social-cognitive ToM was better in BPAD patients. In this study by Donohoe et al. (2012), Hinting test was used for cognitive ToM, RMET was used for perceptual ToM and BPAD I and BPAD II were included in the BPAD group (Donohoe et al. 2012). Our study is consistent with the findings of that study. Only BPAD I group is included in our study in order to avoid possible confounding factors of the BPAD II group. In another study, which included patients with a diagnosis of SZ, psychotic and non-psychotic BPAD I, two factors, socio-emotional processing and ToM, were found effective in social cognition. It was also found that socio-emotional processing differentiated SZ and psychotic BPAD I patients from BPAD I and healthy controls. It was suggested that the ToM factor can differentiate patients with SZ, psychotic and non-psychotic BPAD I from healthy controls (Thaler et al. 2013). Similar to this study, Ekman's emotion recognition battery and RMET test were able to differentiate the patient group from healthy controls in our study. Social cognitive functions were able to differentiate psychotic BPAD I patients from non-psychotic ones. In our study, psychotic BPAD I group was predominantly included, therefore BPAD I patients may be closer to the SZ group. In a study which clinically stable BPAD(I/II) and SZ patients and healthy control groups were included and in which social cognition and neurocognition (non-social cognition) were evaluated, it was found that the BPAD patients were not different from healthy controls in social cognition tests and SZ patients were worse than BPAD and healthy controls in both social cognition and neurocognition. It was also reported that there was more loss in neurocognitive skills in BPAD group compared to social cognition, and more loss in social cognitive skills in SZ group (Lee et al. 2013). In our study, unlike the study mentioned above, the BPAD group had impairments in both neurocognition and social cognition compared to controls, this finding may be related to the difference in the BPAD I sample. Unlike that study, the fact that a group of patients

with predominantly BPAD I diagnosis showed a similar pattern with SZ patients may be an indication that the two diseases are two diagnostic classes lying along a continuum rather than being separate diseases. Bora et al. (2016) conducted a study in Turkey by using the latent class analysis involving BPAD I and SZ patient groups and an HC group in remission, where the groups were compared in terms of executive functions and ToM. In this study, it was shown that the SZ group experienced more difficulties than the BPAD I group in terms of RMET, hinting test, and the number of completed categories of WCST, and the two patient groups were found to be similar in terms of the Stroop Test (Bora et al. 2016). In this study, a total of 4 classes were obtained, and it was reported that while there were more patients with BPAD I in the group without disorders in both functions, the majority of the group with disorders in both domains, with more ToM impairment, consisted of patients with a diagnosis of SZ. Although ToM and executive functional performance of 16 of the patients included in the study were similar to healthy controls, 60% of the patients exhibited similar cognitive profiles and the two diseases were largely similar in terms of ToM and executive functions, which is consistent with the findings in our study group. In addition, in the study, it was reported that 16 patients had similar ToM and executive functional performance with the HC group. It was also reported that in the patient group, there were more BPAD I patients, higher level of education and PANNS negative scores were less. In addition, when the patient groups included in the study were examined, it is seen that the BPAD patients were in remission for at least 4 months, and the SZ patients were in clinical remission for at least 3 months whereas the inpatients in our patient group were from those who were in remission phase. This might be another reason why our findings are different.

Parallel to our findings, many studies examining ToM skills in patients with SZ reported that impairment in all subtypes of ToM (verbal/visual, social-cognitive/social-perceptual) persisted during the remission period (Sprong et al. 2007, Bora et al. 2007, Herold et al. 2002). On the other hand, patients diagnosed with BPAD I, who responded to treatment in the acute period, and were close to discharge and who are outpatients in the remission period, had ToM impairments compared to healthy controls. This finding is consistent with the previous studies. In a meta-analysis investigating ToM impairments in BPAD, it was reported that ToM disorder persists during remission, w more prominent during relapse, and that there was no difference between remission and subsyndromal symptoms, as well as that neurocognitive symptoms and especially manic symptoms were associated with ToM impairments (Bora et al. 2016). In some studies, comparing BPAD and healthy controls, no difference was found between the two groups in social-perceptual ToM, while social-cognitive ToM impairment

were found in BPAD I patients (Shamay-Tsoory et al. 2009, Montag et al. 2009, Barrera Á et al. 2013). The findings in these studies are different from our study, but it is believed that this may be related to the heterogeneity of the sample taken and the inclusion of predominantly psychotic BPAD I group in our study.

In our study, no difference was found between the patients with SZ and BPAD I in terms of face recognition evaluated by BFRT whereas the recognition ability of both patient groups were less than healthy controls. In the emotion recognition task evaluated with Ekman battery, while there was no difference in facial expressions other than fearful facial expressions between the patients with SZ and BPAD I, they were found to experience more recognition difficulties than healthy controls. The fearful facial expression was more difficult to be recognized by the SZ group than in the BPAD I group. Previous studies showed that SZ patients had an impairment in facial identification tasks evaluated by BFRT (Addington and Addington 1998, Bortolon et al. 2015, Penn et al. 2000). There are several studies showing problems in distinguishing facial expressions in patients with BPAD I compared to healthy controls, but no difference was found in facial recognition tasks compared to healthy controls in these studies (Addington and Addington 1998, Getz et al. 2003, Bozikas et al. 2006). This finding is inconsistent with our study, but it is thought that it can be related to more heterogeneous inclusion of the BPAD group (Addington and Addington 1998) and the inclusion the patients in relapse (Getz et al. 2003). In a functional imaging study conducted during emotion recognition and identity recognition tasks in BPAD I patients, increased activity was seen in medial prefrontal cortex (mPFC) and amygdala in both tasks in BPAD I patients compared to healthy controls. In healthy controls, a decrease in mPFC was seen during these tasks. The increase in activity in these regions, which are related to self-referential and social information processes, differentiated the BPAD I patients healthy controls in the facial identification processes (Keener et al. 2012).

The SZ group had more difficulty in recognizing fearful facial expression than the BPAD I group. It has been previously reported that patients with SZ had difficulties in recognizing the expression of fear as a negative expression. Eye regions are involved more in recognizing expressions of fear compared to others (Morris et al. 2009). In addition, it is known that the eye region is processed faster in fearful expressions than in other expressions, and this supports that fear is related to preconscious processing. Since patients with SZ do not establish eye contact, it is expected that they will have difficulty in recognizing fearful expressions, which is consistent with our study. It was reported that patients with SZ have decreased amygdala activity, especially when they look at fearful faces. In an Event-Related Potential study focusing on the differentiation of neutral and fearful facial

expressions in patients with SZ, it was found that patients with SZ and HC groups differentiated neutral and fearful facial expressions in the early stages of facial processing. It was also reported that, unlike controls, there is an amygdala activity in SZ during the recognition of fearful expressions in the later period compared to neutral faces, which is associated with clinical symptomatology (Martin et al. 2005). There was no difference in expressions other than fearful facial expressions between patients with SZ and BPAD I, which is consistent with previous studies with patients with SZ and BPAD I (Thonse et al. 2018, Daros et al. 2014).

SZ and BPAD I patient groups performed worse than healthy controls in terms of both positive and negative FTD. The SZ group was worse than the BPAD I group in terms of negative FTD. Neurocognitive and neuroimaging studies have shown that negative FTD is different from positive FTD. It is reported that while positive FTD is associated with a decrease in the language-related areas of Broca and Wernice, since negative FTD is associated with the medial frontal and orbitofrontal cortex, and the impairment in visual-motor tasks evaluating attention is associated with negative FTD, with not positive FTD, negative FTD is mostly associated with negative symptoms (Roche et al. 2014). Since the patient group in our study was included from a clinically-stable patient population, who were mostly outpatients and close to discharge, negative FTD may have been found to be worse in SZ patients than in BPAD I patients. In our study, a correlation was found between ToM and TLI total scores, which is consistent with the previous finding where thought and language disorders predicted ToM (Greig et al. 2004). However, the number of studies in this area is not sufficient.

The factors predicting social-perceptual and social-cognitive ToM showed different patterns in the SZ and BPAD I groups. The best predictors of DEToMI total score were the executive functions and TLI total score in the SZ group whereas in BPAD I group, Ekman happy and neutral facial expression recognition were the best predictors. This differentiates SZ and BPAD I even if they show predominantly psychotic symptoms. The best predictors of RMET were the Stroop 5 test correction number and the recognition of Ekman happy facial expression in the SZ group whereas in BPAD I group, the recognition of Ekman happy and surprised faces and Stroop 5 test duration were the best predictors. This finding is consistent with the finding that the executive functions predicted ToM in studies examining neurocognitive predictors of social cognition in patients with SZ in remission (Mehta et al. 2014, Fernandez-Gonzalo et al. 2013). In a study examining the relationship between social-cognitive and social-perceptual ToM and executive functions in patients with SZ in remission, the Stroop test was reported to be the best predictor of RMET, similar to the SZ group in our study (López-Navarro 2018). In a study that included

BPAD I patients in the euthymic period and healthy controls, in which Hinting test, RMET, Benton Face Recognition Test, emotion recognition and neurocognitive tests were applied, it was found that face recognition, emotion recognition and psychomotor speed were the predictive of RMET; whereas the number of WCST perseverative errors was a predictor for the Hinting test. (Bora et al. 2005)

Limitations of the study: While choosing the sample in our study, people who did not have clinical mental retardation were included, but there may be differences in the intelligence level, which may have created differences in understanding of and responding to these tests. The BPAD I group included in our study had predominantly psychotic features. More reliable results can be obtained by including different groups such as BPAD I and BPAD II. In the study, YMRS was used for manic attack symptoms in the BPAD I group, but the depressive episode was not evaluated. Since the study is cross-sectional, the predictors determined by linear regression analysis should be supported by longitudinal studies.

As a result, we showed that SZ and BPAD I patient groups received significantly worse results in social-perceptual ToM and social-cognitive ToM than healthy controls. While BPAD I patients had similar social-perceptual ToM impairments to SZ patients, they performed better in social-cognitive ToM skills than SZ patients. In addition, the executive functions and formal thought disorders are the best predictors of DEToMI in SZ patients whereas in patients with BPAD I, it is emotion recognition. Emotion recognition and executive functions were the best predictors of social-perceptual ToM assessed by RMET in both patient groups. Although the patients with SZ and BPAD I were similar to each other in terms of facial recognition and recognizing facial expressions other than fearful, they were found to have impairments compared to healthy controls. The healthy controls are the best in recognizing fearful expressions with which patients with SZ had the most difficulty.

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