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ORIGINAL ARTICLE

Investigating False Memory and Illusory Pattern Perception Bias in Schizophrenia Patients with and without Delusions

Metehan Irak[1] · **Ayşen Karahan**[2]

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Abstract

Background Whether the false memory dysfunction in schizophrenia is at the early (encoding, perceptual) or later (retrieval) stages and how delusions affect it remains unclear.

Method In this study, we examined the perception and memory biases in schizophrenia patients with (Sch/D; n = 31) and without delusions (Sch/Nd; n = 32) and compared them with healthy controls (HCs; n = 35). We used the Deese Roediger McDermott (DRM) Paradigm and the Noise Task to measure the false memory and illusory pattern perception (IPP) biases, respectively.

Results We found that the patient groups performed lower in both the recall and recognition phases for the DRM and the Noise tasks and made more errors compared to the HC group. Additionally, the performance of the Sch/D group was remarkably lower than the Sch/Nd and HC groups.

Conclusions Our results indicated that the information-processing problem in schizophrenia exists in both the encoding and retrieval stages. Also found significant relationship between the presence of delusions and the increase in cognitive deficits.

Keywords Schizophrenia · Delusion · Information-processing · False memory · Illusory pattern perception

Introduction

Schizophrenia is a chronic mental illness that starts in young age and continues with recovery and relapse processes. It characterizes by abnormal ideas like delusions, abnormal perceptions like hallucinations, disorganized speech, behavioral and emotional disorders like affective inappropriateness, and often vary with cognitive, emotional and other functional impairments of behavior (Bowie & Harvey, 2006; Evans et al., 2015). Delusions are one of the most common features of schizophrenia, and they refer to false beliefs that are not based on reality (Bhatt et al., 2010; Dehon et al., 2008; Moritz et al., 2005).

Clinical observations reported that when delusions are present and their severity increases, individuals could produce memory for non-existent situations and events, create connections between random conditions and circumstances, and show memory distortion and bias (Bhatt et al., 2010). Memory bias is a type of cognitive bias that may either improve or impairs the recall memory, and it may alter the content of what we report remembering (Fairfield et al., 2016). However, false memory refers to situations in which people recall events different than they occurred or, in the most extreme scenario, remember events that never occurred (Loftus & Pickrell, 1995). Two critical questions need to be addressed regarding information processing in schizophrenia. First, it is still unclear whether the source of memory bias is in the encoding (learning, perception) or remembering (retrieval) stage. The second is whether the presence of delusions in schizophrenia affects this problem. Therefore, this study aims to investigate the effects of delusions on false memory and illusory pattern perception (IPP) biases in schizophrenia patients with and without delusions. We used Deese, Roediger, and McDermott

✉ Metehan Irak
metehan.irak@eas.bau.edu.tr

✉ Ayşen Karahan
aysenkarahan@gmail.com

1 Department of Psychology, Brain and Cognition Research Laboratory, Bahcesehir University, Çırağan Cad. No:4 Beşiktaş, Istanbul 34353, Turkey

2 Department of Psychiatry, University of Health Sciences Istanbul Bağcılar Training and Research Hospital Dr. Sadık Ahmet Cad. Bağcılar, 34093 Istanbul, Turkey

(DRM) paradigm to measure false memory bias and Noise Task to measure IPP. The DRM task is based on memory; however, the Noise Task is based on perceptual processes. Both cognitive tasks have encoding, recall and recognition stages. Therefore, two tasks used in this study assess different performances (e.g. hit, false positive, false negative) by collecting information from different stages of these tasks (e.g. encoding, recall, recognition), which makes it possible to get information about the source of memory bias.

False Memory in Schizophrenia

False memory differentiates processing in encoding, storing, and retrieving these memories (Fairfield et al., 2016). There is a significant increase in false memory studies in schizophrenia; results, however, are mixed. Previous studies using the DRM paradigm indicated that basic memory intrusions are quite common memory functions in patients with schizophrenia. During the DRM Task, participants are presented with lists of semantically related words (e.g. pillow, bed) at encoding. Then participants are asked to recall or recognize (whether subjects remember previously presented words, as well as related -but never presented- critical lure words) these words (e.g. sleep) (Roediger & McDermott, 1995). According to the activation-monitoring theory, two factors, namely, false monitoring and retrieval of information and activation or coding of related information were effective during the emergence of false memories in the DRM task. It was proposed that examining a lure's associations activates its representation in memory, which expands the likelihood of individuals will have errors with that lure on a future memory test (e.g. Johnson et al., 1993; Underwood, 1965; Van Damme & d'Ydewalle, 2008). On the other hand, the fuzzy trace theory proposes that the stimulus encountered leaves two types of traces in the memory. While verbatim strategy required specific and detailed features regarding recall or recognition, gist strategy required only general and basic features. The DRM paradigm is an effective method to measure the formation of false memory with its high level of semantic overlap in the word lists presented to individuals, and its strong gist strategy effect (e.g. Brainerd & Reyna 1998, 2002; Van Damme & d'Ydewalle, 2008).

Studies using DRM task in patients with schizophrenia indicated that patients are more prone to false memories, increased memory confidence for false memories, made more false positives errors and showed more knowledge corruption (biases and errors in judgment that people fail to foresee or detect in themselves) might contain many intrusions (e.g. Bhatt et al., 2010; Lee et al., 2006; Moritz et al., 2002, 2005, 2006; Paz-Alonso et al., 2013; Peters et al., 2007 Peters et al., 2012).

It was argued that patients with schizophrenia rely on a more fragile decision criterion and less information than healthy individuals because they had a higher degree of certainty regarding their false recognition and omissions errors. However, patients showed lower certainty regarding their correct answers (e.g. Bhatt et al., 2010; Eifler et al., 2015; Moritz et al., 2004; Moritz et al., 2006; Peters et al., 2012; Zhu et al., 2018). In addition, different hypotheses were proposed about the performance variability of patients with schizophrenia in the DRM task. For instance, false memory is linked to a reduced connection between encoding and retrieval processes (Barch et al., 1996) and a lack of attention during the encoding phase (Heinrichs & Zakzanis, 1998). Furthermore, Lee et al. (2007) proposed that low recognition performance is associated with insufficient item-specific processing (encoding individual stimuli). However, in another proposition, low recall performance for studied items is linked to the reduced association between relational (encoding of similarities among a group of stimuli) and conceptual processing during encoding (Paz-Alonso et al., 2013).

Compared to correct answers and false recall, other variables of the DRM task, including critical items and distractors (falsely recognized unstudied and unassociated items), received less attention. Although previous studies (e.g. Bhatt et al., 2010; Elvevag et al., 2004; Lee et al., 2007; Paz-Alonso et al., 2013; Peters et al., 2007) did not find differences between patients and healthy controls regarding critical items, patients' recognition performance for unstudied and unassociated items higher than controls. In addition, studies investigated relationships between clinical symptoms (delusions or hallucinations) and false memory variables found that an increase in delusions and false memory performance (Bhatt et al., 2010), positive correlations between lures (falsely recognized, semantically associated items that were not presented) and distractors and Positive and Negative Syndrome Scale (PANSS; Peters et al., 2012) and positive correlations between true and false memory rates and severity of disorganized and negative symptom scores (Paz-Alonso et al., 2013; Peters et al., 2012). However, other studies (e.g. Eifler et al., 2015; Moritz et al., 2004) reported no significant correlations between these variables. Consequently, the mixed results above revealed that the primary mechanism of the false memory process in patients with schizophrenia is not yet fully understood. Furthermore, various inclusion and exclusion criteria (e.g. age range, symptom severity, treatment history, age of onset, and general cognitive state) were used to form the patient group in these studies, may have paved the way for the mixed results.

Perception in Schizophrenia

Investigating perceptual processing in schizophrenia may contribute to the understanding of positive symptoms. Studies investigating visual perception problems in schizophrenia have reported that due to high and low-level integration mechanisms problems, patients may experience problems in different stages of the visual system affecting either early or late processing (or both) (Zeljic et al., 2021). Previous studies indicated that patients with schizophrenia show some specific abnormalities rather than deficits to general low-level processes and a general trend of increased resistance to high-level visual illusions (for review, see King et al., 2017). These low-level integration anomalies might affect how patients with schizophrenia perceive basic elements of visual stimulus (edges, contrasts), thus leading to a different visual perception process compared to healthy individuals (Kantrowitz et al., 2009).

The perception of meaningful and organized relationships between random and unrelated stimulus clusters is illusory pattern perception (IPP; Whitson & Galinsky, 2008). Relational and conceptual processing during encoding is not fully functional in schizophrenia (Paz-Alonso et al., 2013). In addition, a relationship between unrelated events that form the basis of belief in conspiracy theories is interpreted as IPP. People who believe in high-level conspiracy theories are significantly more inclined to interpret random sequences as set patterns (Çetin & Irak, 2021; Van Prooijen et al., 2018). This form of stereotyping also has the advantage of reducing uncertainty in the world and making the world more predictable. However, it can also be regarded as the beginning of false beliefs, a tendency to doubt, paranoia and conspiracy theories (Walker et al., 2019).

The tendency of people to be deceived by misleading patterns may be related to misunderstanding the actual pattern or trying to validate (or believe) a misleading one (e.g., Beck & Forstmeier 2007; Foster & Kokko, 2009; Shermer, 2011). It was found that participants who perceive patterns in chaotic and unstructured modern art paintings demonstrated greater belief in existing conspiracy theories and imaginary models of conspiracy theories (Van Prooijen et al., 2018). Also people who were manipulated to have a feeling of lack of control had a greater need to perceive clear patterns, perceived more misleading patterns by identifying images in pictures with no real images than the control group (Whitson & Galinsky, 2008). Delusional experiences in humans include supernatural beliefs and conspiracy-like beliefs, and IPP is linked to a lack of control and belief in conspiracy theories (Van Prooijen et al., 2018). Thus, it can be assumed that schizophrenia patients with delusions may produce more illusory patterns during perceptual tasks.

While cognitive bias, a pattern of systematic deviation from norm or rationality in judgment, refers to the tendency to make decisions or act irrationally, it can lead to perceptual distortions, misjudgments and illogical interpretations, can accelerate the decision-making process, increase the probability of making mistakes in changing situations, and hinder rational solutions. These considerations are important, and in terms of memory bias and perception, the decision-making process involves thinking and reasoning (Arnott, 2006; Phillips-Wren et al., 2019; Power, 2016).

Goal of the Study

Information processing comprises interrelated sub-processes. Therefore, a problem in one of the sub-process may affect the others. As mentioned, whether the false memory dysfunction in schizophrenia is at the early (encoding, perceptual) or later (retrieval) stage remains unclear. In other words, false memory dysfunction results from a problematic perceptual process, a memory (retrieval) process, or a combination of both. In addition, the presence of delusions may affect the relationships between perception and memory processes. However, this question also remains unknown. Thus, one of the best strategies to clarify these problems is to examine both perception and memory processes in schizophrenia patients with and without delusional symptoms. Therefore, we investigated false memory and IPP bias in schizophrenia patients with delusion (Sch/D) and without delusion (Sch/Nd) and compared them with healthy controls (HCs). We used the DRM paradigm and the Noise Task to measure false memory and IPP biases, respectively. As discussed earlier, patients with schizophrenia experience problems in different stages of the visual system affecting either early or late information processing. Thus, we choose the Noise Task because it measures the early and late stages of the perceptual process. We assumed that false memory dysfunction and IPP biases of schizophrenia patients with delusions differ from those without delusions.

There are three hypotheses in the present study. The first hypothesis is the Sch/D group will show lower performance (e.g. higher false positive and false negative errors but lower hits) during the DRM task compared to the other groups. The second hypothesis is the Sch/D group will show lower performance (e.g. higher false positive and false negative error but lower accurate perception) than other groups during the Noise Task. Lastly, we hypothesized that there would be negative correlations between the patient groups' DRM accurate recall and recognition, Noise Task accurate perception (in the first and second phases), and positive subscale of PANSS, which reflects symptom severity. In addition, the above-mentioned studies showed that possible confounding factors, namely onset, and duration of illness, affect cognitive performances. Therefore, although this question is out of our primary goal, we analyze relationships between cognitive task scores, and these variables in patient groups.

Method

Participants

Participants consisted of three groups, namely the schizophrenia patients with delusion (Sch/D) (n = 32), schizophrenia patients without delusion (Sch/Nd) (n = 31) and the healthy controls (HCs) (n = 35). The demographic data are presented at Table 1. Diagnosed participants were outpatients registered at Community Bağcılar Mental Health Center and Education and Research Hospital in Istanbul. Participants ranged from 20 to 55 years old ($M = 38.58$; $SD = 9.32$). The age differences were insignificant across the groups ($F = 0.576$, $p = .56$). An a priori power analysis using the G*Power program (Erdfelder et al., 1996) indicated a total sample of 90 people would be needed to detect small-medium effect size ($f = 0.2$) with alpha level of 0.05 and power of 0.80.

The diagnosed participants met *the Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (DSM-5) criteria (American Psychiatric Association, 2013) for schizophrenia, as determined by a psychiatrist through a clinical interview. They were clinically stabilized outpatients treated with a stable dose of the same antipsychotic for at least three months before the study enrollment. Diagnosed participants were divided into two groups according to their delusion scores on the PANSS. In addition, all participants were screened for depression, anxiety, and emotional symptoms using the Inventory of Depression and Anxiety Symptoms-II (IDAS-II; Irak &Albayrak 2020). The inclusion criteria for the diagnosed groups were: having a minimum primary school degree, minimum level of computer skills, a Mini-Mental State Examination (MMSE) score above 24, and the IDAS-II subscale scores below clinical level. Patients were excluded if they (1) fulfilled criteria for an Axis I diagnosis other than schizophrenia, (2) had an IQ score below 85, (3) had severe physical illness, (4) documented or suspected brain damage and/or neurological disease. Control participants were included if they had (1) at least a primary school degree, (2) at least a minimum level of computer skills, (3) an MMSE score above 24, (4) no current and past psychiatric history, and (6) no diagnosis of schizophrenia of their first-degree relatives.

Table 1 Demographic information of study groups

	Sch/D	Sch/Nd	HC
Age			
Min/Max	22–55	23–55	20–55
Mean (SD)	39.50 (8.68)	39.19 (9.18)	37.20 (10.45)
Gender (%)			
Male	19.38	22.44	17.34
Female	13.26	9.18	18.36
Level of Education (%)			
Primary	71.87	48.38	45.71
High School	18.75	41.93	40.00
University	9.38	9.69	18.25
Mean (SD) **of Duration of Illness**	20.03 (7.60)	18.16 (8.75)	
Mean age (SD) **of onset**	19.46 (3.56)	21.00 (2.33)	

Sch/D: Schizophrenia with delusion, Sch/Nd: Schizophrenia without delusion, HC: Healthy control

Measures

Clinical Measures

The Mini Mental State Exam (MMSE) It was developed by Molloy and Standish (1997) to evaluate various cognitive domains (time and place orientation, registration, attention and calculation, recall and language). The test's total score is 30 and a score of 24 or higher is a cutoff indicating the absence of cognitive impairment. The Turkish form of MMSE's validity and reliability study was conducted by Gungen et al. (2002).

Beck Anxiety Inventory (BAI) The BAI (Beck et al., 1988) consists of 21 items for each symptom of anxiety, and each item is scored between 0 and 3 points. The Turkish form of BAI's validity and reliability study was conducted by Ulusoy et al. (1998). In our sample, Cronbach's alpha coefficient was found to be 0.80.

Beck Depression Inventory (BDI) The BDI (Beck, 1961) is a self-report inventory, consists of 21 items, and the total score is 63. The Turkish form of BDI's validity and reliability study was conducted by Hisli (1988). In our sample, Cronbach's alpha coefficient was found to be 0.79.

The Positive and Negative Syndrome Scale (PANSS) The PANNS was developed to determine the primary symptoms of schizophrenia and the severity of these symptoms (Kay et al.,1987). The Turkish version of PANSS was conducted by Kostakoglu et al. (1999). In our study, we used the same cut-off point (19) to determine the delusion levels of the two groups, as Kay et al. (1987) suggested. In our sample, Cronbach's alpha coefficient was found to be 0.81.

The Inventory of Depression and Anxiety Symptoms (IDAS-II) The IDAS-II was developed by Watson et al. (2012), to assess anxiety and depression symptoms as well as emotional disorder symptoms. IDAS-II consists of 99 items and 18 subscales (self-report, scored between 1 and 5). The Turkish version of IDAS's reliability and validity were conducted by Irak and Albayrak (2020). In our sample, Cronbach's alpha coefficients were found to be between 0.61 and 0.83 for all subscales.

Cognitive Tasks

As mentioned earlier, the DRM task was used to measure false memory bias; and, the Noise task was used to measure IPP bias. The DRM task consists of encoding (learning), recall, and recognition. On the other hand, the Noise Task consists of encoding and recognition phases. Therefore, using these two tasks, it is possible to obtain information about the source of memory bias (encoding or retrieval) in schizophrenia.

The Deese–Roediger–McDermott (DRM) Task The DRM lists developed by Göz (2005) for the Turkish population were used in this study. There were six lists, each consisting of 11 words and one target word (the word expected to be produced by the participants). In the first phase of the experiment (encoding), the word lists were randomly shown to the participants (2 s) on the computer. Then, they were asked to write down (recall) as many words as they could recall on a paper in 2 min. In the third phase (recognition), 54 words were shown to the participants (2 s) and they were asked to decide whether they had seen these words before. There were 12 old items (previously shown), six were target words, 12 were semantically similar, another 12 were physically similar, and the remaining 12 words were completely unrelated -new words. For the recall phase, accurate recall (the number of correctly recalled words), the target word (the number of words expected to be produced), and the false positive recall (the total number of unexpected but produced words and target words) scores, for the recognition stage, on the other hand, accurate recognition (sum of hit and correct rejection recognition), false negative (miss recognition), and false positive (false alarm recognition) scores were calculated for each participant.

The Noise Task The Noise Task was developed by Szekely et al. (2005) consisted of 50 images selected from the International Picture Naming Project. The images were manipulated to have visual noise, making it difficult to see the objects they contained. Twenty-five of them contained an actual object behind the noise filter. The remaining 25 images contained no actual object at all. Fifty images were presented on a computer screen in a randomized order. In the first phase, participants were asked to decide if they saw an object or not for each image. Participants used a computer keyboard to respond (yes or no). They were also asked to define the object when they thought there was an object in an image. In the second phase (recognition), a total of 50 pictures (25 from the images previously seen -old items, 25 from the same image database but not included during the second task of the phase -new items) were presented to participants without any noise filter. Participants were asked whether they had seen this picture in the first stage (yes or no). For the first phase, the accurate perception (when the participants saw a real object in the displayed image –yes response- and decided that there is no object in the displayed image –no response-), false negative perception or missed (if the participants had decided that there was an object in the image, but there was no object), IPP-false alarm or false positive (if the participants had decided to see an object in an image that did not contain an object) scores were calculated for each participant. On the other hand, in the recognition phase, the accurate recognition (correctly decided to the hidden object in a noise picture was true or false), false positive (incorrectly decided hidden object in a noise picture), false negative (incorrectly decided to no hidden object in a noise picture) and identifying paradigm (false positive) scores were calculated for each participant. There were no time limits during the experiments. However, participants were instructed to perform the task as fast and accurately as possible. The size for all images was 22 cm x 22 cm and was presented on a black background.

Procedure

The study conformed to the Declaration of Helsinki and was approved by the host Institute's Research Ethics Committee. Participants provided written informed consent and were free to withdraw from the study at any point. Participations were voluntary, and participants did not receive any financial compensation.

Initially, 110 subjects (67 patients, 43 healthy controls) were recruited. Unfortunately, three patients were excluded from the study because their depression scores were high, and one person refused to participate in the study after the initial assessment was completed. Likewise, eight participants in the control group were excluded due to their high depression and anxiety scores after the initial assessment. The study was conducted in two separate sessions for patients. In the first session, clinical measures were administered; however, cognitive tasks were carried out in the second session. On the other hand, HCs' assessment was conducted in one session. During the assessments, there was a small break between clinical measures and cognitive tasks. The order of the cognitive tasks was counterbalanced. Total assessment time was 3.5 to 4 h for clinical groups; on the other hand, it was 1.5 to 2 h for HCs.

Results

Three groups' MMSE, BDI and BAI total scores were compared using multivariate analysis of variance (MANOVA). Results are reported in Table 2. The mean total score of MMSE in the HCs was significantly higher compared to the patient groups. However, results indicated that the three groups were not different on BDI, BAI, and IDAS-II subscales. The Sch/D group's PANSS positive and negative subscale scores were significantly higher than the Sch/Nd group.

Group Comparisons for DRM Task

Results and descriptive statistics are presented in Table 3. MANOVA results showed that the group main effect was significant on the accurate recall, target word recall, accurate recognition, target word recognition, false positive recognition, false negative recognition and missed items ($F(2,95) \geq 4.26$, $p \leq .029$). Post-hoc comparisons showed that the HC group performed significantly better for all variables than the patient groups (all $p \leq .001$). Although the differences between the HC group and the patients' groups were significant for target item recall and accurate recall (all $p \leq .01$), the differences between patient groups for these variables were not significant. In addition, the mean difference between the Sch/D and Sch/Nd groups was significant for accurate recognition, target item recognition, false positive, false negative, correct rejection, and missed item variables (all $p \leq .01$) and for those variables, the Sch/Nd group showed higher performance than the Sch/D group (see Table 3.).

Table 2 Comparison between study groups on MMSE, BAI, BDI, and PANNS Positive Total Scores: MANOVA Results with Descriptive Statistics

Scales	Groups	Mean (SD)	Mean comparison	Post-Hoc
MMSE	Sch/D	26.19 (1.59)	21.60***	Sch/D = Sch/Nd < HC
	Sch/Nd	27.00 (1.61)		
	HC	28.60 (1.39)		
BAI	Sch/D	7.69 (1.87)	0.058	
	Sch/Nd	7.52 (2.18)		
	HC	5.63 (2.01)		
BDI	Sch/D	8.81 (2.20)	1.920	
	Sch/Nd	7.71 (2.92)		
	HC	5.63 (2.01)		
PANSS Positive	Sch/D	22.63 (1.38)	17.02***	
	Sch/Nd	16.65 (1.40)		
PANSS Negative	Sch/D	20.81 (3.96)	4.62***	
	Sch/Nd	16.29 (3.80)		

Note: MMSE: Mini-Mental State Examination, BAI: Beck Anxiety Inventory, BDI: Beck Depression Inventory, PANNS: The Positive and Negative Syndrome Scale, Sch/D: Schizophrenia with delusion, Sch/Nd: Schizophrenia without delusion, HC: Healthy control. *** p < .001

Group Comparisons for Noise Task

MANOVA results showed that the group main effect was significant on hit, false negative, and accurate perception in the first phase and hit, false negative, and accurate perception in the second phase of the Noise Task ($F(2,95) \geq 4.16$, $p \leq .037$). Post-hoc comparisons showed that for all variables, the Sch/D groups showed lower performance than the Sch/Nd and HCs' (see Table 4.). In detail, HC groups showed significantly higher performance than patients groups for all variables (all $p \leq .001$). Although for all variables, the Sch/Nd group's performance was higher than the performance of the Sch/D group, these differences were not statistically significant.

Effects of Symptom Severity and Age of Onset

Pearson correlations were conducted to test relationships between PANSS positive subscale (symptom severity) and cognitive task performance, namely the DRM task accurate recall and recognition and the Noise Task accurate perception (in the first and second phases). The PANSS positive subscale significantly negatively correlated with DRM accurate recall ($r(63) = -0.248$, $p < .05$), with DRM accurate recognition ($r(63) = -0.698$, $p < .001$), and with Noise Task accurate perception scores in the first ($r(63) = -0.272$, $p < .05$) and in the second ($r(63) = -0.225$, $p < .05$) phases. These results indicated that as symptom severity increases, memory performance in both tasks decreases. Therefore, we repeated group comparisons with symptom severity scores as covariates. However, results remained similar. Furthermore, besides correlations between the cognitive task variables, the age of onset and the duration of illness was insignificant ($p \geq .207$). Thus, these results indicated that the statistical group differences reported above could not be attributed to the level of symptom severity, age of onset, and duration of illness of the participants.

Table 3 Comparison between study groups on DRM Task's variables: MANOVA Results with Descriptive Statistics

Phase	Variable	Groups	M (SE)	F	Post-Hoc
Recall	Target Word	Sch/D	0.53 (0.13)	5.59**	Sch/D = Sch/Nd < HC
		Sch/Nd	0.65 (0.22)		
		HC	1.37 (0.23)		
	Accurate Recall	Sch/D	18.08 (0.96)	38.88***	Sch/D = Sch/Nd < HC
		Sch/Nd	19.90 (0.84)		
		HC	30.06 (1.25)		
	False Positive	Sch/D	2.03 (0.33)	1.18	
		Sch/Nd	2.61 (0.83)		
		HC	3.20 (0.38)		
Recognition	Target Word	Sch/D	1.13 (0.23)	24.17***	Sch/D < Sch/Nd < HC
		Sch/Nd	2.39 (0.26)		
		HC	3.74 (0.31)		
	Accurate Recognition	Sch/D	21.06 (1.30)	53.38***	Sch/D < Sch/Nd = HC
		Sch/Nd	37.68 (1.26)		
		HC	37.40 (1.32)		
	Hit	Sch/D	6.25 (0.49)	11.31***	Sch/D < Sch/Nd = HC
		Sch/Nd	8.00 (0.41)		
		HC	9.11 (0.39)		
	False Negative	Sch/D	3.48 (0.44)	4.26*	HC < Sch/Nd = Sch/D
		Sch/Nd	2.34 (0.40)		
		HC	2.14 (0.35)		
	False Positive	Sch/D	14.88 (1.99)	4.59*	HC < Sch/Nd = Sch/D
		Sch/Nd	10.06 (1.36)		
		HC	10.03 (0.90)		
	Correct Rejection	Sch/D	14.81 (1.40)	40.01***	Sch/D < Sch/Nd = HC
		Sch/Nd	28.26 (1i32)		
		HC	29.68 (1.14)		
	Missed Item	Sch/D	15.72 (1.72)	39.50***	Sch/D > Sch/Nd > HC
		Sch/Nd	2.90 (0.43)		
		HC	4.49 (0.74)		

Note: Sch/D: Schizophrenia with delusion, Sch/Nd: Schizophrenia without delusion, HC: Healthy control. *p < .05, **p < .01, ***p < .001

Discussion

Here we compared schizophrenia patients with delusions (Sch/D), without delusions (Sch/Nd), and healthy controls (HCs) on false memory (DRM Task) and illusory pattern perception (IPP) to understand whether the information processing problem in schizophrenia at the encoding or retrieval stage and how delusions affect them. For the DRM and IPP Tasks, the Sch/D group showed less accurate recall and recognition performance and made more errors than the Sch/Nd and HC groups. The following sections discuss the results separately for each task.

False Memory Bias in Schizophrenia

Supporting our hypothesis, we found that the Sch/D group showed poor recall and recognition performance, produced less target words, and produced more false-positive and false-negative errors than the other groups. Previous studies (e.g., Bhatt et al., 2010; Stirling et al., 1997) indicated that patients with schizophrenia showed reduced performance on different memory tasks, produced more false-positive recall and recognition errors and remembered fewer correct words than the HCs. These results indicated that schizophrenia patients may have generalized verbal memory problems (both recall and recognition), which was more common and comprehensive than memory disorder, implying a decrease in an item or source-specific remembering and consequent dependence on familiarity.

Despite that, other studies (e.g. Moritz et al., 2004, 2005, 2006; Weiss et al., 2008) indicate no false memory problems in schizophrenia. On the other hand, these studies revealed noticeable memory-related differences (e.g. encoding and retrieval) between the Sch/Nd and HC groups. For instance, Lee et al. (2007) found that schizophrenia patients exhibited more deterioration in item-specific and gist memory performance compared to the HCs. Also, the Peter Delusion Inventory (PDI) determined the level of delusional susceptibility, and individuals prone to delusions with higher PDI scores produced significantly more false-positive responses and made more errors (e.g. Dehon et al.,2008; Laws &

Table 4 Comparison between study groups on Noise Task's variables: MANOVA Results with Descriptive Statistics

Task Number	Variable	Groups	M (SE)	F	Post-Hoc
First Task	Hit	Sch/D	16.09 (1.18)	4.35*	Sch/D = Sch/Nd < HC
		Sch/Nd	17.29 (1.21)		
		HC	20.69 (1.10)		
	False Negative	Sch/D	8.91 (1.18)	4.32*	Sch/D = Sch/Nd < HC
		Sch/Nd	7.68 (1.22)		
		HC	4.31 (1.10)		
	False Positive	Sch/D	7.38 (1.22)	4.43*	Sch/D < Sch/Nd = HC
		Sch/Nd	5.90 (1.18)		
		HC	4.51 (0.63)		
	Correct Rejection	Sch/D	17.62 (1.21)	2.01	
		Sch/Nd	19.13 (1.17)		
		HC	20.49 (0.63)		
	Accurate Perception	Sch/D	33.72 (1.17)	11.18***	Sch/D = Sch/Nd < HC
		Sch/Nd	36.42 (1.20)		
		HC	41.17 (1.07)		
Second Task	Hit	Sch/D	9.81 (1.17)	5.09**	Sch/D = Sch/Nd < HC
		Sch/Nd	10.13 (1.43)		
		HC	14.66 (1.07)		
	False Negative	Sch/D	15.19 (1.17)	5.20**	Sch/D = Sch/Nd > HC
		Sch/Nd	14.94 (1.42)		
		HC	10.34 (1.07)		
	False Positive	Sch/D	8.49 (1.23)	4.88*	Sch/D > Sch/Nd = HC
		Sch/Nd	6.41 (0.86)		
		HC	5.32 (0.77)		
	Correct Rejection	Sch/D	17.81 (1.23)	1.88	
		Sch/Nd	16.94 (0.86)		
		HC	19.55 (0.77)		
	Accurate Perception	Sch/D	27.63 (1.14)	4.16*	Sch/D = Sch/Nd < HC
		Sch/Nd	29.68 (1.18)		
		HC	31.60 (0.61)		

Sch/D: Schizophrenia with delusion, Sch/Nd: Schizophrenia without delusion, HC: Healthy control. *p < .05, **p < .01, ***p < .001

Bhatt 2005). Our results are consistent with these studies in which the Sch/D made significantly more false-positive and false-negative errors than the Sc/Nd and HCs. It was argued that false-negative differences might result from differences between the formation and maintenance of delusions (e.g. Bhatt et al., 2010), Moritz et al., 2004, 2005, 2006). We concluded that an increase in false-negative responses underpins individuals' defensive reactions when faced with misleading evidence and contradicts their false beliefs.

People diagnosed with schizophrenia tend to have difficulty during the source monitoring process and are expected to make more errors during recognizing non-presented semantically related words (Keefe et al., 2002; Vinogradov et al., 1997). Moreover, it is expected that individuals can report more non-presented semantically related words than studied words because after studying semantically related words, the cumulative activation of the non-presented related words may be greater than the semantic activation of the studied words. In addition to semantic memory deficits, patients with schizophrenia typically have also deficits in episodic memory, which may result from difficulty acquiring item-specific information and abnormalities in their semantic memory. Thus, based on previous studies discussed above and our results, we concluded that patients with schizophrenia exhibit a weaker spread of activation and that a combination of item-specific and gist-based memory issues may cause their failure in the memory process.

Alternatively, it was proposed that strong semantic (gist) coding versus weak physical (verbatim) coding was the cause of memory error during the DRM task. When people are asked to remember the words in the test phase, recall is based on semantic encoding since the physical encoding is entirely or partially lost; options close in meaning to the original stimulus are considered the original stimulus; it is this mechanism that is the basis of memory error (Brainerd & Reyna, 2004, 2012). In the DRM task, the target word is not phonologically similar to the list words. However, it can mistakenly be produced during the recall and/or recognition phase due to semantic relations because physical encoding is weaker than semantic encoding. In our study, we found that the Sch/D group showed poor performance for correct rejection, accurate recall and accurate recognition than the other two groups in both stages of the DRM task. However, their false positive, false negative and number of missed items scores were significantly higher than the other groups. Thus, we concluded that patients diagnosed with schizophrenia have memory deficits associated with both the encoding and retrieval phases. In addition, higher memory problems associated with the presence of delusions. We also argued that multiple and interrelated errors during the encoding stage, which are inaccurate processing of physical and semantic clues and inability to integrate and parse them, reveal the memory deficit.

Illusory Pattern Perception in Schizophrenia

In the Noise Task's first and second phases, the Sch/D group showed lower hit and accurate perception scores; they produced higher false positive and false-negative errors than the other groups. In parallel with our hypothesis, patients made more perception (decision) errors regarding whether images contained any object and were less successful at recognizing stimuli they had seen and/or had not seen before. The results were consistent with the previous study (Van Prooijen et al., 2017) that ambiguous stimulus did not play a precipitating role for people with a tendency to have delusions neither for seeking meaningful patterns nor producing non-existent illusory patterns.

Hypersensitivity is in the early stages of the disease and in untreated patients with schizophrenia turns into hyposensitivity and begins to affect visual perception. Changes (or inconsistency) in visual signals can lead to the formation of inconsistent internal models of the world (Adámek et al., 2022; Butler et al., 2008). In addition, the lack of control and integration required for the perceptual function is strong evidence of their impairment in schizophrenia. The strength of both constructs is that they are based on both computational and cognitive theory and known brain functions in humans and animals (Butler et al., 2008). IPP was usually studied concerning lack of control phenomena. Previous studies (e.g. Greenaway et al., 2013, van Elk & Lodder 2018; Whitson & Galinsky, 2008) showed that the IPP level increases with uncertainty as lack of control decreases. For instance, Greenaway et al. (2013) showed that threat did not inevitably lead to prejudice but interacted with levels of perceived control to guide social defensiveness. The authors also explained perceived control as an essential psychological resource that could work to overcome socially detrimental effects of threat. Thus, decreased perceived control and increased threat might cause visual perception (and interpretation) errors and consequent memory problems in schizophrenia.

Schizophrenia patients used more limited visual scanning, spent more extended time on a specific feature of an image, and they showed less attention shift (Sprenger et al., 2013). It was emphasized that these processes became more evident as the cognitive complexity and emotional strain of visual signals increased. Consistent with our hypothesis, schizophrenia patients were less successful at both phases of the IPP task and made more false-negative and false-positive errors. False-negative perception causes people to be unable to realize and protect themselves when faced with dangerous situations and uncertainty (Blanco, 2017). In addition, we found that patients with schizophrenia did not perceive objects accurately they saw in the noise image and could not identify what they saw, and Sch/D group made more errors than Sch/Nd. These results are consistent with previous studies (Taylor & Brown, 1988; van Elk & Lodder 2018) in which people with schizophrenia could not detect stimuli that posed a danger to them and could not exhibit self-protective behavior. During the assessments, we also observed that the Sch/D group tended to create a pattern perception out of randomness in the noise image shown to them and to identify this as an object. The human cognitive system detects and interprets environmental patterns to predict essential outcomes and optimize behavior. However, we concluded that patients with schizophrenia are unsuccessful in visual perception optimization due to having problems integrating low- and high-level visual perception systems.

In conclusion, our results have contributed to understanding memory and perception errors/bias in schizophrenia. In the recall and recognition phases of perception and memory tasks, patients with schizophrenia showed lower perception and memory performance than HCs. Furthermore, they made higher false-positive and false-negative errors than HCs suggesting that incorrectly encoded (or perceived) information causes more memory errors and deficits. Lastly, the presence of delusions related to higher memory deficits. Cognitive intervention and therapy programs designed to improve cognitive skills and minimize the cognitive decline in schizophrenia should focus on both encoding and memory processes. In addition, these programs should be arranged considering the existence of delusions.

There are some limitations to the study. First, the level of education among the groups was not balanced. Second, although we gave small breaks during the experiments, we observed that some patients were tired. This fatigue may have adversely affected the results. Third, we did not assess confidence and metacognitive judgments. Including judgments ratings in cognitive research can potentially increase our knowledge of memory bias in schizophrenia. Fourth, although we compared delusional schizophrenic patients with non-delusional schizophrenic patients and healthy controls, no other psychiatric comparison group was recruited. Fifth, there are some criticisms of PANSS (e.g. obsolete categorizing of symptoms). Although different scales can be used to evaluate positive syndromes in schizophrenia, their Turkish validity and reliability studies have not yet been conducted at the time of our study. Lastly, although we excluded people who have had Covid-19, it should be considered that some of the data were collected during the Covid-19 pandemic. Therefore, these variables should be taken into account in future studies.

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Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

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