

# Neurocognition, social cognition and functional outcome in schizophrenia

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**ABSTRACT – Background and Objectives:** A relationship has been found between cognition and functioning in patients with schizophrenia. Our objective was to study the relationship between the cognitive domains assessed by the MATRICS Consensus Cognitive Battery (MCCB), and functioning as evaluated using the functioning subscale of the Global Assessment of Functioning scale (GAF-f).

**Methods:** A sample of 83 clinically stable outpatients diagnosed with schizophrenia according to DSM-IV criteria were assessed using the MCCB and the GAF-f. Pearson correlations and stepwise linear regression analyses were performed.

**Results:** Correlation analysis between the GAF-f and the cognitive domains of the MCCB showed a significant relationship between functioning and all of the cognitive domains. Regression yielded a statistically significant model ( $F_{2,74} = 20.4, p < 0.001$ ) in which functioning was related to Speed of processing (standardized  $\beta = 0.369, p = 0.001$ ) and to Social cognition (standardized  $\beta = 0.325, p = 0.003$ ). Together, these two variables explained 33.8% of the variance of functioning.

**Conclusions:** Both speed of processing and social cognition have an important association with functioning in patients with schizophrenia.

## Introduction

Cognitive deficits have been considered to be a core symptom of schizophrenia from the earliest descriptions of the disorder<sup>1,2</sup>. Cognitive impairments have been found in patients suffering from years of illness<sup>3</sup>, but also in those with a first psychotic episode<sup>4</sup>, in clinically remitted<sup>5,6</sup> and in neuroleptic-naïve patients<sup>7</sup>, in subjects at high risk for developing psychosis<sup>8,9</sup>, and even in healthy siblings of patients with schizophrenia<sup>10</sup>. The cognitive performance of schizophrenia patients is one to two standard deviations below that of healthy subjects<sup>11-13</sup>.

Schizophrenia patients also exhibit important deficits in their personal and social functioning leading to difficulties in different areas such as everyday activities, interpersonal relationships, or academic and work performance<sup>14-17</sup>. Cognitive impairment is considered to be one of the main factors influencing functioning in schizophrenia, and many studies have found associations between cognitive performance and functioning in patients with this disorder<sup>18,19</sup>.

Regarding the different cognitive processes, neurocognition has often been separated from social cognition. Neurocognition refers to the processes of linking and appraising information, and includes cognitive domains that have traditionally been referred to as “cognitive” in the literature, such as speed of processing, working memory, attention, memory, or executive functions<sup>20</sup>. Social cognition refers to the mental operations underlying social interactions such as perception, interpretation, and generation of responses to the intentions, dispositions, and behaviors of others<sup>21-25</sup>.

The relationship between neurocognition and functioning has been quantified as moderate in different studies. Thus, between 20%

and 60% of the variance of functioning in schizophrenia patients could be explained by neurocognitive performance, which is a better predictor of functioning than the positive symptoms of the disorder<sup>26-29</sup>.

In addition to neurocognitive deficits, patients with schizophrenia have been shown to exhibit deficits in social cognition<sup>30-33</sup>. Many studies in the last years have also associated social cognition with functioning, so that social cognitive performance would explain an additional proportion of the variance of functioning that is not explained by neurocognition<sup>16,34-42</sup>. Some studies have even found that social cognition could be a better predictor of functioning than neurocognition itself<sup>29,43</sup>.

One of the problems when comparing the results of different studies on cognition in schizophrenia was the lack of consensus regarding which cognitive domains to evaluate and what instruments to use for their assessment. This obstacle, which also hindered the development of interventions designed to improve cognition, led the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) initiative of the U.S. National Institute of Mental Health (NIMH) to develop a consensus battery for the assessment of cognitive functioning: the MATRICS Consensus Cognitive Battery (MCCB). The battery is composed of 10 tests<sup>44</sup> which evaluate the 7 cognitive domains (6 neurocognitive domains, plus a seventh social cognition domain) that are impaired in schizophrenia<sup>20</sup>, and the process of standardization and obtaining normative data was carried out in the U.S. by Kern *et al.*<sup>45</sup>. Our group carried out the co-norming and standardization of the MCCB in Spain in collaboration with developers of the battery<sup>46</sup>.

To our knowledge, there are no studies in our country assessing the relationship between cognition and functioning in schizophrenia using the MCCB (with the translation

and community norms for Spain) and the functioning subscale of the Global Assessment of Functioning (GAF-f)<sup>47</sup>. The objective of the present study was to analyse the relationship between functioning as assessed using the GAF-f and the different cognitive domains evaluated by the MCCB in a sample of Spanish patients with schizophrenia.

## Methods

### Sample

The present cross-sectional study was carried out in 83 clinically stable outpatients aged 18 to 60 years with a confirmed DSM-

IV diagnosis of schizophrenia<sup>48</sup> as diagnosed with the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)<sup>49</sup>. The patients were recruited at Hospital Universitario 12 de Octubre (Madrid, Spain). All participants were on antipsychotic treatment and had been clinically stable (no changes in treatment, no significant psychopathological changes, no hospital admissions) for at least 3 months before inclusion. Patients with substance dependence in the past 6 months, substance abuse in the past month, neurological disease or head injury were excluded from the study. Written informed consent was obtained from all participants prior to their inclusion in the study. The demographic and clinical characteristics of the sample are presented in Table 1.

Table 1  
Demographic and clinical characteristics and MCCB cognitive domain scores for the sample. Results are displayed as Mean (*Standard deviation*) or *N (%)* as appropriate.

Age (years)	41.2 (8.3)
Age at onset of illness (years)	25.0 (6.8)
Gender	
Male	56 (67.5%)
Female	27 (32.5%)
Educational level (years)	10.8 (3.8)
Antipsychotic	
Second generation	63 (78.8%)
First generation	9 (10.8%)
Combined	8 (9.6%)
GAF - f <sup>a</sup> score	56.5 (13.5)
Speed of Processing T - score	37.4 (13.0)
Attention/Vigilance T - score	39.8 (10.1)
Working Memory T - score	38.3 (13.6)
Verbal Learning T - score	33.6 (15.6)
Visual Learning T - score	36.0 (14.5)
Reasoning and Problem Solving T - score	40.8 (12.4)
Social Cognition T - score	39.5 (13.6)

<sup>a</sup> Global Assessment of Functioning, functioning subscale.

## Instruments

### *The Global Assessment of Functioning (GAF) scale*

The GAF scale<sup>50</sup> is a global measure of the patient's status. It assesses the severity of mental illness through the individual's symptoms and functioning on a social and occupational level. Based on a revision of Endicott's Global Assessment Scale (GAS)<sup>51</sup>, the GAF was published in 1987 and became Axis V for DSM-III-R, DSM-IV and DSM-IV-TR<sup>48,50,52</sup>. The score for both symptoms and functioning ranges from 1 to 100, and is divided into 10 intervals of 10 points. Each of these intervals has a description of the level of symptoms and functioning that are appropriate for this score. At the two extremes, the 1 to 10 interval includes the most severely ill subjects (persistent danger of severely hurting self or others, or persistent inability to maintain minimal personal hygiene, or serious suicidal act with clear expectation of death), whereas the 91 to 100 interval represents the healthiest individuals (superior functioning in a wide range of activities, life's problems never seem to get out of hand, is sought out by others because of his or her many positive qualities; no symptoms). After publication of the GAF, the GAF-Split version<sup>53,54</sup> was described, with separate scales for symptoms (GAF-s) and functioning (GAF-f), and whose validity has later been established<sup>55</sup>. Because the goal of our study was to evaluate functioning, only the GAF-f subscale was used.

### *The MATRICS Consensus Cognitive Battery (MCCB)*

The MATRICS Consensus Cognitive Battery (MCCB) was used for the cognitive assessment of patients. This battery is composed of 6 neurocognitive domains, plus a seventh

social cognition domain. These seven domains are assessed using 10 neuropsychological tests, as follows: 1) Speed of Processing (Trail Making Test, Part A; Brief Assessment of Cognition in Schizophrenia, symbol coding subtest; Category fluency test, animal naming); 2) Attention/Vigilance (Continuous Performance Test, Identical Pairs version); 3) Working Memory (Wechsler Memory Scale, 3rd ed., spatial span subtest; Letter - Number Span test); 4) Verbal Learning (Hopkins Verbal Learning Test - Revised); 5) Visual Learning (Brief Visuospatial Memory Test - Revised); 6) Reasoning and Problem Solving (Neuropsychological Assessment Battery, mazes subtest); and 7) Social Cognition (Mayer - Salovey - Caruso Emotional Intelligence Test, managing emotions branch)<sup>44</sup>. The tests are administered in a specified order, and take approximately 65 minutes. Participants' scores for each cognitive domain were converted into T-scores using Spanish normative data, based on the results of the MCCB co-norming and standardization process that was carried out by our group in Spanish population<sup>(46)</sup>.

### *Statistical analysis*

The mean and standard deviation (SD) were used to describe continuous variables, while percentages were used for categorical variables. Pearson's correlations were first performed between the GAF-f score and the different MCCB cognitive domains. This was followed by stepwise linear regression analyses with the GAF-f score as the dependent variable, and the cognitive domains scores that were found to be significant in the correlation analysis as the independent variables. P-values of < 0.05 were considered statistically significant. Data was managed and analysed using SPSS version 20.

## Results

Table 1 shows the GAF-f and MCCB cognitive scores for the sample. The mean GAF-f score was 56.5 (SD = 13.5). Among the different cognitive domains, the highest scores were obtained for Reasoning and problem solving (mean = 40.8, SD = 12.4) and Attention/vigilance (mean = 39.8, SD = 10.1). The lowest scores corresponded to the Verbal learning (mean = 33.6, SD = 15.6) and Visual learning (mean = 35.9, SD = 14.5) domains.

The first step of the data analysis was a correlation between the GAF-f and MCCB cognitive domain scores. As shown in Table 2, all correlations were statistically significant. Pearson's correlation coefficients ranged from 0.273 ( $p = 0.014$ ) for Attention/vigilance, to 0.523 ( $p < 0.001$ ) for Speed of processing.

Finally, a linear regression analysis was performed, with the GAF-f score as the dependent variable and the different MCCB cognitive domain scores as the independent

Table 2  
Pearson's correlations between the GAF-f and the MCCB cognitive scores.

	Speed of processing	Attention/Vigilance	Working Memory	Verbal Learning	Visual Learning	Reasoning and Problem Solving	Social Cognition
GAF-f <sup>a</sup>	$r = 0.523$ $p < 0.001$	$r = 0.273$ $p = 0.014$	$r = 0.359$ $p = 0.001$	$r = 0.368$ $p = 0.001$	$r = 0.470$ $p < 0.001$	$r = 0.460$ $p < 0.001$	$r = 0.499$ $p < 0.001$

<sup>a</sup> Global Assessment of Functioning, functioning subscale.

variables. Using the stepwise method, a significant model emerged ( $F_{2,74} = 20.4$ ,  $p < 0.001$ ). As shown in table 3, better functioning was related to higher scores in Speed of processing (standardized  $\beta = 0.369$ ,  $p = 0.001$ ) and

in Social cognition (standardized  $\beta = 0.325$ ,  $p = 0.003$ ). Calculation of corrected  $R^2$  showed that these two variables together explained 33.8% of the variance in functioning.

Table 3  
Stepwise linear regression analysis with the GAF-f scores as the dependent variable, and the MCCB cognitive domain T-scores as the independent variables.

Dependent variable	Independent variables	Standardized $\beta$	$t$	$p$
GAF-f <sup>a</sup>	Speed of processing	0.369	3.486	0.001
	Social cognition	0.325	3.068	0.003

<sup>a</sup> Global Assessment of Functioning, functioning subscale.

## Discussion

Schizophrenia patients in this study had a mean level of functioning as assessed by the GAF-f indicating moderate difficulties in social, occupational, or school functioning. These results are comparable to the scores found in other studies that have used the GAF to assess functioning in schizophrenia patients<sup>56,57</sup>. As has been previously described in schizophrenia<sup>12,13</sup> the mean scores of our patient sample for all MCCB cognitive domains were between one and two standard deviations below the population mean ( $T = 50$ ).

The main finding of the present study was that although all of the MCCB cognitive domains showed a statistically significant correlation with functioning, when the regression analysis was performed only Speed of processing and Social cognition were significantly related to functioning.

Speed of processing scores for our patient sample were below the population mean, as has been described in other schizophrenia studies<sup>44,58-61</sup>. In fact, impaired speed of processing has been found not only in patients with schizophrenia, but also in subjects at high risk for developing psychosis<sup>62,63</sup>, in patients with first-episode schizophrenia spectrum disorders<sup>64</sup>, and in healthy relatives of schizophrenia patients<sup>65,66</sup>. The relationship between speed of processing and functioning found in the present study has also been described by other authors. Thus, speed of processing deficits have been associated with impairments in different domains of functional outcome such as global psychosocial functioning<sup>60,67</sup>, community functioning<sup>68</sup>, daily problem solving skills<sup>69</sup>, job tenure<sup>70</sup>, social skills<sup>71</sup>, or independent living skills<sup>72</sup>.

It is noteworthy that the remaining cognitive domains were not included in the regression model. Speed of processing has been

defined as a basic cognitive process which allows processing information and performing simple cognitive tasks fluently and automatically. Over two decades ago, Salthouse<sup>73</sup> proposed that a decrease in the speed of processing led to impairments in more complex cognitive processes. Later, different authors have described processing speed impairments as underlying other cognitive deficits in schizophrenia<sup>74-77</sup> and in first-episode schizophrenia spectrum disorders<sup>78</sup>. This could explain why, despite the fact that all of the neurocognitive domains correlated significantly with functioning, only Speed of processing made it to the regression model. This highlights the relevance of this cognitive domain with regards to functioning in schizophrenia patients, and its special consideration when developing therapeutic strategies that target cognitive symptoms in these patients.

The other cognitive domain that appears in the regression model is Social cognition. As has been described in previous studies, there is a relationship between social cognition and functioning in schizophrenia<sup>15,33-41,79</sup>. For example, a review published by Couture *et al.*<sup>15</sup> established an association between community functioning and different domains of social cognition (social perception, emotion perception and Theory of Mind). It has been even suggested that social cognition may be more relevant for functional outcome than neurocognition<sup>28,34,42</sup>. Thus, the Fett *et al.*<sup>28</sup> meta-analysis studying the relationship of neurocognition and social cognition with different functional outcome domains in schizophrenia found that social cognition was more related to community functioning than neurocognition. However, our regression model yielded very similar standardized betas for Speed of processing and for Social cognition (in fact, the standardized beta for Social cognition was found to be slightly lower than for Speed of processing). This discrepancy with the studies that found social cognition to

be more related to community functioning than neurocognition could be due to different methodological factors, especially the fact that the social cognition construct includes several domains, and the existence of different instruments for their assessment. In this respect, although social cognition has been extensively studied in healthy individuals, only a subset of social cognition domains have been studied in patients with schizophrenia<sup>80</sup>. Thus, the MATRICS initiative has proposed that for research in this area, social cognition may be divided into five partially overlapping domains: Theory of Mind, social perception, social knowledge, attributional bias and emotional processing. When predicting functional outcome, it could be that social cognition may have a greater impact than neurocognition if certain domains of the two constructs are considered. For example, in the above-mentioned study, Fett *et al.*<sup>28</sup> concluded that social cognition was more related than neurocognition to functional outcome and that this was specifically due to the association between the Theory of Mind domain of social cognition and the Community Functioning domain of functional outcome. Thus, the prevailing role of social cognition over neurocognition when predicting functional outcome should be generalised with caution to the remaining domains of social cognition, or to other aspects of functioning<sup>15</sup>. The need for valid and reliable consensus instruments for the assessment of both social cognition and functioning is evident.

In this respect, a possible limitation of our study is the selection of instruments. The MCCB only assesses one aspect of social cognition (managing emotions, which is a part of emotional processing). Although the use of other instruments was considered, we preferred to use a consensus instrument that is used worldwide to assess neurocognition and social cognition, and has been translated and validated in our country. Similarly, al-

though there are other instruments designed to assess functioning, we chose the GAF-f due to its extensive and ample clinical use.

To conclude, this is the first study in Spain with results that support the existence of a relationship between functioning and cognition in patients with schizophrenia using the MCCB. Functioning is mainly related to speed of processing and to social cognition. Given the relevance of functional recovery in these patients, further research is required to improve our knowledge of the factors that may be associated with functional outcome in schizophrenia.

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## Contributors

IT, TP and RRJ designed the study and wrote the protocol. AB, MD, MJC and LG managed the literature searches and analyses. MD, MJC, LG and JRT selected the sample, evaluated patients and contributed in some aspects of the study design and in the interpretation of results. IT, MAJA, TP and RRJ undertook the statistical analysis. IT, AB and RRJ wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

## Conflict of interest

The authors report no biomedical financial interests or potential conflicts of interest.

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