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The role of non – semantic factors in semantic satiation effect in schizophrenia

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ABSTRACT – Background and Objectives: Semantic satiation is defined as the subjective experience of the loss of access to the meanings of words or images caused by prolonged and quick repetitions of the material. Previous researches indicated that the semantic satiation of words and images occurs faster in schizophrenics than in healthy subjects. Individuals suffering from schizophrenia reveal the tendency to lose of access to the meaning of words after fewer words repetition than healthy controls.

The aim of the research was to establish whether the semantic satiation of images in schizophrenia is the effect of the loss of meanings of images or is caused by non - semantic factors i.e. fatiguing experimental procedure.

Methods: It was assumed that in conditions where the participant's level of fatigue was parallel to the fatigue observed in the research on semantic satiation and the meaning of satiated images was not required for semantic decisions, schizophrenic patients and healthy controls would not reveal the semantic satiation effect defined as an increase in reaction time. Two groups of participants: patients suffering from schizophrenia (10 women and 10 men, average age 30) and healthy controls (9 female and 9 male, average age 30.7) were shown 80 trials. Each one of them consisted of a satiated image which appeared repeatedly on the computer screen, and a non – satiated image accompanied by a written word, which were shown simultaneously after the final presentation of the satiated image. The participants' task was to decide whether the written word named the object presented on the non – satiated picture correctly. The participants did not make any decisions on the basis of satiated images.

Results: The results obtained confirmed the hypothesis. In conditions where participants were shown the images flashing on the computer screen but were not required to make a semantic decision related to those images, their reaction time to subsequently presented stimuli did not lengthen.

Conclusions: The results confirmed the hypothesis that the semantic satiation effect in schizophrenia is a semantic phenomenon and is not related to non – semantic factors such as the subjects' fatigue.

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Introduction

Semantic satiation is defined as the subjective feeling of the loss of access to the repeatedly pronounced material which appears after a quick succession of a repeated word or an image¹⁻⁴. The effect of satiation appears during a word or an image repetition and fades away once the repetition stops. The semantic satiation effect can significantly affect the process of communication, since the person experiencing it is unable to understand the text or image which is being conveyed.

Current researches on semantic satiation effect are based on semantic priming procedures, where the subjects are presented with two consecutive words: the first one is being satiated by repeated displays. In a classic procedure the first word is displayed 30 times whereas the second one is shown only once. After the presentation of the second stimulus the subjects decide whether the two words are semantically connected, i.e. whether they are synonyms or the objects they refer to belong to the same category. It is assumed that, once satiation occurs, subjects would temporarily lose access to the meaning of the first word, which should result in a longer decision time and greater number of mistakes being committed.

Most of the studies on semantic satiation were based on lexical material, with the exception of Lewis and Ellis research¹. Lewis and Ellis showed participants a series of photographs of a famous person. They assumed that the satiation of the image limited the access to the information concerning the person. The participants were later presented with a photograph of another person and asked to decide whether both figures were related. When the first photograph was presented for the third time, the subjects could easily establish the relationship between the two models. However, in case of an image showed to them 30-times they would take

longer time to decide and the number of mistakes increased.

Semantic satiation appears as a result of intensive stimulation of a node in semantic network. While single pronunciation of the word activates an adequate concept node, the quick succession of repeated pronunciations may cause an overload (i.e. period of sustained activation should be followed by a reduction of node's sensitivity), and can make it difficult to access the meaning. The research on semantic network activation shows that excessive semantic activation is common among the schizophrenic patients⁵⁻¹⁰. Since the satiation phenomenon appears when the semantic nodes become excessively activated, in schizophrenic patients, the reduction of sensitivity of the node may be caused by fewer repetitions, as compared to the subjects who are not prone to hyperactivation. In schizophrenics, excessive activation of semantic network should cause the loss of meanings much faster than in healthy subjects. This hypothesis was the main focus of the research on satiation of positive, negative and neutral images in schizophrenia as conducted by Prochwicz¹¹. In the study, participants performed a computerized categorization test which used negative, positive and emotionally neutral images, photographs from different categories of International Affective Picture System technique (animals, plants, furniture, vehicles, buildings)¹². The participants were provided with pictures which were repeatedly shown on a computer screen with short intervals. All photographs were divided into 4 groups on different satiation levels: first group: the pictures presented 3 times; second group: the pictures presented 13 times; third group: the pictures were presented 23 times; fourth group: the pictures were presented 33 times. All 4 groups mentioned here were adjusted to the levels of valence. Each presentation was followed by a word representing a specific category. The

participants were asked to decide whether the object presented in each photograph belonged to this particular category. The experiment confirmed the hypothesis that the satiation effect occurs faster in schizophrenics than in healthy subjects. Separate reaction time analysis for positive, negative and emotionally neutral images showed that the satiation effect occurred only for positive and negative ones, while the meanings of neutral objects remained accessible even in the intensive satiation conditions. These results stress the significance of the patients' tendency to ignore the meaning of affective information provided in some previous researches, in which patients suffering from schizophrenia recalled emotionally ambiguous information as a positive one¹³ or described pictures displaying emotionally negative situation without consideration of its emotional meaning¹⁴.

The aim of the current research was to establish whether the semantic satiation effect of positive and negative images in patients suffering from schizophrenia is caused by either the loss of access to the meanings of objects presented in the pictures or simply by the grulling experimental procedure. It was assumed that in case the participants' level of fatigue was parallel to the fatigue observed in the research on satiation and the meaning of satiated images was not required for semantic decisions, then the reaction time would not be prolonged and the number of mistakes would not increase.

Methods

Participants

Twenty patients with schizophrenia, 10 women and 10 men aged 22 – 41 (average age = 30, SD = 4.67) participated in the study.

All patients were recruited from Jozef Babiński Psychiatric Hospital in Krakow. The present study involved only patients with the paranoid schizophrenia diagnosis. The diagnoses were made according to ICD – 10 criteria and were based on medical history and extended personal contact with the patients. All diagnoses were provided by the psychiatrists working in the research ward. All patients had been previously hospitalized. The mean duration of illness was 13.2 years (SD = 5.87). The patients' education was on secondary education (16 subjects), academic (5 subjects) and vocational level (1 subject). Patients with additional disorders or the history of head trauma, neurological illnesses, epilepsy, alcohol or substance dependence and subnormal intelligence were excluded. The election criteria included the lack of distinct symptoms of motoric deceleration estimated by hospital staff. All patients were under neuroleptic medication receiving either standard or atypical neuroleptics at the time of the testing.

The control group involved twenty healthy individuals, 9 female and 9 male (the mean age 30.7, SD = 3.82). The healthy subjects were matched with the group of patients on the basis of gender and educational level. The educational level criteria were treated as a measure of overall intellectual level. Only subjects who did not take any psychotropic medication and had never been treated for neurological and psychiatric disorders were included in the control group.

Materials

The task was based on the procedure described by Smith and Klein³, where the subjects were not required to make any decisions on the basis of satiated stimuli. The stimuli consisted of 80 trials, each trial included two color photographs: snapshot one and non –

instantaneous one, plus one written category. All photographs were taken from The International Affective Picture System¹² technique and showed objects referring to one of five different categories (animals, plants, furniture, vehicles, buildings). The photographs in question were chosen with respect to the valence. Equal numbers of negative, positive and emotionally neutral pictures were selected for the experiment. Category names (animals, plants, furniture, vehicles, buildings) were written in Arial font in capital letters in the vertical direction. All trials were divided into four groups, each one consisting of 20 sets. Each group contained eight neutral, six negative and six positive photographs. Within each of the 4 groups in a target conditions, one half of the trials used semantically related stimuli, whereas the other half used semantically unrelated photographs and category names.

Procedure

Each subject was tested individually in a single session lasting about 40 minutes. Before the experiment all schizophrenic patients were asked to complete the paper version of categorization test by choosing the odd – one image from a sequence. The aim of the test was to eliminate any possible influence of categorization process disturbances. Before attending to the experimental task, each participant was instructed in the procedure and completed 15 practice trials. The stimuli were shown on a computer screen. A trial began with the appearance of a control photograph which was shown a number of times. Within the first group of stimuli, the satiated pictures were repeated 3 times, within the second one – 13 times, within the third one – 23 times and within the last one – 33 times. All control photographs, each one sized about 100 x 130 mm, appeared in the central position of the screen. Each repetition of satiated picture lasted 500 ms with a 200 ms intervals before

the subsequent repetition followed. The subjects were instructed to look at the flashing picture without any reaction. After the final repetition, the second picture and the category name were displayed on the screen. The target picture appeared above the category name. The participants were to decide whether the category name is relevant to the object shown in the picture. They pressed the ‘/’ key to indicate that the object in the picture belonged to the given category or the ‘z’ key to indicate that the object in the picture and the category were unrelated. Both the second image and category name remained on the screen until the response was provided. The subjects were instructed to respond to queries as quickly as possible. Later on the schizophrenic patients were asked to assess the valence of each image used in the task in order to confirm that the emotionally positive, negative and neutral pictures chosen from IAPS have the same emotional sense for schizophrenic patients and for healthy controls. Patients rated the valence of each image on a 10 – point scale (W Kendall = 0.62).

Results

Table 1 presents the mean response latencies and the mean number of mistakes for the six experimental conditions for patients suffering from schizophrenia and for healthy controls. To further minimize the effect of outliers the response times that were less than 100 ms and more than 3000 ms were excluded. The exclusion of these extreme types of responses accounted for less than 2% of the overall trials for both groups of participants.

The 2 (group of participants) x 4 (repetition) x 3 (valence) x 2 (related vs unrelated target stimuli) analysis of variance (ANOVA) did not reveal the main effect ($F[1.136] = 0.38, p < 0.88$).

Table 1
Means reaction times (RT) and means number of mistakes (M) as a function of group of participants, valence of control images, and relatedness of target stimuli

Valence of control images	Repetitions							
	3		13		23		33	
	RT	M	RT	M	RT	M	RT	M
Schizophrenic patients								
Neutral control images								
Related target stimuli	2829.91	2.0	1977.28	0.33	2216.55	0.0	2179.35	0.20
Unrelated target stimuli	2244.53	1.0	2132.92	0.25	2185.48	0.33	2244.07	0.50
Negative control images								
Related target stimuli	2598.16	1.33	2503.73	1.00	2528.37	1.25	2891.25	1.00
Unrelated target stimuli	2112.75	0.33	2407.97	1.00	2362.45	0.00	2243.09	2.00
Positive control images								
Related target stimuli	1995.65	0.00	2068.53	0.25	1978.17	0.00	2237.46	0.33
Unrelated target stimuli	2368.43	0.33	2013.40	0.00	2047.03	0.33	2162.62	1.00
Healthy controls								
Neutral control images								
Related target stimuli	1472.26	3.00	1153.94	0.66	1209.27	1.00	1256.18	0.80
Unrelated target stimuli	1455.69	0.25	1263.88	0.75	1206.38	0.33	1249.80	0.55
Negative control images								
Related target stimuli	1540.00	1.33	1439.90	1.40	1493.08	1.25	1505.94	1.00
Unrelated target stimuli	1473.25	0.00	1560.69	0.50	1390.98	0.00	1281.41	0.4
Positive control images								
Related target stimuli	1283.38	0.66	1257.73	0.25	1205.72	0.50	1125.37	0.66
Unrelated target stimuli	1486.61	0.00	1266.58	0.00	1222.75	0.33	1192.19	1.00

The comparison of mean reaction times obtained by patients suffering from schizophrenia and control group indicated that healthy controls responded faster than schizophrenic patients ($t = 18.23$, $df = 158$, $p < 0.000$), but within each group the mean reaction time did not differ significantly. In the schizophrenic group the analysis yielded the main effect of valence of control pictures ($F[2.56] = 3.67$, $p < 0.032$) indicating that the reaction time for negative images were longer than for the positive and neutral ones. Neither the effect of repetition ($F < 1$) nor relatedness ($F[1.56] = 1.47$, $p > 0.05$) was significant. Furthermore, the analysis of interactions between these factors did not reveal noteworthy differences.

The reaction time analysis in tasks with control pictures of different valence showed

that only emotionally neutral pictures evoked faster reaction times as the number of repetitions increased from 3 to 13 ($F[1.68] = 4.78$, $p < 0.03$). Reaction time for 13, 23 and 33 repetitions did not differ significantly.

Within the control group the analysis yielded the main effect of repetitions and the effect of a valence of control picture. Healthy controls responded faster in conditions of 13, 23 and 33 repetitions of control pictures compared with the conditions of 3 repetitions ($F[3.56] = 4.35$, $p < 0.008$), their reaction times were also shorter in the tasks with negative control pictures compared to the conditions where the positive and neutral images were presented ($F[2.56] = 7.92$, $p < 0.001$). There was no significant effect of relatedness, and no effect of interactions between factors.

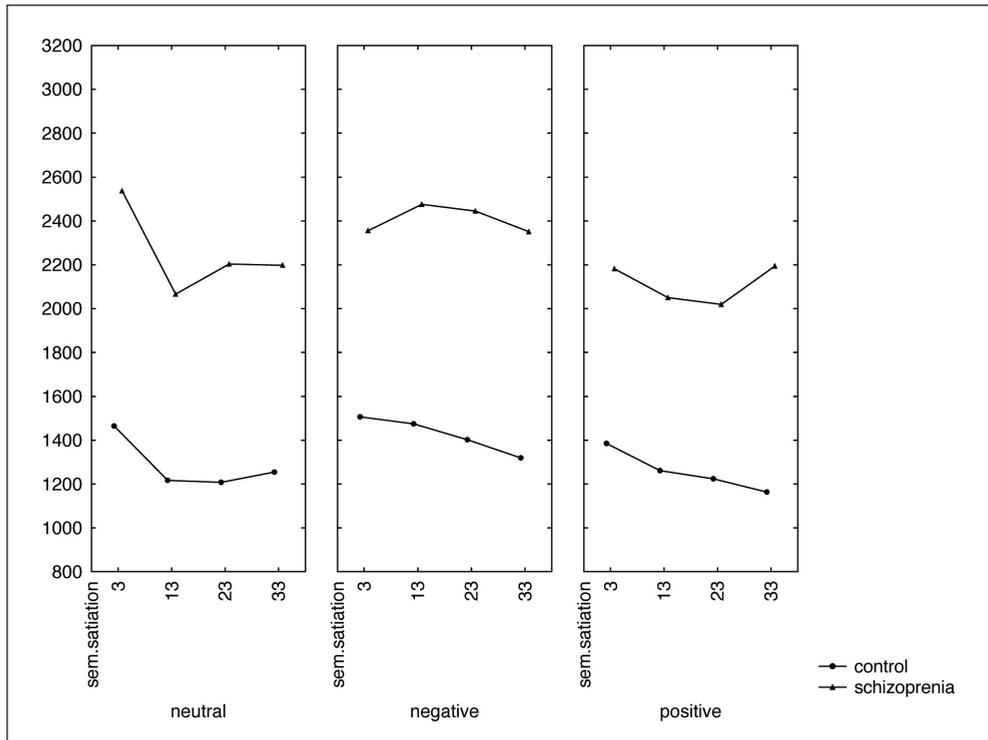


Figure 1. Means decision times as a function of the numbers of control images repetitions and the valence of the control images for schizophrenia patients and control group.

The reaction time analysis in tasks with control picture of different valence indicated that only reaction times for emotionally neutral pictures got shorter as the number of repetitions increased. That is to say, participants reacted faster in conditions of multiple repetitions of satiated images (13, 23, 33) rather than just 3 repetitions ($F[1.68] = 8.36, p < 0.00$). The reaction time for satiated positive and negative control photographs remained stable regardless of the number of control pictures repetitions.

Analysis of response accuracy indicated that schizophrenic patients were slightly more accurate (2.87%) than healthy controls (4.16%); however, this effect was not statistically significant ($F < 1$). The analysis of variance indicated that there was no evidence of a decrease in the numbers of mistakes made as a function of repetition, relatedness and valence of stimuli both in the group of schizophrenic patients and in healthy controls. The interactions between these factors remain insignificant.

Discussion

The results of the present research show that when to – be – satiated image was not a part of the reaction component of a task, the semantic satiation did not slower participants' reactions. It indicated that a high level of participants' fatigue caused by the necessity of prolonged fixing at flashing pictures did not affect the speed of participants' reaction to the subsequently displayed images.

Thus it can be assumed that slower reactions appearing when participants attend to the satiated images¹¹ were not caused by non – semantic factors. We should rather say that they stem from the satiation of the images' meaning.

In the current study the rise of the control picture repetitions to the level which may initiate its satiation facilitated the participants' reaction to the following non – satiated photograph. The effect was observed in both schizophrenic patients and control group. The paradoxical effect of decision facilitation after multiple displays of control picture could be explained in context of semantic inhibition. In conditions when the number of displays of the control picture was relatively low, the reaction to the following non – satiated picture was blocked by the previous activation of the control picture' meaning. In other words, participants may not be able to inhibit the control picture meaning even if they were instructed not to react to its presentation. When control picture was presented many times, the inhibition process was effortless since the control picture became satiated and its meaning was deactivated. This effect was observed only for neutral stimuli. In conditions when participants' decisions concerned positive and negative images, the reaction times did not change as the number of control picture repetition increased. It suggests that the meanings of emotionally neutral images became satiated slower than the meanings of negative and positive ones. In other words, for positive and negative stimuli just 3 repetitions were enough to evoke semantic satiation effect; thus, the inhibition process mentioned above is blocked at the very beginning of the task.

This interpretation is consistent with the results of Prochwicz research¹¹, which demonstrated that the images with strong emotional valence are more susceptible to satiation than emotionally neutral images.

The current study has several limitations which should be addressed in future research. Firstly, although all patients who participated in the study were chosen on the basis of the absence of motor retardation, reaction times prove not to be adequate parameter in re-

search on schizophrenia since patients usually have slower and more variable reaction times when compared with those belonging to control group. The results should be interpreted with caution because of small sample of patients participating in the research and the fact that no method of measurement of thought disorders and emotional symptoms of schizophrenia was employed in the study. Secondly, the IAPS constitutes a method which has not been adapted to research on schizophrenia. It is possible that schizophrenic patients process pictures of high complexity differently than healthy people. That is to say, they may need longer display times to perceive images, and the perceptual processing deficits diminish their task performance. Although the perception of valence of stimuli in schizophrenic patients was controlled, the level of arousal related to the images in question was not taken into account.

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