
Semantic and pragmatic relations in categorization in early-course psychosis

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Abstract

In schizophrenia, language processing indicates an over-inclusiveness (Chen, 1994; Brebion, 2010) in category (hypernymy and hyponymy) relations. The aim of this study was to examine the preservation of category relations of semantic memory in first-episode and early-course schizophrenia-spectrum psychosis as it offers an insight to foundations of schizophrenia language deficits. The study was conducted in cooperation with the University Psychiatric Hospital Vrapče on 17 patients. The patients' results were correlated with those of a matched control group. The test that was used to conduct the experiment was constructed for the intent of this study, and it consisted of 10 categories, each of which was tested over 5 trials. For each trial, participants had to choose a member of a presented category. Possible answers included the target word (a category member such as *hobotnica* 'octopus'), a pragmatic-semantically related distractor (e.g. *more* 'sea'), a lexical-semantically related distractor (e.g. *krak* 'tentacle'), and an unrelated distractor (e.g. *truba* 'trumpet'). None of the unrelated distractors in either group were selected as category members. Although both pragmatic-semantically related and lexical-semantically related distractors were classified as category members more often in the patient group, pragmatic-semantically related distractors were chosen more often than lexical-semantically related distractors. While the results support the theory that concept representations in the semantic memory are not completely lost, the question remains whether the representations are degraded or whether there is a difference in search and retrieval processes in patients with first episode psychosis (FEP) when compared to a healthy control group.

Key words: category relations, semantic memory, executive functions, first-episode psychosis

1. Introduction

1.1. Semantic memory and cognitive deficits in schizophrenia

Semantic memory is considered to be organized into concepts represented by nodes of interconnected links which indicate semantic relationships between them (Minzenberg, 2002). Language processing includes the activation of specific connections and nodes in the processes of search and retrieval in language production and reception. Such a framework assumes that the nodes represent boundaries that border concepts themselves and that concepts are enclosed in semantic categories based on their shared properties through their connections.

Theories investigating semantic memory deficits in schizophrenia can be divided into three categories: (i) theories of semantic memory disorganization (Chen et al., 1994; Rossell et al., 1999; Bozikas et al., 2005), according to which the concepts in the semantic memory are disorganized; (ii) theories of impaired semantic memory knowledge (Tamlyn et al., 1992; McKay et al., 1996); and (iii) theories of search and retrieval deficits (Allen et al., 1993; Joyce et al., 1996; Giovannetti et al., 2003), according to which the semantic memory is preserved but the connections between the concepts are not, or access to the memory is impaired. These theories can be further defined as dyssemantic (the first and second theories) and dysexecutive (the third theory) hypotheses (McKenna & Oh, 2005).

The theory of semantic memory degradation, which presumes that concepts and their representations within semantic memory are completely or partially degraded in schizophrenia, was abandoned after studies found that schizophrenia patients had word pools similar to those of control subjects, but that they had difficulties in retrieval under different task conditions. Allen et al. (1993) found that, given enough time, patients could produce an equal number of verbal fluency exemplars on repeated tasks. Considering the findings of studies claiming that semantic knowledge in schizophrenia is not impaired, their language deficits are explained in terms of search and retrieval deficits presumably related to components of executive functions or working memory (Kuperberg, 2010). Hence, language processing deficits are described as attention, working-memory and executive-function deficits, or as semantic memory deficits.

In their meta-analysis of studies on declarative memory, Cirillo and Seidman (2003) show that patients with schizophrenia have a clear deficit in declarative memory, while Goldberg et al. (1990), examining procedural memory, show subtle differences in relation to control groups. Studies investigating the working memory also show deficits in the working memory in schizophrenia (Lee & Park, 2005), while others show an executive function deficit (Orellana & Slachevsky, 2013), deficits in motor functions and speed (Dickinson et al., 2007), and social cognition and attention (Green et al., 2015).

Many studies have tried to establish whether there are executive dysfunctions in schizophrenia subjects and have come to differing conclusions about which domains are affected, such as attentional selection (Pessoa, 2009), cognitive integration (Duff & Brown-Schmidt, 2012), inhibition and cognitive control (Leeson et al., 2005), self-monitoring of speech (Nienow & Docherty, 2004), and working memory (Elvevåg & Goldberg, 1997). Furthermore, executive function deficits have been found in first-episode schizophrenia subjects (Flashman, 2002, as cited in Orellana & Slachevsky, 2013; Joyce et al., 2002). Executive functions, working memory, and attention are different but interconnected domains that enable contextual information processing, reaction to context, planning, directed actions, etc. These domains can be affected separately or mutually in schizophrenia (Poole et al., 1999). Furthermore, some studies indicate that there is evidence of combinatory semantic and executive dysfunctions in thought disorder (Leeson et al., 2005).

1.2. Changes in associations as a symptom of schizophrenia

As loose associations were among the first defined symptoms of schizophrenia (Moskowitz & Hein, 2019) and remain the most prominent symptom in language processing in schizophrenia, many studies have analyzed the production and reception of associations.

Although psycholinguistics uses different methods of studying associations, priming is a prominent one because it enables the specification of the produced association in advance. Priming presupposes the activation of a concept and its features in the semantic memory for a time, which then serves as a source of activation for related concepts. In direct priming, word pairs are directly connected, while indirect priming presupposes word pairs where the target is an association to an association of a prime. In other words, in indirect or mediated priming, word pairs have a connection that is evident through a mediated association. Both priming methods are useful for association studies in schizophrenia because they demonstrate the spreading of activation in the semantic memory in which activated concepts are or are not inhibited.

Priming task studies show that there is a higher activation of the semantic memory (a positive priming effect) in language production in schizophrenia subjects than in healthy subjects. For example, studies conducted by McNamara and Altarriba (1988), Spitzer et al. (1993a), Spitzer et al. (1993b), Moritz et al. (2001), Moritz et al. (2003), and Wentura et al. (2008) show an indirect priming effect. Indirect priming presupposes the construction of a language stimulus with the condition of associative connection. That is, in indirect priming the prime and target words are indirectly connected by an association which both share (for example, the prime *white* and the target *cow* share the association

milk). Direct priming effect is shown in studies conducted by Rossell and David (2005), Manschreck et al. (1988), and Maher et al. (2005). Direct priming presupposes that the prime and target words are directly connected, as are the words *white* and *black*. The hyperpriming effect in direct and indirect priming tasks is demonstrated in studies conducted by Weisbrod et al. (1998), Moritz et al. (2001), Assaf et al. (2007), Maher et al. (2005), and Kreher et al. (2008). Other studies did not show any effects of hyperpriming Vinogradov et al. (1992), Ober et al. (1995), but other authors conclude that these studies have methodological problems, such as stimulus onset asynchrony or the choice of language material.

A positive correlation in schizophrenia patients between positive priming effects and associations produced in discourse was established by Maher et al. (2005) using a computer program named CAST (*Computed associations sequential test*), which is in line with the spreading activation theory. Increased automatic spreading of activation is further affirmed by idiosyncratic answers on fluency tasks (Johnson & Shean, 1993).

1.3. Semantic categorization

Categories are an integral part of language processing as they represent a natural taxonomy of the world. In 1938, Cameron described a deviation in the means of grouping objects into categories, an overinclusion of objects in categories, in schizophrenia patients in comparison to healthy controls. Lawrence et al. (2007) define overinclusion as an inability to preserve boundaries of categories, a consequence of which is the development of indistinct and broadened category boundaries. In a meta-analysis of semantic categorization studies in schizophrenia, Doughty and Done (2009) conclude that 16 studies have shown a deficit in category relations compared to healthy subjects, although their analysis did not distinguish verbal from non-verbal semantic tasks. Chen et al. (1994) analyzed the integrity of semantic memory and showed an intact integrity of concepts but a broadening of semantic category boundaries where patients include related (*bat – bird*) and unrelated (*rifle – bird*) non-members and borderline (*penguin – bird*) members in categories. Elvevåg et al. (2002), in a study that repeated the task used by Chen et al. (1994), found that patients and controls do not have qualitative differences in their results, although both patients and controls did have slower reaction times to ambiguous borderline category exemplars (exemplars that could be classified as within or outside the category).

They conclude that, although representations may be intact, “movements” between them may not be optimal (Elvevåg et al., 2002). Spitzer et al. (1997) offer a theory of faster spreading activation in semantic memory in search and retrieval processes in schizophrenia, which could account for a different activation

of concepts and features than Elvevåg et al. (2002) conclude. Brébion et al. (2004, 2010) are also inclined toward this explanation after conducting studies of the production of category exemplars and verbal memory and finding a broadening of semantic categories.

Moelter et al. (2005) found that patients have difficulties utilizing higher-order categorization processes (cognitive functions simultaneously using basic executive functions) in conducting an animal similarity judgement and organization test. While the control group produced overlapping clusters when exemplars had semantic attributes belonging to different categories, patients produced isolated clusters without considering the overlapping of attributes. Patients relied on the most salient attributes and did not use alternative categorization strategies. The authors conclude that the deficits are a consequence of higher-order categorization process deficits and concur with the explanation of Vinogradov et al. (2002), who propose that the semantic memory in schizophrenia patients is characterized by an increased complexity and diffusion of activation.

Tallent et al. (2001) and Elvevåg and Storms (2003) conducted similar category organization tests with similar results. The broadening of automatic activation of the semantic memory in schizophrenia was indicated on a neural level by Kreher et al. (2008) in an ERP study using indirect priming tasks. Their results indicate that activation spreads further within a shorter time and language processing deficits may be the result of a faster network spreading or/and a reduced inhibition mechanism. Berberian et al. (2016) also conclude that there may be a broader semantic memory activation but propose, based on the results of a verbal fluency test analysis, that semantic categories, while facilitating responses and acting as cues, may also increase neural noise, i.e. activation, which consequently demands an increase of cognitive control. Such an interpretation supports Kreher et al.'s (2008) findings of a broader activation of the semantic memory and a need for a compensating inhibition mechanism and its deficit.

1.4. The current study

The aim of this study was to examine the processing of hierarchy relations in FEP (first-episode psychosis), as they offer a view of category structures and their boundaries in the semantic memory. It was hypothesized that, if the semantic memory was degraded, patients would have difficulties in solving the categorization tasks, but if the semantic memory was intact, patients would be able to solve the tasks with a minimum of incorrect answers. Therefore, it was hypothesized that patients would have less correct answers compared to the healthy control group. Furthermore, if the incorrect answers were pragmatic-semantically related and related both to the category and the target word, they would be activated

in the search and retrieval process, while there would be no activation and no need for inhibition for unrelated answers.

The hypothesis supports the model of an intact semantic memory with reduced inhibition processes, which presupposes heightened activation in the semantic memory and a lack of inhibition of incorrectly activated concepts, or a model of loose semantic representations with the activation of concepts loosely connected with the target concepts.

2. Methods

2.1. Participants

The study included 17 first-episode and early-onset psychosis patients from the University Psychiatric Hospital Vrapče (School of Medicine, University of Zagreb) and 17 control subjects. The control group consisted of 17 participants, all students from the Faculty of Humanities and Social Sciences, University of Zagreb. None of the control subjects had a history of a psychiatric disorder, substance abuse, or traumatic head injury. Before the administration of the test, an informed consent was obtained from each of the participants, and the test had been approved by the Ethics Committee of the University Psychiatric Hospital Vrapče (Registry number: 23–485/2–15).

The control group was matched with the patients in age, handedness, and sex. The average age of the patients was 24.18 (SD=3.97) years, 10 were male and 7 female. 16 patients were right-handed, and 1 was left-handed.

Average time after the appearance of symptoms of psychosis was 1.18 (SD=1.63) months. All patients received antipsychotic therapy. Average daily dose of antipsychotics expressed in chlorpromazine equivalents was 442.16 mg (SD=215.11). Thirteen patients were receiving a concomitant psychopharmacological therapy of benzodiazepines, 4 patients were receiving anticholinergics, 2 patients hypnotics, one patient was receiving a mood stabilizer, and one an antidepressant.

2.2. Materials and procedure

The category reception test was constructed for the intent of this study and consisted of 50 examples from 10 different categories (5 examples for each category). The categories used in the test were *animals, vegetables, fruit, trees, musical instruments, food, drinks, vehicles, clothes, and furniture*. These categories were chosen because they are known and used frequently in everyday life occasions. The test booklet was composed of 50 A5-size pages. In each trial, the subjects were presented with a hypernym, and they were supposed to choose the one item out of four possibilities that was a member of the given category. The category

was written on top of the page in upper-case Times New Roman font size 36, and the possible answers were stated underneath in lower-case Times New Roman font size 20, both the category and each answer were presented in a frame. For each of the 50 categories, possible answers were constructed consistently. In each trial, three distractors were used, along with a target word. The distractors included a semantic-pragmatically related distractor, a lexical-semantically related distractor, and an unrelated distractor. For example, for the category *životinje* 'animals', along with the target word *hobotnica* 'octopus' three distractors were shown: the semantic-pragmatic distractor *more* 'sea', the lexical-semantically related distractor *krak* 'tentacle', and the lexical-semantically unrelated distractor *truba* 'trumpet'. The target word is a hyponym of the given category, which is its hypernym. The target words and distractors are all consistently highly concrete, unambiguous, and well-known Croatian words. Before the trial, the material was given to several random native Croatian speakers whose task was to recognize if ambiguous or unfamiliar words were used in the test. The categories, as well as the possible answers, are all stated in a random order: the target words and distractors for each task are located in a different position on each page, and therefore, the answers cannot follow an intentional design. The following instructions were given to the participants (which were the same for both the patients and the control group): "After reading the word in upper-case letters at the top of the page, please read all four words in lower-case letters at the bottom of the page. After reading all of them, please choose, and read aloud, the one of those four which you consider to be most connected with the one written at the top of the page." The tasks are shown in succession in the printed material. The participants read their answers, and the examiner marked them on a control form. The testing of the patients was carried out in a quiet and isolated environment at the University Psychiatric Hospital Vrapče, and the testing of the control subjects at the Faculty of Humanities and Social Sciences. The participants performed the tasks at their own pace.

3. Results

Statistical analyses were conducted using the SPSS. Normality of distribution was tested by the Shapiro-Wilks test. Considering that all four dependent variables showed statistically significant deviation from normal distribution, in both the patient group and the control group ($p < 0.001$), group comparisons were conducted using the nonparametric Mann-Whitney U-test. All correlations and relations of the categorization test were tested with all the variables.

Both the control group and the patient group achieved high accuracy. The average correct response for the control group was 49.29 (SD=1.21), while the patient group scored 45 correct answers on average (SD=7.13).

Table 1. Number of chosen semantic-pragmatically related, lexical-semantically related and lexical-semantically unrelated distractors in both the control and patient group

	Patients	Control group
semantic-pragmatically related distractors	3.18 (SD=5.11)	0.18 (SD=0.53)
lexical-semantically related distractors	1.77 (SD=2.49)	0.53 (SD=0.94)
lexical-semantically unrelated distractors	0.12 (SD=0.33)	0

On average, the patients chose 3.18 (SD=5.11) semantic-pragmatic distractors, 1.77 (SD=2.49) lexical-semantically related distractors (meronyms), and 0.12 (SD=0.33) lexical-semantically unrelated distractors. On average, the control group chose 0.18 (SD=0.53) semantic-pragmatic distractors, 0.53 (SD=0.94) lexical-semantically related distractors (meronyms) and none of the participants chose a lexical-semantically unrelated distractor. The Mann-Whitney U-test showed significantly fewer correct answers in comparison to the control group ($U=71.00$; $p=0.011$). Furthermore, the patients chose significantly more pragmatic-semantically related distractors than the control group ($U=82.00$; $p=0.031$). There were no significant differences in the number of meronyms ($U=92.50$; $p=0.073$) and lexical-semantically unrelated distractors ($U=127.50$; $p=0.563$). There were no significant correlations of age or sex with the test results in either group. There were no significant correlations with time that had passed since the appearance of first symptoms of psychosis, or the daily dose of anti-psychotics in the patient group. A chi-square test did not show any significant relation between additional psychopharmacological therapy and the test results.

4. Discussion

Although the Mann-Whitney U-test showed that patients' answers were significantly less accurate than those of the controls, the patients nevertheless had an average of 45 correct answers out of 50 tasks. If the semantic memory were considerably damaged, we presume that the average number of correct answers would be significantly lower. Therefore, an answer to the question of the statistically lower accuracy in the patient group needs to be answered in line with the theory of loose connections of representations in the semantic memory or in other domains of cognitive functioning. One possible explanation is an executive function deficit that leads to an incapability to inhibit distractors. This is further supported by the fact that the patient group mostly chose a semantic-pragmatic distractor in place of the target word, and not a lexical-semantically related or unrelated distractor. The presupposition is that, during category activation in the semantic memory, the patients' activation was higher, and

because of the weakening of executive functions, they were unable to inhibit semantically related answers. Unlike the semantically related answers, the semantically unrelated distractors were not activated because they are not related to the default category or the target word and thus did not need inhibiting. The present data once more suggests the presumption that the semantic memory in schizophrenia patients is not damaged because, if it were, there would be a considerably higher number of unrelated distractors among their answers. Generally speaking, the hypothesis that the concepts in the semantic memory are not lost is confirmed, which corresponds to the viewpoints of authors who suggest that the semantic memory in schizophrenia is not damaged and that the foundations for lexical-semantic deficits in schizophrenia are to be found in other segments of language processing. Primarily, executive functions are a suggested domain of cognition responsible for the deficits, as they are responsible for the retrieval and manipulation of long-term memory information which are necessary components of language processing. Nevertheless, additional studies of executive functions are needed to confirm results that suggest their dysfunction as a basis for lexical-semantic deficits in schizophrenia.

5. Conclusion

Lexical-semantic deficits in FEP have been explored relatively well, but a few questions remain answered in full. Although the results of this study show that there was a marked lexical-semantic impairment in the FEP group of participants in comparison to the healthy control group, they do not corroborate semantic memory deficits but rather indicate deficits in other domains included in language processing. The aim of this study was not to affirm or deny semantic memory deficits but to investigate the preservation of category relations in the mental lexicon of FEP patients with schizophrenic symptoms or symptoms similar to schizophrenia. The categorization test constructed for this study was designed not only to investigate the preservation of semantic memory, but also to test the structural integrity of its relations and activation. The results support the hypothesis that there is no significant damage to the semantic memory in FEP, and that lexical-semantic deficits can be attributed to two possible explanations: a loosening of representations in the semantic memory or a heightening of activation and a lack of inhibition of falsely activated concepts. We argue that the latter explanation corresponds better with our results, as patients were unable to inhibit semantically related distractors but had no need to inhibit unrelated distractors as they were not activated because the structure of the semantic memory remains intact. This further implies that lexical-semantic deficits in FEP are largely due to deficits in executive functioning and specifically inhibition. The results of this study were analyzed in accordance with current psycholinguis-

tic theories, but further studies in domains of executive functions are needed in order to establish a better understanding of language processing and deficit foundations in schizophrenia. Along with the lack of a cognitive test which could establish a correlation with executive functions, another shortcoming of this study is the small subject sample. We conclude that further categorization studies accompanied by executive function studies could additionally enlighten language processing deficits in first-episode and early-onset psychosis.

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