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Relationship between Semantic Memory and Social Cognition in Schizophrenia

Javier Pérez-Flores [1,*], Antonieta Nieto [1] and Ofelia Delgado [2]

[1] School of Psychology. University of La Laguna; jperezfl@ull.edu.es (J.P.-F.); anieto@ull.es (A.N.)
[2] University Hospital Nuestra Señora de Candelaria. Tenerife, Spain; odelgado999@gmail.com
* Correspondence: jperezfl@ull.edu.es

Abstract: This study examines the relationship between semantic memory and social cognition in schizophrenia, addressing how these cognitive domains intersect. Semantic memory, which includes general world knowledge and word meanings, was evaluated using verbal fluency tasks and the Camels and Cactus Test. Social cognition, essential for social interaction, was assessed through emotion recognition (Faces Test) and Theory of Mind (Hinting Task). Participants included 50 individuals with schizophrenia and 30 controls. The schizophrenia group showed significantly lower performance on both semantic memory and social cognition tasks. Notably, strong correlations were found between the Camels and Cactus Test and social cognition measures, suggesting that social cognition deficits in schizophrenia may be linked to semantic memory impairments. Regression analyses highlighted that the Camels and Cactus Test significantly predicted social cognition performance, independent of symptomatology. These findings underscore the interconnectedness of semantic memory and social cognition in schizophrenia, suggesting that semantic memory deficits, particularly in non-categorical associations, play a important role in social cognitive impairments. This study provides new insights into the cognitive underpinnings of schizophrenia, emphasizing the need for further research to explore these relationships and their implications for cognitive models and therapeutic interventions.

Keywords: schizophrenia; semantic memory; social cognition

1. Introduction

Semantic memory contains general information about the world, including the meanings of words, concepts, and knowledge about objects and events. This knowledge is abstract, generalized, and not tied to a particular experience [1]. Traditionally, two main perspectives have sought to explain how information is stored in semantic memory. The first proposes that concepts are stored in hierarchical networks, exemplified by models like that of Collins and Quillian [2]. This approach has a fundamental limitation: its rigidity. Outside of laboratory tasks, category boundaries are not so clear, and the importance assigned to categories may vary depending on personal experience [3]. The second approach proposes that knowledge is distributed in networks but not organized hierarchically. In this model, nodes activate to varying degrees based on the relationship distance, which depends on how concepts co-occur in an individual's experience. An example of this type of model is that of Collins and Loftus [4]. Although these models are less rigid [3], they overlook the impact of perceptual context on semantic memory and its relationship with episodic memory [5].

In the last decade, a new explanatory framework has emerged aiming to overcome the limitations described: grounded cognition. This approach posits that context plays a central role in conceptual activation. The term "context" not only refers to the perceptual features of the particular situation but also includes the interaction with the individual, their goals, expectations, and prior learning experiences. Therefore, semantic activation involves not only the activation of an abstract concept but also the activation of sensory and motor representations that guide experience by

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generating expectations about the future [6]. Thus, grounded cognition presents semantic memory as a set of conceptual frameworks in constant interaction with experience [6,7].

Parallels can be drawn between grounded cognition and the concept of social cognition. Social cognition encompasses several related processes that are essential for the development of social interaction, primarily involved in the perception, encoding, storage, retrieval, and regulation of information about others and oneself [8]. Social cognition relies on mentalization, a process that allows us to internalize our experiences by transforming bodily-physical experience into a mental-verbal symbol [9]. Therefore, effective social cognition requires an interaction between current experience and previously abstracted conceptual frameworks, as proposed by grounded theory.

The study of social cognition in different psychiatric disorders has identified deficits in various populations, most notably in schizophrenia [10]. Individuals with schizophrenia display several social cognition deficits, such as difficulties in perceiving and recognizing emotions [11], challenges with Theory of Mind (the ability to represent and infer others' mental states) [12] and problems with abstraction and the use of social knowledge, encompassing stored information about the rules, roles, expectations, and goals governing social interactions [13].

In the case of semantic memory, while alterations in semantic associations can be observed in the speech of individuals with schizophrenia [14]. Semantic memory has received less attention than other domains. Available studies indicate that individuals with schizophrenia showed lower performance than controls in several semantic memory tests, especially in semantic fluency and categorization. In the case of semantic association tasks, studies are scarce and results are contradictory [15,16].

Given the conceptual relationship between grounded cognition and social cognition, it is reasonable to think that the deficits in social cognition of people with schizophrenia could be linked to their performance on semantic memory tasks. The objective of this study is to examine the relationships between performance on semantic memory tasks and social cognition tasks in schizophrenia and to assess the predictive capacity of semantic memory for social cognition in individuals with schizophrenia.

2. Materials and Methods

2.1. Participants

The study included two groups of participants: a group of individuals with schizophrenia and a control group. The Schizophrenia group consisted of 50 participants (14 women and 36 men). All of them were recruited from psychosocial rehabilitation centers (CRPS) of Tenerife. They were outpatients who voluntarily attended services aimed at their functional recovery. All participants were under psychopharmacological treatment and their symptomatology was predominantly negative, with few positive or disorganized symptoms.

The control group comprised 30 participants without psychiatric or neurological diagnoses (6 women and 24 men).

All participants were volunteers and were provided with informed consent in advance, clearly stating the procedures that would be followed in the research. This work was conducted in accordance with the Declaration of Helsinki for human research and was previously reviewed by the ethics committee of the University Hospital Nuestra Señora de Candelaria de Candelaria (Tenerife, Spain).

2.2. Materials

Vocabulary subtest of the Wechsler Adult Intelligence Scale (WAIS-IV) was used as an estimator of general intellectual functioning [17].

Schizophrenia symptomatology was assessed using the Scale for the Assessment of Negative Symptoms (SANS) [18] and the Scale for the Assessment of Positive Symptoms (SAPS) [19]. These scales are clinical assessment tools used to measure negative and positive symptoms in individuals with psychotic disorders, primarily schizophrenia. SANS evaluates negative symptoms such as

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alogia, affective flattening, avolition, anhedonia, and diminished attention. In contrast, SAPS measures positive symptoms like hallucinations, delusions, bizarre behavior, and formal thought disorders. Both scales were designed to be administered by a clinician and are widely used in research and psychiatric diagnosis.

Semantic memory was evaluated using two approaches: a verbal fluency tasks and a semantic association task.

Verbal Fluency. The semantic fluency task was used. This task involves generating words that fall into a given category within one minute. In this study, we used the category "animals".

Semantic Association. The Camels and Cactus Test was used [20]. This is a neuropsychological assessment designed to evaluate non-categorical semantic associations between concepts. Instead of grouping items by traditional categories (such as animals or plants), this task focuses on associations based on other types of semantic relationships, such as context of use, function, or shared characteristics. For example, the participant might be asked to associate a camel with a cactus due to their contextual relationship in a desert environment, rather than belonging to the same taxonomic category. A computerized version of the task was employed. In each trial, a word appeared at the top of the screen (e. g. Camel), while four words were displayed at the bottom (e. g. Tree; Sunflower; Cactus; Rose). The participant's task was to select the word at the bottom most related to the word at the top.

Social cognition was assessed through two indicators: emotion perception and recognition, and Theory of Mind.

Emotion Perception and Recognition. The Faces Test was used [21]. In this task, participants were shown an image of a person's face displaying a specific emotional state. In each trial, they had to choose between two words shown at the bottom of the image to best match the facial expression.

Theory of Mind. The Hinting Task was used [22]. In each trial, participants were presented with a short story involving two people. This story was read aloud, and a copy was placed in front of the participant so they could reread it if necessary. In each story, one character hinted at something to their interlocutor. After hearing and reading the story, participants had to infer what the hinting character wanted to achieve. If the participant couldn't infer it at first, they were given a second chance after a continuation of the story, which added information and made the inference easier. Scoring was 0 if the participant couldn't identify the character's intentions, 1 if they made the inference correctly after more information was provided, and 2 if they made the inference correctly after the first reading.

2.3. Procedure

Symptom assessment was conducted by the clinical psychologists and psychiatrists who develop, coordinate, and monitor treatment plans for the functional recovery of the participants.

The assessment of semantic memory and social cognition was carried out by an experienced neuropsychologist. The assessment was organized into separate sessions. Verbal fluency and emotion perception and recognition were evaluated first. In another session, the Hinting Task was administered, and in a final session, semantic association was evaluated. This distribution aimed to avoid bias due to participant fatigue or task interference.

2.4. Data Analysis

Descriptive statistics were first obtained for each variable, and group performance was compared using Student's t-tests. To avoid potential increases due to successive contrasts, Bonferroni correction was used for seven comparisons ($\alpha/7 = 0.05/7 = 0.007$). Homogeneity of variances was assessed with Levene's test, and Welch's correction was applied for degrees of freedom when appropriate. Effect sizes of the differences were calculated using Cohen's delta (ẟ).

Pearson correlations between the studied variables were subsequently analyzed. Significant relationships served as the basis for regression models aimed at predicting social cognition performance based on semantic memory performance. The stepwise procedure was used to avoid variance redundancy, and in all cases, tolerance indices and variance inflation factors were

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calculated. Tolerance indices were always above 0.7, and the variance inflation factors were below 5. Dominance analysis was employed to estimate the percentage of variance associated with each variable in the regression.

3. Results

3.1. Descriptive Statistics of the Sample and Intergroup Contrasts

The groups were statistically equivalent in age, years of education, and Vocabulary score (WAIS-IV). This information can be found in Table 1.

Table 1. Sample characteristics.

	SG: Mean (sd)	CG: Mean (sd)	t (78)	p
Age	42.54 (9.98)	42.06 (12.50)	-0.19	>.05
Education	10.28 (2.85)	11.30 (2.69)	1.57	>.05
Vocabulary subtest	26.00 (13.54)	31.43 (10.50)	1.96	>.05

The analysis of symptomatology showed that negative symptoms were more prevalent, especially anhedonia/asociality. Descriptive statistics of the symptomatology are presented in Table 2.

Table 2. Scores obtained for the evaluated symptoms.

	Mean (sd)	Range
Alogia	1.44 (1.15)	0-4
Affective flattening	1.13 (0.92)	0-3
Avolition/apathy	1.32 (0.86)	0-3
Anhedonia/asociality	1.92 (1.09)	0-4
Attention	1.17 (0.95)	0-3
Hallucinations	0.89 (0.69)	0-2
Delusional ideas	0.73 (0.64)	0-2
Bizarre behaviour	0.69 (0.84)	0-3
Formal thought disorders	0.63 (0.89)	0-4

The performance of the groups across different variables and potential differences between them were analyzed. In the case of semantic memory measures, the patients performed significantly worse than the control group in the two tasks. Similarly, their performance was lower in the two social cognition tasks. All effect sizes were large ($\delta > 0.80$). This information can be found in Table 3.

Table 3. Descriptive statistics of the variables and intergroup contrasts.

	SG: Mean (sd)	CG: Mean (sd)	t(78)*	p	δ
		Semantic Memory			
Semantic fluency	15.62 (6.52)	24.47 (3.66)	7.77	<.007	1.79
Camels and Cactus test	44.38 (9.43)	52.60 (4.09)	5.37	<.007	1.26
		Social Cognition			
Face test	16.34 (2.23)	19.03 (1.38)	5.94	<.007	1.34
Hinting Task	11.08 (5.79)	17.93 (1.76)	7.79	<.007	1.79

*It was necessary to apply Welch's correction for semantic verbal fluency (df = 77.74), Camels and Cactus test (df = 72.48) and Hinting Task (df = 62.75).

3.2. Pearson Correlation between Measures

Pearson correlations between the measures were examined. All correlations were significant, although those involving the Camels and Cactus Test were larger and of greater magnitude. These

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results are shown in Table 4. Moreover, since the literature suggests that symptomatology can influence performance on semantic memory tasks [15], the correlation between these tasks and the disease's symptomatology was determined. Semantic fluency showed significant negative correlations with bizarre behavior ($r = -.34$, $p < .05$), alogia ($r = -.32$, $p < .05$), affective flattening ($r = -.41$, $p < .01$), and attentional difficulties ($r = -.42$, $p < .01$). The Camels and Cactus Test showed no significant correlations with any of the symptom dimensions. This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

Table 4. Pearson correlations between the measures.

	Face Test	Hinting Task
Semantic fluency	$r = .39$, $p < .01$	$r = .35$, $p < .01$
Camel and Cactus test	$r = .63$, $p < .005$	$r = .54$, $p < .005$

3.3. Linear Regression Analyses

Linear regression analyses were conducted with the semantic memory measures as predictors and the social cognition measures as criteria variables. Given that semantic fluency significantly correlated with symptomatology, the corresponding regression analyses were conducted including symptomatology and using a stepwise procedure. The first model included the Faces Test as the dependent variable and, after the stepwise process, bizarre behavior, affective flattening, and Camel and Cactus test were selected as predictors. This model was significant [$F(3,46) = 17.35$, $p < .005$] and explained 53% of the variance in the Faces Test. Dominance analysis allowed estimation of the percentage of variance associated with each predictor. Bizarre behavior explained 6% of the variance, Affective flattening 13%, and Camel and Cactus test 35%.

The same process was conducted using the Hinting Task as the dependent variable. The predictors selected in the stepwise procedure were the same as in the Faces Test case: bizarre behavior, affective flattening, and the Camels and Cactus Test. The model was significant [$F(3,46) = 18.39$, $p < .005$] and explained 54% of the variance in the Hinting Task. Dominance analysis showed that bizarre behavior explained 8% of the variance, affective flattening 23%, and the Camels and Cactus Test 23%.

The statistics of the linear regression analyses are found in Table 5.

Table 5. Linear regression analyses.

Criterion variable: Face Test					
	β	SE	t	p	DW test*
Bizarre behavior	0.26	0.30	2.44	<.05	
Affective flattening	-0.36	0.21	-3.37	<.005	2.23, p > .05
Camel and Cactus test	0.55	0.02	5.28	<.005	
Criterion variable: Hinting Task					
	β	SE	t	p	DW test*
Bizarre behavior	0.34	0.76	3.21	<.005	
Affective flattening	-0.51	-4.82	3.21	<.005	1.71, p >.05
Camel and Cactus test	0.42	0.06	4.17	<.005	

* Durbin-Watson Test: when its result is not significant ($p > .05$), it indicates that the assumptions of linear regression are met.

4. Discussion

As expected, individuals with schizophrenia have shown significantly lower performance in Semantic fluency. This test is one of most commonly used to assess semantic memory in the schizophrenia and presence of impairment in this task is a robust finding [15,16]. On the contrary, performance on Camel and Cactus has been scarcely studied. Our results indicate a poor performance in this task. In general, semantic association task have been less used than other semantics test and results are mixed. Thus, for example, Barrera et al. [23] observed a deterioration in the Camel and Cactus task only in patients with a Formal Thought Disorder ranging from moderate to severe. Lawrence et al. [24], in contrast, observed impaired performance on two semantic association tasks in an unselected sample of patients with schizophrenia, while Stirling et al. [25], obtained no evidence of impaired performance on the Pyramid and Palm trees test and no differences between patients with and without thought disorder. Interestingly, our results indicate an impaired performance in the conceptual association task with greater effect size than found in the meta-analysis by Doughty & Done [15], even though no significant correlation was found between the Camels and Cactus Test and symptomatology, including formals thought disorder. This highlights the importance of studying these semantic association task further in schizophrenia and to clarify their relationship with the disorder's characteristics.

Our results are also clearly supporting the impairment of social cognition in schizophrenia. Participants with schizophrenia show significantly lower performance in the emotional recognition task, with an effect size similar to that found by Kohler et al. in their meta-analysis [26]. The impairment of perception and recognition of faces with emotional expressions is a widely replicated finding in the scientific literature [27]. In the case of Theory of Mind, we obtain similar results. Participants with schizophrenia showed significant lower scores than controls on the Hinting Task, with a large effect size. This result is consistent with previous literature [28].

Both fluency test and the Camels and Cactus Test showed significant correlations with the Faces Test and Hinting Task. Curiously, although intergroup differences were greater for semantic fluency, the strength of correlations with social cognition tasks was higher for the Camels and Cactus Test. To assess the predictive capacity of semantic memory for social cognition, regression models were constructed considering symptomatology. As a result, semantic fluency was excluded from the models through stepwise selection because it showed significant relationships with symptomatology. However, the Camels and Cactus Test remained in the models and was found to account for most of the explained variance in the Faces Test, with an equivalent proportion to Affective flattening in the Hinting Task. This suggests that the predictive capacity of semantic memory depends on the indicators used for its measurement. Verbal fluency tasks involve self-regulation of the search process, thus making significant demand of executive functioning [29] that is not present in the Camels and Cactus test. This task relies on spontaneous associations and not on spontaneous associations in response to a stimulus and not on a self-directed search process restricted to a specific instruction. It is probably this executive component that explains why semantic fluency is associated with symptomatology while the Camels and Cactus test has no such relationships.

To the best of our knowledge, there are currently no studies in the literature that relate semantic memory with social cognition in schizophrenia. One possible interpretation of the predictive capacity of semantic memory difficulties for impairments of social cognition may be that both have common causes. A common cause could be a central difficulty in using semantic information related to contextual associations. This information is more related to the uses, functions, and shared characteristics between objects and/or concepts than to traditional semantic categories. It is precisely the use of this information that is necessary to perform the Camels and Cactus task. This deficit in the use of information related to contextual associations is part of the conceptualization of both grounded cognition [6,7] and social cognition [8]. Moreover, it represents a common link with the cognitive model of schizophrenia proposed by Gray et al. and Hemsley [30–32].

This study has some limitations. First, both semantic memory and social cognition are constructs encompassing many different domains. Future research should increase the number of indicators to gain a broader picture of participants' difficulties and relationships between variables. Additionally, schizophrenia exhibits high heterogeneity based on the disease stage. It would be interesting to conduct longitudinal studies or, alternatively, include patient groups at different stages to evaluate how the interactions between semantic memory and social cognition vary over time.

In conclusion, our work supports evidence that semantic memory is impaired in individuals with schizophrenia. It also indicates a significant relationship between semantic memory and social cognition, particularly when using non-categorical semantic association tasks. This opens new lines of research and provides a common link with cognitive models of schizophrenia.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

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