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Research Paper: Preferences, Descriptions, and Response Latency to Fractal Images Among Individuals With and Without Schizophrenia

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ABSTRACT

Background: Early simple, low-cost diagnosis of schizophrenia may accelerate the beginning of the treatment process. Here, utilizing the projective tools, including fractal images, are some of the diagnostic aids.

Objectives: This study aimed to compare the preferences, descriptions, and response latency to fractal images between schizophrenic and healthy individuals.

Materials & Methods: In this case-control study, the statistical population included all schizophrenic patients hospitalized in Shafa Hospital in Rasht City, Guilan, Iran, in summer 2018 and matched healthy individuals considering the gender and age. Twelve fractal images were shown to schizophrenic patients and healthy people, and their psychological projections to these pictures were recorded.

Results: For the image called extraviganze, the latency time to elicit the descriptions in patients was noticeably more than that in the healthy group (t=2.465, df=58, P=0.017). Meanwhile, the patients' interest in dark and dreadful fractals such as fractal beings, North, and Apophys eyes was significantly higher than that in the healthy group (P<0.05). However, people with schizophrenia refrained from bright, light fractals with a regular geometric/graphical structure such as Gridspace and redf-shift images (P<0.05). The people with schizophrenia provide less appropriate associations and more irrelevant descriptions, especially about the abstractive and complex fractals, compared to the healthy group.

Conclusion: The latency to elicit descriptions for fractal images in people with schizophrenia is longer than that in the healthy group, and they have more pauses, irrelevant, and incoherent speech when describing more abstractive images. People with schizophrenia prefer darker, more dreadful images and avoid clear, luminous, and fractal images with a regular geometric/graphical pattern.

Keywords: Schizophrenia; Fractals; Reaction time; Patient preference

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Highlights

- Latency to elicit descriptions of fractal images in people with schizophrenia is longer than that in healthy individuals.
- People with schizophrenia have more pauses, irrelevant, and incoherent speech than healthy people when describing more abstractive images.
- People with schizophrenia give darker, more dreadful images a higher priority than healthy people.
- Compared to healthy people, those with schizophrenia avoid clear, luminous, and fractal images with a regular geometric/graphical pattern.

Introduction

Schizophrenia is a well-known complex syndrome characterized by various symptoms. Some prevalent symptoms of people with schizophrenia can be divided into negative, positive, and cognitive dimensions. Positive symptoms are commonly absent behaviors and thoughts, such as recurrent psychosis, which may include losing contact with reality, along with the hallucination, delusions, and indistinct and incoherent speech and behaviors. On the other hand, the negative symptoms include social isolation, emotional flattening or flat affect, anhedonia, and decreased initiative and energy. Finally, the cognitive symptoms are described as a broad set of cognitive disorders [1]. Schizophrenia is a severe mental illness that is associated with disturbances in thoughts, emotions, and perceptions [2].

Early diagnosis of schizophrenia and accordingly, the early process of treatment can be beneficial for patients. One of the diagnostic methods is to compare the status of schizophrenia patients with healthy individuals. One of the major differences between people with schizophrenia and healthy individuals is their perceptual, memory, and emotional state. Some previous research studies have shown some differences in both form and size of brain parts of schizophrenic people compared with healthy individuals. Based on this finding, their abstractive thoughts are more clumsy than the ones of healthy people. Interpreting meaningful images can be a powerful tool to assess the cognitive symptoms of schizophrenia [3].

Moreover, the results also indicate that emotion perception in schizophrenic patients is also impaired. They are not quite able to detect facial expressions, which is one of the reasons for their inability to establish social relationships [4]. Kohler et al. showed that one of the characteristics of schizophrenic individuals is emotion perception deficiency, which is due to various factors [5]. Besides, content and context are both essential for the formation of perception as well as helping its creation [6].

Researchers have shown that the ability of social cognition and facial emotion recognition in newly diagnosed schizophrenia patients can be defective and may negatively affect their social and occupational performance [7]. Some researchers have suggested that people who have schizophrenia have difficulty identifying facial and visual emotions due to their asymmetric activity of hemispheres [8]. The related studies have confirmed that schizophrenic patients have more writing irregularities than bipolar and schizoaffective patients and have less emotional and affective speech sources [9]. Some studies have found that men who have schizophrenia are weaker than schizoaffective men, both in mentioning the number of emotional events and occurrences in their lives and the expression of emotional and sentimental words [10].

As a result, some critical differences between people with schizophrenia and healthy individuals lie in their perceptual, diagnostic, and emotional differences, which can be used to distinguish these individuals from healthy individuals. Therefore, powerful diagnostic tools are also essential to recognize these people from others. Besides, it seems that by using more straightforward and cheaper diagnostic methods, the treatment process will begin sooner. So the therapy will be more cost-effective for patients and the health system.

In this regard, one of the novel psychological and diagnostic assessment methods is the use of fractal images. Research studies have shown that images of nature affect human affectional states. It is believed that they can be utilized in art therapy due to the artistic nature of fractal images [11]. The concept of a fractal is often associated with irregular geometric objects that exhibit self-similarity [12]. The history of fractals dates back to 1975 when

Mandelbrot discovered them. Regardless of whether these images come from natural processes, hand-made things, or mathematics, people have different aesthetic preferences towards these pictures [13].

Fractals are a set of colorful paintings, including abstract, self-similar, and repetitive shapes that can be stated as an abstractive mathematical representation of many natural elements. Three years of effective work with fractal images as a projective tool, as support for creative meditation, or merely just as a provocative object, have confirmed that these images can have psycho-diagnostic and optimizing values. Also, these images can have a positive impact on reducing stress and anxiety if used appropriately [14]. Recent research has shown that these images and shapes have a projective property, which can be utilized in the diagnostic field if they are used creatively and correctly [15].

There are numerous fractal images in nature, such as trees, mountains, rivers. There are also some instances of fractals in the human body, such as the lungs, nerve branches, and even the brain. According to previous investigations, our brain structure is not only fractal in structure but also in function [16]. Computer fractal images have also been used as a tool for psycho-diagnostic purposes [17]. Matveev et al. investigated the relationship between the visual complexity of laser images and the psychological states of individuals. They concluded that the perceived visual complexity of the presented images could be varied based on the nature of the images [18]. Kuikka used the analysis of fractal images to evaluate the blood flow to the brain of people with Alzheimer disease [19].

Averchenko et al. found that the high self-similarity of the spectra and their high degree of stability against the structural distortion are the essential factors to provide positive emotional background in understanding objects with fractal properties [20]. These findings provided a physical explanation for fractal art therapy that is widely used. The basis of this action-fractal art therapy is the static and dynamic understanding of fractal images. Thus, knowing more about how fractal images are perceived by patients, including schizophrenic patients with impaired perception, can be a proper way to become more aware of these individuals' inner world. It provides us another way to help these people establishing more effective social relationships and getting closer to the real world around them. As a result, their efficiency in individual, interpersonal, and social levels of performance would increase.

Today, the use of fractal music, fractal image, and the general properties of fractals in many fields of science, such as Medicine and Psychiatry, is expanding. For this purpose, more research is needed to understand its impact and application. These studies assist us in identifying the correct, useful, and effective ways of using this emerging phenomenon as well as to employ it more effectively and efficiently to diagnose and assist people with mental disorders. Based on what was mentioned and a review of the studies, we concluded that no studies had been conducted to evaluate schizophrenia using fractal images. The results of this study could be the basis for further research to diagnose other mental illnesses. This research answers two major questions as follows:

What is the difference between the descriptions of the content of fractal images observed by people with and without schizophrenia?

What is the difference in characteristics of likes/dislikes between the people with and without schizophrenia about fractal images?

Regarding the fact that schizophrenic patients have disjointed visual perception and different analysis of perceived stimuli compared with healthy individuals [1, 2], the proposed hypotheses were postulated as follows:

Hypothesis 1: Schizophrenia patients need a longer time to understand and analyze fractal images compared with healthy people.

Hypothesis 2: Schizophrenia patients are interested in different types of fractal images compared with healthy people.

Hypothesis 3: Schizophrenia patients rate images differently from healthy people.

Materials and Methods

This study is conducted as a case-control analytic study to compare the patient group with a healthy group considering their features of interest and preferences in ordering fractal images.

Statistical population, sample size, and sampling method

The statistical population comprises all schizophrenic patients hospitalized in Shafa Hospital in Rasht City, Iran, in summer 2018, and their healthy peers matched in age and gender. Machin et al.'s [21] table was em-

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ployed to determine the sample size as well as to compare the two study groups with the effect size of 0.75 for each group (men and women). As a result, we needed 30 people for each group. Patients and controls who were matched according to gender and age were chosen using a convenient sampling method. The inclusion criteria for the patient group were the diagnosis of schizophrenia by a psychiatrist and being hospitalized in a mental hospital, being 25 to 50 years old, lacking vision, or speech defect at the time of the interview.

The exclusion criteria were comorbidity with other mental disorders such as depression, drug addiction, impaired vision and or speech. Psychiatric examinations based on the DSM-5 diagnostic criteria of each patient in the clinical records were used to determine these inclusion and exclusion criteria. The inclusion criteria for healthy individuals were no history of psychiatric problems or referral to psychiatric centers, no use of psychiatric medications, impaired vision, or speech. They were 25 to 50 years old. The exclusion criteria included having a history of severe mental illnesses (schizophrenia and bipolar disorder, major depression), or referring to psychiatric centers, impaired vision or speech. A clinical psychologist with a master's degree investigated these entry and exit criteria based on a semi-structured clinical interview and self-report of healthy participants.

Study tools

Personal datasheet, as well as participant responses

The data sheet included personal information such as name, age, gender, marital status, education, occupation, and place of birth and residence, all of which were kept confidential. The information in the tabs contains the number of each image, the person's perception of the image, how he/she likes it based on a Likert-type scale (1=lowest to 5=highest interest), the viewing time to describe each image (latent time), and the rating taken by the picture among all the pictures.

Fractal images

It consisted of 12 fractal images that were printed in color on A4 sheets. These images were chosen based on the grouping criteria introduced in the research by Meshcheryakova and Larionova [17] and from the Fractal World website (Available at https://www.enchgallery.com). These images contained four photos from each of the three different groups of nature, emotion rising, and photos containing basic concepts and elements. Their research [17] concluded that the terms used to describe fractal images generally represent these three categories: 1. Nature; 2. Emotions; and 3. Fundamental concepts. The Nature group images include as bellow:

Leaf with resolution 72.

Fracworld with resolution 72.

Tentacle Tree with resolution 96.

Vines with resolution 96.

Basic Group images (basic concepts) include as below:

Gridspace with resolution 96.

North with resolution 96.

Redf-shift3 with resolution 96.

Series4 with resolution 96.

Emotional group images include as below:

Apophys-eyes with resolution 96.

Extraviganze1 with resolution 96.

Fractal beings with resolution 96.

The sea of emotions by the fiery fire with resolution 96.

Research implementation

Everyone was informed about his or her consent to participate in a research project before starting work. People were told that they could withdraw at any time, or if they needed to stop and rest, they could freely make the request. In practice, however, no one gave up or even felt the need to stop or rest. After explaining how to do the research and describing the questions and materials needed and executing an objective example using the Sierpinski carpet image to illustrate the process and how to do it, the images were shown to the people one after the other, and they were asked to answer the questions based on their perception of each image.

The latency (from the moment the image was presented to the moment the description started) was recorded in seconds using a stopwatch. Then the subjects were asked to rate the image based on a 5-point Likert-type scale with the reason given (1=least interest and 5=most interested in that image). After performing these steps on all images, individuals were asked to sort the entire image from 1-12 according to their interest/preference so that 1 indicates the most and 12 indicates the least interest/preference. The participants were asked the following questions:

What do you see in this picture?

What does this picture remind you of?

How do you feel when you look at this picture? (Express your feeling)

On a 5-point scale (with 1 marker lower and 5 marker interest), what would you rate this image?

After implementing the steps mentioned above on all photos, the images were again disassembled on the table, and participants were asked to arrange all images according to their interest/preference so that 1 showed the most and 12 showed the least interest. The terms and concepts used about each picture were drawn out separately from the answers of patients (n=30) and healthy people (n=30), and the number of repeating each term about each picture was measured for each group. The interviewer in the information register recorded participants' responses to rating images. The words and themes used for each image were extracted from the responses of healthy individuals (n=30) and patients (n=30) separately.

In addition, five commonly-used words for each image were listed separately for both healthy and patient groups. The duration of the image description for each image was listed in seconds for both groups, and the amplitude and the average time of each image was calculated. The scores given to each image were listed separately for both groups, and the highest numbers of repeating for each image were used to determine the level of interest for each image in each group. Ordering the pictures by both groups was studied to determine the position or rank of each photo for each group.

Statistical analyses

Results were analyzed at two levels. Inferential statistics were used on the first level. The Chi-square test was utilized to compare the two groups in terms of gender and marital status. Also, the Student's t test was used to compare the similarity of the two groups considering the mean of educational levels, to compare the average time spent eliciting descriptions for individuals with and without schizophrenia about fractal images, and to compare the interest of individuals with and without schizophrenia in fractal images. The Chi-square test of the likelihood ratio was used to determine the differences between the two groups in the rank of each image. Finally, the Mann-Whitney U test was used to compare the rank or overall preference of individuals with and without schizophrenia.

At the second level of analysis, quantitative content analysis was used to answer the research questions about the observed content and the favorite features of fractal pictures mentioned by people with and without schizophrenia. To do this, the participants were asked to say whatever came to their minds about fractal images. Then, the words used by the two groups to describe each image were extracted, and the frequency of each word used by the participants was separately calculated. Finally, the most commonly-used words were separately listed for each image and each group.

Results

Table 1 presents the results of the Pearson chi-square test for comparing gender frequencies between the two study groups. According to these results, there was no significant difference between the two groups in terms of gender (χ^2=2.44, df=1, P=0.118). Results of χ^2 likelihood ratio based on marital status showed no significant difference between the two groups in terms of marital status (χ^2= 3.04, df=3, P=0.385). The results mean that the two groups are matched in terms of marital status.

The results of the medical reports showed that 14 patients (46.7%) were in the acute phase, with a diagnosis of fewer than three months, and 16 patients (53.3%) had chronic schizophrenia. Table 2 reports the obtained results of the independent t test for comparing the two groups of patients in terms of mean years of education, and average time elapsed to elicit the fractal image descriptions.

The results of the independent t test showed a significant difference between the two groups regarding the mean level of education (t=7.38, df=58, P<0.0001). This finding indicates that the patient group is less educated, and therefore, the two groups are not matched by education. It was also assumed that schizophrenic patients needed more time to look at images to understand and analyze them and to find words to describe them. The results of the Student's t test showed that the patients spent more time talking about the image called extraviganze than the healthy group did (46.20 s in the patient group vs. 34.50 s in the normal group). For the other images, the time elapses for the descriptions were almost equal, and there was no significant difference between the two groups (P> 0.05).

The first hypothesis stated that schizophrenia patients needed a longer time to understand and analyze fractal images compared to healthy people. Based on the observations by the interviewer, although there was no significant difference between the two groups in the total time elapses to respond (except for picture 2 or extraviganze mentioned in Table 2), patients spent the time looking at the images in silence and thoughts. In contrast, healthy people spent their time responding and talking about images. Schizophrenia patients spent significantly more

Table 1. Comparison of gender and marital status in two groups of patients and normal

Variables	Groups	Patients	Healthy	%	χ^2	df	P
Sex	Female	10	16	43.3	2.433	1	0.118
	Male	20	14	56.7			
Marital status	Single	15	18	55	2.661	3	0.465
	Married	9	10	31.7			
	Divorced	5	2	11.7			
	Others	1	0	1.7			

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Table 2. Comparison of education and elapsed time for recalling fractal image descriptions in two groups of patients and normal

Variables	Groups	N	Mean±SD	df	t	P
Education level	Patients	30	15.40±2.17	58	7.376	0.0001
	Healthy	30	10.60±2.82			
Image 2 extraviganze	Patients	30	34.50±15.44	58	2.465	0.017
	Healthy	30	46.20±20.90			

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Table 3. Student's t test with an unequal variance to determine the difference of interest between two study groups

Images	Groups	Mean±SD	df*	t value	P
No. 1: Leaf	Patients	3.86±1.38	57.440	1.076	0.286
	Healthy	3.50±1.25			
No. 2: extraviganze	Patients	4.00±1.31	57.983	0.892	0.376
	Healthy	3.70±1.29			
No. 3: Fracworld	Patients	3.30±1.44	54.346	1.306	0.19
	Healthy	2.86±1.10			
No. 4: Gridspace	Patients	3.53±1.40	50.484	1.080	0.2285
	Healthy	3.86±0.93			
No. 5: Fractal beings	Patients	3.20±1.60	52.486	2.210	0.031
	Healthy	2.40±1.16			
No. 6: North	Patients	3.73±1.36	55.135	2.099	0.040
	Healthy	3.06±1.08			
No. 7: Redf-shift	Patients	3.63±1.47	46.208	0.860	0.393
	Healthy	3.90±0.84			
No. 8: The sea of emotions by fiery fire	Patients	3.86±1.33	55.998	1.047	0.299
	Healthy	3.46±1.61			
No. 9: Vines	Patients	3.80±1.27	65.443	0.878	0.384
	Healthy	3.53±1.07			
No. 10: Apophys eyes	Patients	3.20±1.44	54.005	3.017	0.004
	Healthy	2.20±1.09			
No. 11: Tentacle tree	Patients	3.53±1.30	57.802	1.627	0.109
	Healthy	3.00±1.23			
No. 12: Sier	Patients	3.50±1.59	54.413	0.091	0.298
	Healthy	3.50±1.22			

*With unequal variance.

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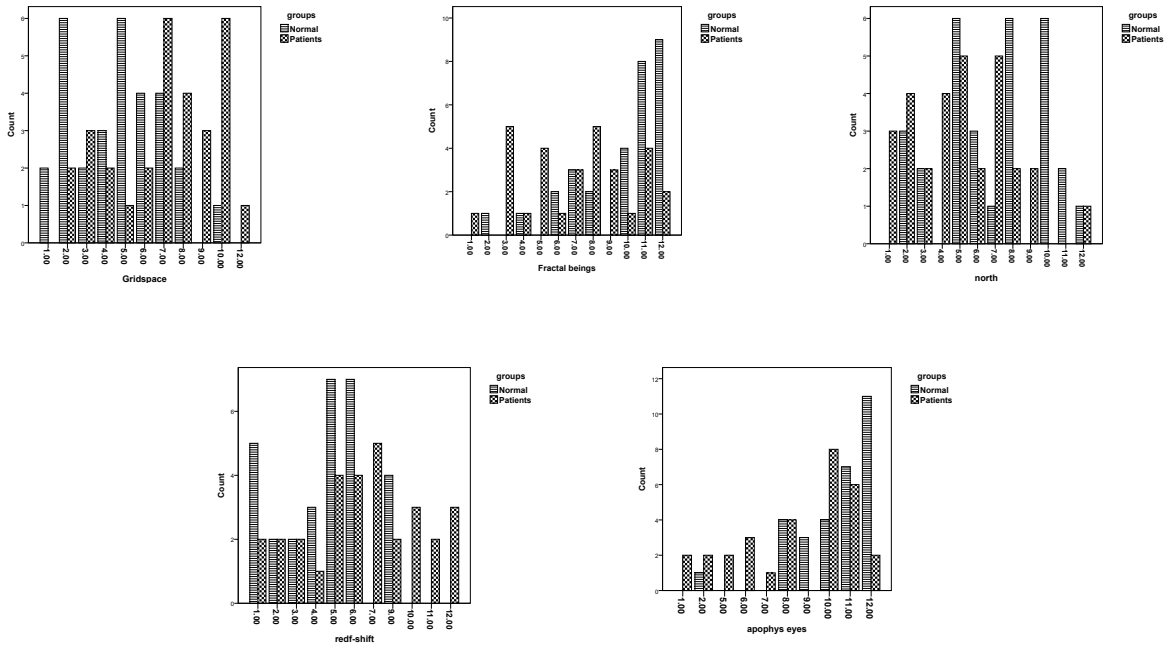

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Figure 1. The frequency distribution of differences in ratings of Gridspace, Fractal beings, north, redf-shift, apophys eyes in the patient and healthy groups (1=most preferred, 12 least preferred)

time looking at pictures and responding than healthy people. Patients also had longer pauses during the response.

The second hypothesis stated that schizophrenic patients are interested in different types of fractal images compared to healthy people. To answer this hypothesis, Table 3 presents the interest of the two groups of patients on each image based on a 5-point Likert-type scale.

It was assumed that schizophrenic patients would be interested in different types of images compared to healthy people. The results of independent t test (with unequal variance) to distinguish the difference of interest in each image showed that the patient group had more interest in images 5 (Fractal beings), 6 (North), and 10 (Apophys eyes) compared to the healthy group. Patients scored higher on images that were not significantly favored by healthy subjects. So the second hypothesis was accepted.

The third hypothesis stated that schizophrenic patients would rate images differently from Healthy individuals. As the results of the Chi-square test of the likelihood ratio show in the diagrams in Figure 1, the patient group reported images 5 (Fractal beings, χ^2=29.181, df=11, P=0.002), 6 (North, χ^2=29.007, df=11, P=0.002), and 10 (Apophys eyes, χ^2=23.885, df=9, P=0.004) with lower ratings of their visual preferences compared with the healthy subjects. On the other hand, the healthy group scored images 4 (Gridspace, χ^2=20.500, df=10, P=0.025) and 7 (Redf-shift, χ^2=22.733, df=10, P=0.012) in lower orders of being close to their visual preferences compared with the patient group. For the other images, there was no significant difference between the two groups (P>0.05).

Here, to compare the rank or overall preference given to each of the fractal images by individuals with and without schizophrenia, the Mann-Whitney U test was implemented. The results are listed in Table 4.

The results of the Mann Whitney U test confirmed that patients' overall preferences for fractal images 5, 6, and 10 were significantly higher than the ones for the healthy group. In contrast, for the healthy group, there was a higher rating of preference for image 4. For the other images, there was no significant difference between the two mentioned groups (P>0.05).

Results based on quantitative content analysis and research questions

In the second subsection, the quantitative content analysis was employed to answer the questions. The participants were asked to say whatever came to their minds after looking at the fractal images and describe each image based on their perception and the sensation they were inspired by that (see research implementation questions). The com-

Table 4. Comparison of the rating means for each fractal image between the patients (n=30) and healthy group (n=30)

Images	Groups	Mean Rank	U	Z	P
No. 1: Leaf	Patients	29.12	408.50	0.627	0.531
	Healthy	31.88			
No. 2: extraviganze	Patients	30.30	444.00	0.089	0.929
	Healthy	30.70			
No. 3: Fracworld	Patients	34.17	340	1.637	0.102
	Healthy	26.83			
No. 4: Gridspace	Patients	23.03	226	3.334	0.001
	Healthy	37.97			
No. 5: Fractal beings	Patients	37.80	231	3.268	0.001
	Healthy	23.20			
No. 6: North	Patients	36.20	279	2.545	0.011
	Healthy	24.80			
No. 7: Redf-shift	Patients	24.78	278	2.557	0.011
	Healthy	36.22			
No. 8: The sea of emotions by fiery fire	Patients	32.00	405	0.670	0.503
	Healthy	29.00			
No. 9: Vines	Patients	26.32	324	1.875	0.061
	Healthy	34.68			
No. 10: Apophys eyes	Patients	37.47	241	3.139	0.002
	Healthy	23.53			
No. 11: Tentacle tree	Patients	26.73	337	1.688	0.091
	Healthy	34.27			
No. 12: Sier	Patients	27.95	373.50	1.141	0.254
	Healthy	33.05			

mon and frequently used vocabularies reflect the common understanding and perception of each image by the individuals that will be described below. The concepts used to describe each image by the two groups of patients and healthy subjects were extracted, and the frequency of each word used by the participants was separately calculated for each group. The most frequently-used words were then listed separately for each image and each group (Table 5).

In the image called "Leaf," nature-related vocabularies were repeatedly used by each group. In both groups, this image was conceived and then described in almost the same way, indicating an easy understanding of natural images. About extraviganze1, both groups refer to the words associated with the colors in the image as well as the peacock feathers. This image was also relatively easy to understand. It should be mentioned that the first two words were common about the image called Fracworld. Still, the patient group had fewer vocabulary associations than the healthy group and used a limited vocabulary to describe the image, and the picture ambiguity was more for the patients than for the healthy people. Here, the healthy people generally described the image as two upper and lower parts that evoked contrasting emotions. Still, patients generally ignored the upper part of the image as a background and did not talk about it, as if only the lower part of the image existed in the picture.

Some patients were even unable to associate any words (either appropriate or irrelevant) to state the lower part of the image. For the image called Gridspace, the patient group associations were more connected with more familiar and simpler concepts such as sky, computers, and television, and even smaller elements such as lines and squares. But, the healthy group used the word drawing (or draw) more often. In the image called Fractal beings, the patients referred more to the tiny components in the image, such as the eye, whereas healthy people referred to the sense the picture evoked by mentioning the two faces in the image. Besides, the whole image, which is seen as two faces, was less recognized by the patient

Table 5. Quantitative content analysis of the extracted concepts and their frequencies in the patient and healthy groups

Images	Healthy Group		Patient Group	
	Extracted Concepts	Frequency	Extracted Concepts	Frequency
No. 1: Leaf	Leafage	15	Leafage	20
	Tree	11	Tree	8
	Road	8	Branch	4
	Jungle	4	Memories/Father's House	3/3
No. 2: extraviganze	Colors	14	Colors	11
	feather	11	Painting	6
	Peacock	6	Peacock	5
	Painting	4	Mountain/Sky	3/3
	Jungle	5	Phoenix	2
No. 3: Fracworld	Mushrooms	12	Mushrooms	9
	Under sea	10	Sea	6
	Wonderland/castle or palace	6/6	Jellyfish	4
	Cartoons	4	Don't know/Painting	3/3
No. 4: Gridspace	Drawing or math	7	Sky	5
	Space	5	Computer	4
	Black hole/Tunnel/Unknown world/Dimension/Light /Line/ Computer	4/4/4/4/ 4/4/4	TV/Math	3/3
No. 5: Fractal beings	Horror	9	Eye	12
	The face	8	Animal	5
	Man/Violence	6/6	Monster/Horror	4/4
	A demon or a monster	5	Face / Bird	3/3
	Cartoons	4	--	--
No. 6: North	Winter	12	Tree	7
	Snow	11	Winter / Snow	6/6
	The cold	10	Sea	4
	Tree	8	Fall	3
	Shrub	7	Shrubs/Ice/Sunset	2/2/2

Table 5. Continued: Quantitative content analysis of extracted concepts and their repeat frequencies in the patients and healthy groups

Images	Healthy Group		Patient Group	
	Extracted Concepts	Frequency	Extracted Concepts	Frequency
No. 7: Redf-shift	The light	19	The light	7
	Hope	8	The darkness	7
	Circle or ring/Sun	6/6	Circle or ring	3
	Tunnel/Sky	4/4	Vein or globule	2
	Vein or globule	3	--	--
No. 8: The sea of emotions by fiery fire	The combination of colors	12	Reference to colors	10
	Sea	10	Nothing	5
	Water	9	Water/Painting/Sea	3/3/3
	Earth (satellite image)	7	-	--
	Painting/Volcano/Complexity	5/5/5	-	--
No. 9: Vines	Flower	16	Flower	9
	Underwater plants	6	Tree	6
	Green/Fabric Design	5/5	The darkness	5
	Stems/Ivy/Dark	4/4/4	Branch/Miniature/Yarn/Fabric	3/3/3/3
No. 10: Apophys eyes	Eye	20	Eye	22
	The darkness	9	Black	6
	Look at others	8	People's eyes	4
	Reptiles	7	-	--
	The fear	5	-	--
No. 11: Tentacle tree	The darkness	8	Tree	9
	Forest/Tree	7/7	The darkness	5
	Branch/Fear	6/6	Painting	4
	Seaweed	4	Branch/Don't know	3/3
No. 12: Sier	Triangle	17	Triangle	13
	Pyramids/Math	7/7	The pyramids	9
	The geometry	6	Bermuda Triangle/Math	5/5
	Order/Drawing	4/4	Diamond	4
	Ruler/Riddle/Dry sense	3/3/3	--	--

group, which expresses their limited comprehension of Gestalt (totality).

Moreover, when referring to faces, patients usually interpreted them as animals, demons, or monsters. Besides, the sense of "horror" in this image was significantly lower perceived in patients than in healthy subjects. Healthy people frequently used the word terror and violence. In contrast, patients used the word terror less frequently, indicating a narrower understanding of the Gestalt (or totality) of the image by patients.

In the image called North, many healthy people referred to words such as winter, snow, and cold, rather than pa-

tients. Patients had more irrelevant associations with this image, including the sea, the sun, the lung, which were not used by healthy individuals. In the image called Redf-shift3, healthy people used "positively charged" words such as light and hope to a great extent, while patients used the words light and dark in equal proportions. Healthy people never used the word darkness. Several associations were used about this image by the patients, such as glass, bats, eggs, eyes, and so on. The picture was more complex for patients, and they had difficulty understanding it. About the image of Sea of Emotions by Fiery Fire, both groups have largely mentioned color combinations. However, in the healthy group, the words sea and water were used more than in the patient group, and patients had difficulty understanding the whole picture.

To describe the image, they also utilized more irrelevant associations, including Ferdowsi's Shahnameh and a tree stump. In the image called Vines, the patients used the word flower less frequently to describe the whole picture, which indicates a difficulty in understanding the whole picture because of their narrower gestalt. In the image called Apophys eyes, the words used were very similar. However, the healthy group also used the word fear to describe the sense in the image. In contrast, the patient group only used the term "bad feeling" a few times to describe it. These observations may indicate patients' difficulty in accurately recognizing their inner sense. The healthy people also used the words snake, crocodile, and other reptiles extensively, but the patients only referred to the word animal, often describing the image as one or more eyes. In the image called Tentacle tree, the first two words were common in both groups. But the patient group resorted to irrelevant associations such as bird feathers, fire, paradise, painting, or "I do not know".

The healthy subjects also used the word fear to describe their feelings toward the image, while patients had no reference to the image-induced feeling. In the image called Sier, the most commonly used words (i.e., triangles and pyramids) were common between the two mentioned groups. Still, some patients specifically referred to the name "Bermuda Triangle", while healthy people did not use the term at all. Some patients also described it with words like rhombus, square, or cube, which may be affected by their lower level of education.

Regarding the findings and the analysis of the data and to answer the first question of the study (what is the difference between the descriptions by individuals with and without schizophrenia of the content observed in fractal images?) based on the results and content analysis of the data, it was revealed that schizophrenic patients perceive and describe simple and clear images such as images of nature similar to the healthy people. At the same time, they have difficulty understanding complex and abstractive images, providing less relevant associations, and the number and variety of inappropriate and irrelevant associations in patients are greater than healthy individuals (Table 5).

Regarding the response to the second question (what is the difference between interesting/not interesting features in people with and without schizophrenia about fractal images?) Data content analysis showed that people with schizophrenia put pictures, including a sense of violence and darkness (images 5, 6, and 10) in higher priorities (more preferred) than healthy people. In contrast, they put the image called Gridspace, which showed regular and geometric shapes, in lower priority (less preferred) than healthy people (Tables 4 and 5).

Discussion

The purpose of this study was to compare fractal image preferences in people with and without schizophrenia. The first hypothesis showed that schizophrenia patients need a longer time to understand and analyze images than healthy people. In other words, patients spend more time looking at the images than healthy people to rate or describe them. Based on the quantitative results presented in Table 2, there was a significant difference in response time for the image called extraviganze between the two groups. It was also found that this time in the patient group was more spent looking at images than responding to or describing them. Besides, patients had several pauses while responding, while healthy subjects were able to express their associations with minimum pauses and with fluency.

The results of the second hypothesis showed that schizophrenic patients are interested in different colors and designs compared with healthy people because of their different perceptions of the world around them. In other words, the interest in a particular image in people with schizophrenia is different from that of healthy people. According to Table 3, the patient group's interest in three images of 5 (Fractal beings), 6 (North), and 10 (Apophys eyes) was significantly higher than the healthy group.

The third hypothesis also confirmed that schizophrenic patients preferred different colors and designs different from healthy people because of their different perceptions of the world around them, and their ratings of images were different from the healthy ones. As reported in the column cluster chart (Figure 1 and Table 4), schizo-

phrenia patients had significantly preferred images 5 (Fractal beings), 6 (North), and 10 (Apophys eyes) more than the healthy group. In contrast, they were significantly less interested in images 4 (Gridspace) and 7 (Redfshift). As a possible interpretation, it can be noted that people with schizophrenia tend to place darker, more dreadful images on higher priorities than healthy people, and avoid bright, luminous images and fractals with a regular geometric pattern/drawing.

Concerning the first question in this study, the quantitative content analysis showed that schizophrenia patients perceive and describe simple, clear images such as natural fractals similar to the healthy individuals, but have difficulty understanding complex and abstractive pictures and provide more limited appropriate associations. Moreover, the number and variety of inappropriate and irrelevant associations in patients are much higher than in healthy people. Also, to answer the second question, it was found that people with schizophrenia gave higher priority to the images containing the sense of violence and darkness (images 5, 6, and 10) than the healthy subjects and avoided geometrically patterned fractals.

Assessments indicate that a schizophrenia patient prefers random-based and fractured inputs over smooth, continuous, internal patterns. Reaction time to the visual stimulus was also delayed due to a slower perception of the input. They focus on an object to recognize it, but due to their inability to receive visual feedback, they might only scrutinize certain parts of the object [22].

In general, by studying the vocabulary used about different images in both groups, it was concluded that schizophrenic patients had a poorer choice of words in describing abstractive and more perceptually-complex images. This finding is consistent with previous studies [7-10]. For example, it has been found out that newly diagnosed schizophrenia patients have severe deficits in facial emotions recognition [7, 8] and show more written disorders than bipolar and schizoaffective patients do, and their affective and emotional vocabulary source is weaker [9]. Researchers have also confirmed that men with schizophrenia are weaker than schizoaffective men in both expressing the number of emotional events in their lives and in expressing words containing emotional and affective senses [10]. Reviewing the previous results partially justifies the verbal poverty, inability to express and talk about internal feelings, and the frequent pauses observed in schizophrenic patients participating in this study.

The results of this study showed that schizophrenic patients have limited relevant vocabularies to describe fractal images. As the complexity of fractals increases, they usually resort to irrelevant associations to describe them. This suggests that more abstractive fractals add to the complexity and ambiguity of schizophrenic patients' thoughts and cause them to sink into their disrupted world and have longer pauses than healthy people. However, when these patients were asked to describe clear, natural fractals, the time elapsed, and their descriptive performance approached the ones of healthy people. For example, in image 1, which was specifically a fractal leaf, the patients were able to describe it well and to talk about the good feeling they received from the image as well as the pleasant memories and places they saw such images. For instance, one of the patients has talked about this picture like this: "Tree leaf. I think the pine tree. We have one of them in my father's house, which is very large".

Nevertheless, about the abstractive images, these patients had difficulty describing and associating, making them use irrelevant words. For example, image 8, which is an abstractive fractal, was described by healthy people by mostly using the terms such as water, sea, color combination, and a satellite image of the Earth. However, patients used words such as pumpkin, cartoon, tree stump, and Ferdowsi's Shahnameh. One patient has talked about the picture as: "Good, children's TV program, blue water, red water". This finding suggests that fractal images are of diagnostic value if standardized in a large study. Previously in the general population, researchers have found that individuals have different preferences over fractal images [13] and can have diagnostic power if used correctly and creatively [14, 15].

Studies on the therapeutic use of fractal images, especially in psychiatric patients, are very limited. The present study might be pioneering in this regard, but the selected images need to be standardized in another large study with respect to the age and gender of the patients. Also, the level of education that we failed to control is a variable that can influence verbal poverty and the latency of eliciting responses. It is recommended to compare newly diagnosed patients and those with chronic schizophrenia in terms of understanding fractal images in the future.

Conclusion

The results of this study revealed that the latency for eliciting description of fractal images in schizophrenic patients is more prolonged than healthy subjects, and

patients have more pauses, irrelevant speech, and incoherent speech toward more abstractive images. Analysis of responses shows that schizophrenic patients prioritize darker, more dreadful images compared with the healthy people, and avoid clear, luminous, and fractal images with a regular geometric/graphical pattern.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Ethics Committee of the Islamic Azad University, Rasht branch (No. IR.IAU.RASHT.REC.1396.170). All the study procedures were in compliance with the ethical guidelines of the Declaration of Helsinki (2013).

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Authors contributions

Drafting the original paper: Sajjad Rezaei and Amir Qorbanpoor lafmejani; Writing, reviewing, and editing the paper: Sajjad Rezaei and Fatemeh Yousefi; Collecting resources and data collecting: Fatemeh Yousefi; Supervising the research and analyzing the data: Sajjad Rezaei.

Conflict of interest

The authors declared no conflict of interest.

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