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The communicative impairment as a core feature of schizophrenia: Frequency of pragmatic deficit, cognitive substrates, and relation with quality of life

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Abstract

Background: Impairments in specific aspects of pragmatic competence, supporting the use of language in context, are largely documented in schizophrenia and might represent an indicator of poor outcome. Yet pragmatics is rarely included in clinical settings. This paper aims to promote a clinical consideration of pragmatics as a target of assessment and intervention. We investigated the frequency of the pragmatic deficit, its cognitive substrates, and the relation with quality of life.
Methods: Pragmatic abilities were compared in a sample of patients with schizophrenia and healthy controls based on a comprehensive pragmatic test (APACS). We assessed also for psychopathology, cognition, social cognition, and quality of life. We explored the co-occurrence of deficits in different domains, and we used multiple regressions to investigate the effect of cognition and social cognition on pragmatics, and of pragmatics on quality of life.
Results: Pragmatic abilities, especially comprehending discourse and non-literal meanings, were compromised in schizophrenia, with 77% of patients falling below cutoff. Pragmatic deficit co-occurred with cognitive or socio-cognitive deficits in approximately 30% of cases. Multiple regression analysis confirmed the interplay of cognition and social cognition in pragmatic behavior. Quality of life was predicted by symptoms and by pragmatic abilities.
Conclusions: The high frequency of impairment suggests that the pragmatic deficit is a core feature of schizophrenia, associated with quality of life. Cognitive and socio-cognitive abilities might represent necessary though not sufficient building blocks for the acquisition of pragmatic abilities throughout development. Therefore, a more precise incorporation of pragmatics in the description of the pathology is of high clinical and translational relevance.

1. Introduction

Alterations of communication are largely documented in schizophrenia since the first descriptions of the illness [1,2]. In modern days, multidisciplinary approaches combining psychiatry, linguistics, and neuroscience of language have paved the way to a more principled characterization of linguistic disruption in schizophrenia [3]. In this perspective, the deficit seems to encompass both comprehension and production [4,5], especially in the domains of syntax [6] and high-level semantics [7].

In this view, it has been claimed that the most obviously disordered language level in schizophrenia is pragmatics [3,8], i.e. the ability of processing the relationship between language and context [9]. Beyond the grammatical aspects of language, patients with schizophrenia suffer from a failure in the use of language in social interaction, in producing contextually appropriate speech, and in inferring context-dependent meanings. Evidence supporting the claim of a diffuse pragmatic impairment

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is abundant yet sparse. Deficits in the comprehension of non-literal language, for instance, have been reported since at least 100 years, traditionally attributed to the inability of abstract thinking, clinically defined as "concretism", i.e. adherence to the physical aspects of stimuli and words [10]. Recently, the interest on this topic has grown remarkably, with a plethora of studies reporting breakdowns in patients with schizophrenia across a range of specific tasks involving the comprehension of pragmatic aspects of language [11–17]. For instance, in a story comprehension task, when required to judge the appropriateness of a statement, patients make more errors than controls when the speech is metaphorical or ironic [11]. Similarly, patients are impaired in the comprehension of idiomatic expressions, as tested both in sentence-to-picture matching task [13] and in online sentence continuation verification task [15]. Several studies also deal with discourse production in schizophrenia [18–21], reporting failures in maintaining thematic coherence and respecting the rules of conversation. For instance, Perlini et al. compared a sample of patients with schizophrenia with healthy controls and patients with bipolar disorder, evaluating several micro- and macro-linguistic aspects of discourse, including fine-grained analysis of pragmatic parameters such as informativeness and coherence [19]. Results showed diffuse deficits in the performance of patients with schizophrenia, compared to both the other groups. Linscott et al. showed that patients scored higher than controls in the Profile of Pragmatic Impairment in Communication (PPIC), being less compliant with Gricean conversational rules [18].

Globally, these findings strongly indicate a widespread pragmatic impairment in schizophrenia, yet this bulk of evidence is rarely described under the unifying umbrella of pragmatic competence. Only a few studies included a broad assessment of pragmatic abilities [22]. Among these, Colle et al. presented a preliminary assessment of verbal and non-verbal communicative abilities in patients with schizophrenia based on the Assessment Battery of Communication (ABaCo), with a special focus on the interplay between pragmatics and mind-reading in understanding speech acts of different complexity. Results evidenced a wide dysfunction, with 80% of patients' scores below the 20th percentile of the normative data [22]. Apart from a few investigations, most studies focus on specific aspects of pragmatic capacity in schizophrenia, preventing from a comprehensive evaluation of the communicative disruption in this clinical population.

This "fragmentation" of the literature also hampers a clearer understanding of the relationship between pragmatics and both the cognitive and socio-cognitive abilities that are typically impaired in schizophrenia, as well as between pragmatics, psychopathology, and intellectual level. Indeed, performance in specific pragmatic tasks has been related either to executive functions or theory of mind (ToM) [11,23–25]. For instance, cognitive abilities, especially executive functions and working memory, were found to predict the comprehension of idiomatic expressions [13] and proverbs [12]. Other authors, however, argued that the role of social cognition abilities is stronger than that of executive functions in comprehending proverbs [23] as well as indirect request [24]. Also, there is evidence that the role of ToM might vary across pragmatic tasks, being associated for instance with the understanding of irony, but unrelated to the understanding of metaphors [11]. Conflicting results are reported also for symptoms [15,17,18,26]. Some studies found a relation between pragmatic performance and symptoms [14,17], while others reported no association between though disorders and high-level language aspects such as idioms comprehension [13] or conversational abilities [18]. In sum, the relationship between the global domain of pragmatic abilities, cognition, and psychopathology appears still unclear.

Interestingly, several authors suggested that communicative and pragmatic impairment could impact on social interaction and daily living [27]. However, up to date, only a few studies explicitly explored the effect of communication abnormalities on functioning in schizophrenia [28–30]. According to these studies, disconnected speech and verbal underproductivity compromise the patients' social skills, including the ability to engage in social relationships [29], and the inability to comprehend sarcasm affects recreational functioning [30].

Further research shows that the pragmatic deficit is present in prodromal samples [31,32] and in first-degree relatives [33,34], and even that specific discourse coherence features in youths' speech might help predicting future development of psychosis [35], suggesting that communication [36] and more specifically pragmatic disruption may represent a biomarker of schizophrenia, fitting into the neurodevelopmental hypothesis [37], as rooted in early brain development.

In sum, so far pragmatics has been mainly confined to the research setting, and a complete and reliable assessment of pragmatic abilities is not included in the clinical practice. This undermines our comprehension of the frequency of the deficit, its possible role as a core feature of schizophrenia, its impact on daily living, and its cognitive substrates, as well as its possible consideration as a target of intervention.

In this study we sought to promote a clinical turn in the consideration of the pragmatic deficit in schizophrenia. Specifically, we aimed at: (i) providing a first estimation of the frequency of pragmatic impairment in schizophrenia; (ii) exploring the interplay of cognitive domains in determining the pragmatic deficit; and (iii) assessing the relation of pragmatics with quality of life. Our hypotheses were as follows: (i) we expected to observe a high frequency of pragmatic impairment, comparable to the frequency of core features of schizophrenia, such as the neurocognitive deficit [38]; (ii) the pragmatic deficit was expected to be intertwined with both cognition and social cognition; (iii) we predicted that pragmatic abilities would significantly contribute to quality of life, even when other variables are taken into account. To address these issues, we employed a comprehensive and reliable assessment tool for pragmatic abilities (the APACS test), recently validated and normed on the Italian population [39] and previously shown to be capable of detecting a pragmatic deficit in psychiatric illness [40]. Here the APACS test was administered to a wider sample of patients with schizophrenia and accompanied with a

large-scale assessment of psychopathological, cognitive, socio-cognitive, intellectual, and daily living measures.

2. Materials and methods

2.1. Participants

Forty-seven Italian native speakers outpatients, age 18–65 years, were recruited from the Department of Clinical Neurosciences, IRCCS San Raffaele Scientific Institute, Milan, Italy. They all met DSM IV-R criteria for schizophrenia [41] and were clinically stabilized and treated with a stable dose of the same antipsychotic therapy for at least 6 months. Exclusion criteria were: substance dependence or abuse, co-morbid diagnosis on Axis I or II, major neurological illness, and perinatal trauma.

Thirty-five Italian native speakers control subjects were selected for similarity in age and education from the general population and were screened for psychiatric diagnosis and family history on the basis of a clinical interview.

All subjects provided informed consent to a protocol approved by the local ethical committee, following the principles of the Declaration of Helsinki.

2.2. Assessments

Patients were assessed for pragmatics, psychopathology, intellectual level, cognition, ToM, and quality of life. In a subgroup of patients (n = 36), pragmatic assessment was repeated with a 2-week interval, to evaluate test–retest reliability.

2.2.1. Pragmatic assessment

Pragmatic abilities were assessed in patients and controls through the APACS (Assessment of Pragmatic Abilities and Cognitive Substrates) test [39], which targets two major domains of impairment in pragmatics, namely discourse and non-literal meanings. APACS is divided into two main sections, devoted to production and comprehension, for a total of six tasks, based on refined linguistic materials and paying attention to the ecological validity of the stimuli:

- Interview, measuring the ability of engaging in conversation through a semi-structured interview on autobiographical topics. Discourse production is rated for the presence of communication difficulties at the contextual-pragmatic level (e.g., over- or under-informativeness, abrupt topic shift). The frequency of each type of communication difficulty is annotated (always/sometimes/never) and then converted into scores (0/1/2). Maximal score: 44.
- Description, measuring the ability of producing and sharing informative descriptions of everyday life situations, based on the description of photographs depicting everyday life scenes (e.g., a woman waiting at the bus station). For each salient element in each picture, a score is assigned differentiating missed identification, partially correct identification, correct identification (0/1/2). Maximal score: 48.
- Narratives, measuring the ability to comprehend discourse and the main aspects of a narrative text. Stories inspired by real newspaper and TV news are read and followed by comprehension questions on discourse and pragmatic contents. Each question is scored for accuracy (either 0/1 or 0/1/2). Maximal score: 56.
- Figurative Language 1, measuring the ability to infer non-literal meanings through multiple-choice questions following the presentation of idioms, novel metaphors, and proverbs (e.g. “I have just seen a F1 race. Some cars are arrows”). Each item is scored either 1 or 0 according to the accuracy. Maximal score: 15.
- Humor, measuring the ability to comprehend verbal humor through multiple-choice questions requiring to select the best punch-line of a story. Each item is scored either 1 or 0 according to the accuracy. Maximal score: 7.
- Figurative Language 2, measuring the ability to infer non-literal meanings through verbal explanation of idioms, novel metaphors, and proverbs. Responses score 2 when the subject provides a good description of the meaning of the figurative expression; 1 when the subject provides an incomplete explanation, such as concrete examples, but fails in providing a general meaning; 0 when the subject provides a literal explanation, paraphrases the figurative expression or ignores it. Maximal score: 30.
- Composite scores. Three composite pragmatic scores are computed from the six APACS single task scores. The Pragmatic Production score is calculated from Interview and Description, whereas the Pragmatic Comprehension score is calculated from Narratives, Figurative Language 1, Figurative Language 2, and Humor. Each composite score is obtained by transforming the original task scores in proportion and averaging these proportions. Hence, each task equally contributes to the final composite score. Moreover, the APACS Total score is calculated by averaging Pragmatic Production and Pragmatic Comprehension scores.

Concerning the psychometric properties, in a previous validation study the APACS test showed satisfactory internal consistency (α range for the six tasks: 0.60–0.70) and good to excellent test–retest reliability (r range for the composite scores: 0.82–0.91) [39]. In addition, we tested inter-rater reliability on a sample of 17 subjects taken from the normative sample in [39] by two raters, using videos randomly selected from the pool. The instructions followed by the raters to score the APACS performance were the same used by all the experimenters who collected the data from the normative sample. Intra-class correlation coefficient values were in the range of fair to good agreement for three tasks (range: 0.57–0.62) and excellent for the other three tasks (range: 0.86–1).

APACS was administered by psychologists upon receiving extensive training. After reading the manual, training entailed

a session reviewing the administration guidelines and discussing potentially critical examples with the authors of the test. Raters were also blind to cognitive data.

2.2.2. Additional linguistic assessment

After APACS administration, to examine deficits in language comprehension, a shortened version of the Token Test was administered, scored as in the Token Test included in the Italian version of the Aachener Aphasie Test [42].

2.2.3. Patients assessments

Psychopathology was assessed with the Positive and Negative Syndrome Scale for Schizophrenia (PANSS) [43]. The PANSS is a standardized measurement for typological and dimensional symptoms evaluation. It includes 30 items that provide balanced representation of positive and negative symptoms and gauges their relationship to one another and to global psychopathology. It consists of three subscales (Positive, 7 items, score range 7–49; Negative, 7 items, score range 7–49; General, 16 items, score range 16–112), assessing positive symptoms, negative symptoms, and general psychopathology, respectively. A global measure of illness severity can be derived from the sum of the three subscales (Total PANSS, score range 30–210). Based on the validation in Refs. [43] and [44], reliability values for each subscale are good: Internal (α range: 0.73–0.83), Longitudinal 3–6 months (chronic medicated) (r range: 0.77–0.89) and Inter-rater (range: 0.83–0.87).

The PANSS scale was administered by psychiatrists trained to a standardized level of reliability and certified in the procedures related to administration.

Intellectual level was assessed with the Wechsler Adult Intelligence Scale — Revised (WAIS-R) [45], a standardized test designed to measure intelligence in adults and older adolescents, consisting of six verbal (Information; Digit Span; Vocabulary; Arithmetic; Comprehension; Similarities) and five performance (Picture Completion; Picture Arrangement; Block Design; Digit Symbol; Object Assembly) subtests. As a global measure of intellectual level, Total IQ score, is derived from verbal and performance subtests.

Cognition was evaluated with the Italian version of the Brief Assessment of Cognition in Schizophrenia (BACS) [46,47]. BACS is a broad neuropsychological battery including the following tasks: word recall (verbal memory), digit sequencing (working memory), token motor task (psychomotor speed and coordination), symbol coding (processing speed), semantic and phonemic fluency (verbal fluency), and Tower of London (executive functions — planning). From the BACS raw scores, equivalent scores were obtained in order to define the presence or absence of a deficit in each function [47]. z-Scores were also calculated for each BACS score and a Total score was derived from the sum of z-scores. The token motor task, evaluating psychomotor speed and coordination, was excluded from the analysis, to rule out possible differences related to the antipsychotic treatment, as it is more sensible to pharmacological effects.

ToM was assessed with the Picture Sequencing Task (PST) [48], consisting of six cartoon picture stories depicting: (1) two scenarios where two characters cooperate; (2) two scenarios where one character deceives a second character; and (3) two scenarios with two characters cooperating to deceive a third. In the Sequencing task, a measure of non-verbal ToM processing, four cards were presented face-down in mixed order. Participants were asked to turn the cards over and to order them in a logical sequence of events; two points were given for the first and last correctly sequenced cards and one point was given for correct sequencing of each of the two middle cards. In addition, a ToM Questionnaire with 23 questions was administered to the subjects to test their ability to appreciate the mental states of the characters involved in the cartoon stories, as a measure of cognitive ToM. The questions referred to the mental states of the characters according to different levels of complexity and included first- to third-order false belief questions and requests involving the understanding of cheating detection, as well as two reality questions, included to rule out major attentional problems. PST Total score is derived from Sequencing and Questionnaire scores, as a global measure of ToM abilities.

Quality of life was assessed with the Quality of Life Scale (QLS) [49], a semi-structured interview balancing subjective questions regarding life satisfaction and objective indicators of social and occupational role functioning. The QLS is made up of 21 items that evaluate: (1) Interpersonal relations (items 1–8), evaluating the ability of the patient to establish and maintain social relationships; (2) Instrumental role (items 9–12), assessing the ability to obtain and maintain a job, to study, and to collaborate in everyday housework; and (3) Self-directedness (items 13–21), evaluating planning abilities, personal autonomy, affective and cognitive functioning, and motivation level. Each item score ranges from 0 (severe impairment) to 6 (high functioning).

WAIS-R, BACS, PST and QLS were administered by trained psychologists. For the QLS, the answers given by patients were reviewed with caregivers and/or psychiatrists in charge of the patients.

2.3. Statistical analysis

Differences between groups (patients vs controls) with respect to demographic variables were analyzed with a Chi square test for gender and *t*-tests for age and education.

The scores on each APACS task (Interview, Description, Narratives, Figurative Language 1, Humor, Figurative Language 2) and the three composite pragmatic scores (Pragmatic Production, Pragmatic Comprehension, APACS Total) were compared between patients with schizophrenia and controls by means of separate independent sample *t*-tests. Cohen's d was employed as effect size measure. All p values were corrected with the Bonferroni method. The Token Test was analyzed separately and not corrected. The relation between the performance in APACS and in the Token Test was further analyzed in the patients' group with Spearman correlations.

To determine the prevalence of the pragmatic deficit, individual data of patients were compared to cutoff scores for each APACS task and the three composite scores, according to the normative data [39].

In a subgroup of patients, test–retest reliability was calculated by means of Pearson correlations. Practice effect was evaluated by means of a series of paired *t*-tests comparing the scores at the two measurements.

Then, in the patients' group, the association between pragmatic abilities and both cognition and ToM was addressed in two different ways. First, the co-occurrence of a deficit in pragmatic abilities and a deficit in cognition or ToM, respectively, was analyzed by means of Fisher's exact tests on contingency tables. Cognitive deficit was defined based on the presence of an equivalent score ≤1 in at least two BACS subtests. The cutoff for ToM deficit was calculated as the value delimiting the 5% of the worst scores of PST Total score from a control sample available from [50]. This value was determined as −1.96 standard deviations from the control mean.

Second, the influence of cognition and ToM on pragmatic performance was assessed with multiple regression modeling, also taking into account psychopathology. Two separate models were fit to analyze effects on Pragmatic Comprehension and Pragmatic Production, respectively. BACS Total score, PST Total score, Total IQ, PANSS Total score, age, years of education, and duration of illness were entered as regressors, while Pragmatic Comprehension and Pragmatic Production were separately included as dependent variable.

Finally, to analyze the interplay of pragmatics, cognition, ToM, and psychopathology on quality of life, a regression analysis with APACS Total score, BACS Total score, PST Total score, and PANSS Total score as regressors and QLS Total score as dependent variable was performed.

In all regression models, predictors were standardized before entering in the analysis, and collinearity across predictors was checked. All the condition numbers k were below <10, thus below the threshold of 30 that indicates a harmful collinearity [51].

For exploratory purposes, pairwise Pearson's correlations were run between APACS task and composite scores and the different domains of cognition, social cognition, psychopathology, intellectual level, and quality of life.

Analyses were performed with R, 3.1.0 [52].

3. Results

3.1. Demographic and clinical features

Demographic characteristics of all subjects and psychopathological, intellectual level, cognitive, socio-cognitive and quality of life measures for patients are reported in Table 1. The antipsychotic treatment was distributed as follows: 17 patients were treated with clozapine (mean daily dose 327.21 ± 130.98 mg), 10 with risperidone (mean daily dose 4.63 ± 2.94 mg), 6 with paliperidone (mean daily dose 7.50 ± 1.64 mg), 6 with haloperidol (mean daily dose 6.13 ± 4.91 mg), 4 with aripiprazole (mean daily dose 20 ± 11.55 mg), 3 with olanzapine (mean daily dose 20 ± 10 mg), and 1 with zuclopentixol (mean daily dose 10 mg). No significant differences were observed between patients and controls for age nor for gender.

3.2. Performance in the pragmatic tasks

Patients with schizophrenia performed significantly worse in all pragmatic tasks compared to healthy controls (all p values ≤0.01, Bonferroni corrected). Large effect sizes (>1.5) were observed for both Pragmatic Production and Pragmatic Comprehension, as well as for APACS Total. Among the single pragmatic tasks, the largest effect size was detected for Narratives, namely the task assessing the

Table 1
Demographic characteristics of patients with schizophrenia and healthy controls, and clinical, intellectual, cognitive, socio-cognitive, and quality of life measures of patients.

	Patients (N = 47)[1] Mean (S.D.)	Controls (N = 35) Mean (S.D.)	t	p
Age	39.74 (10.54)	41.69 (11.61)	t(80) = 0.79	p = 0.43
Years of education	11.77 (2.66)	12.26 (2.72)	t(80) = 0.82	p = 0.41
Sex (M/F)	29/18	14/21	χ^2 (1) = 2.97	p = 0.08
Onset	24.49 (6.52)	–	–	–
Duration of illness	15.45 (10.05)	–	–	–
Antipsychotic treatment (atypical/typical)	40/7	–	–	–
Mean daily dose (chlorpromazine eq.)	438.62 (210.74)	–	–	–
Diagnostic subtype (paranoid/undifferentiated/disorganized)	28/17/2	–	–	–
PANSS Total	77.42 (11.51)	–	–	–
Total IQ	84.19 (11.98)	–	–	–
BACS Total z-score	−4.42 (4.12)	–	–	–
PST Total	42.56 (12.32)	–	–	–
QLS Total	46.59 (12.13)	–	–	–

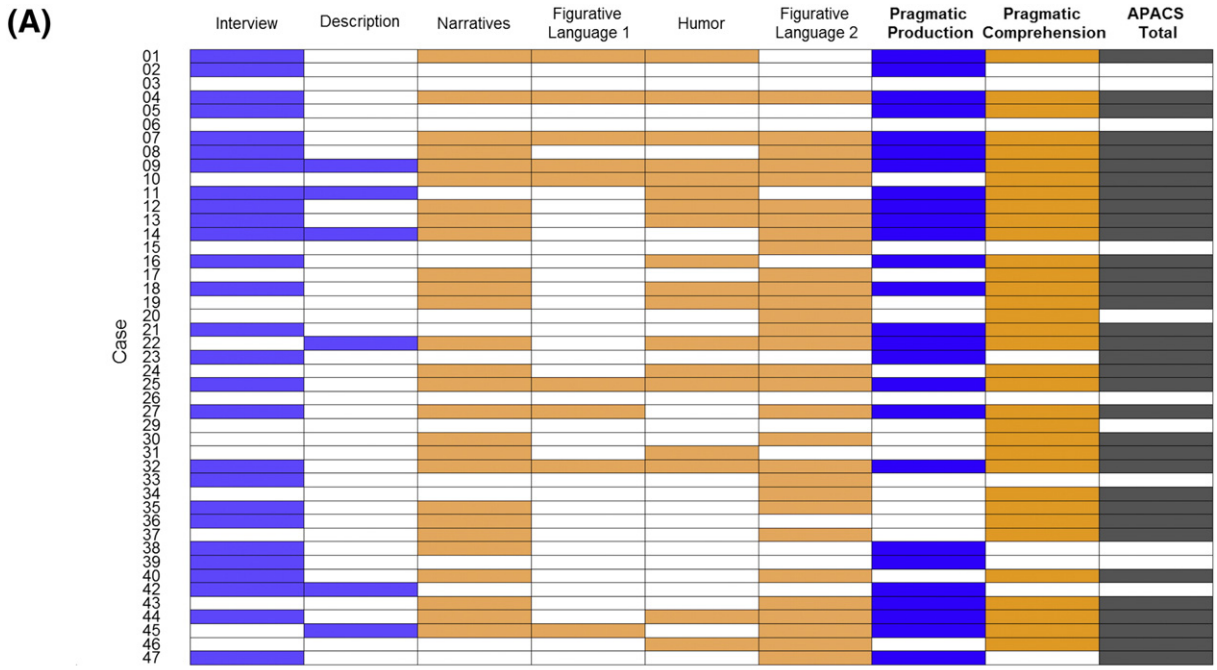
[1] All patients completed the psychopathology assessment; a few drop-outs were reported for the other domains, specifically 1 for quality of life, 2 for cognition and 4 for both ToM and intellectual level.

Table 2
Performance in APACS task and composite scores in patients with schizophrenia and healthy controls.

	Patients (N = 47) Mean (SD)	Controls (N = 35) Mean (SD)	t (df = 80)	p	d (effect size)
Interview (max score 44)	39.72 (3.21)	43.6 (1.17)	6.8	p < 0.001*	1.5
Description (max score 48)	46.91 (1.83)	47.94 (0.34)	3.3	p = 0.014*	0.73
Narratives (max score 56)	44.13 (6.75)	53.57 (1.94)	8	p < 0.001*	1.8
Figurative Language 1 (max score 15)	13.28 (2.47)	14.74 (0.56)	3.4	p = 0.009*	0.77
Humor (max score 7)	4.55 (1.68)	6.51 (0.7)	6.5	p < 0.001*	1.4
Figurative Language 2 (max score 30)	20.91 (4.43)	27.6 (3.35)	7.5	p < 0.001*	1.7
Pragmatic Production (range 0–1)	0.94 (0.04)	0.99 (0.01)	7.3	p < 0.001*	1.6
Pragmatic Comprehension (range 0–1)	0.76 (0.14)	0.95 (0.05)	7.8	p < 0.001*	1.7
APACS Total (range 0–1)	0.85 (0.08)	0.97 (0.03)	8.6	p < 0.001*	1.9

comprehension of different aspects of stories. The second largest effect size is reported for Figurative Language 2, assessing the ability to infer non-literal meanings through verbal explanation. Detailed results are reported in Table 2.

A significant difference was observed also between patients and controls in the Token Test, although both groups performed almost at ceiling (max score 32; mean score 30.98, SD 2.14 and 31.89, SD 0.4, respectively; t(80) = 2.5;



(B)

	Interview	Description	Narratives	Figurative Language 1	Humor	Figurative Language 2	Pragmatic Production	Pragmatic Comprehension	APACS Total
Deficit	0.62	0.13	0.62	0.19	0.43	0.64	0.77	0.6	0.77
No Deficit	0.38	0.87	0.38	0.81	0.57	0.36	0.23	0.4	0.23

Fig. 1. Patient's individual performance and frequency of the deficit in APACS tasks and composite scores. The figure in panel (A) shows the patients who scored below cutoff (based on normative data) in the six pragmatic tasks and in the three composite scores included in APACS. Each row denotes a patient, whose case number is reported in the left part of the figure. Each column denotes a task or a composite score in APACS. White cells indicate a performance equal to or above cutoff, whereas colored cells indicate a performance below cutoff. Light blue cells are used in the columns with the pragmatic tasks assessing production and dark blue cells in the column of the Pragmatic Production score. Light orange cells are used in the columns of the pragmatic tasks assessing comprehension and dark orange cells in the column of the Pragmatic Comprehension score. Dark gray is used for APACS Total. The table in panel (B) shows the frequency of the deficit, as the proportion of patients of the total sample showing an impaired performance (based on normative data) in each pragmatic task and in the three composite scores in APACS.

p = 0.016). Spearman correlations revealed that the performance in the Token Test does not correlate with the performance in any APACS single task nor composite score, except for Description (rho = 0.284, p = 0.053, n = 47).

According to APACS normative data, 96% of patients fell below cutoff in at least one pragmatic task, 77% of patients showed a deficit in APACS Total and in Pragmatic Comprehension while 60% showed a deficit in Pragmatic Production. Individual data for each pragmatic task and composite scores, as well as the frequency of the deficit (as the proportion of patients of the total sample showing an impaired performance) are shown in Fig. 1.

3.3. Test–retest reliability and practice effect

The test–retest reliability of APACS, assessed with Pearson correlations, was 0.76 for Pragmatic Production, 0.82 for Pragmatic Comprehension and 0.82 for APACS Total, all indicative of a good reliability, in line with the results in the validation study on the normative sample [39].

The paired *t*-tests did not show any significant difference between test and retest composite scores, thus excluding a practice effect.

3.4. Relationships between pragmatics, cognition, and ToM

Individual data of patients falling below cutoff in each BACS subtest and Pragmatic Production and Pragmatic Comprehension are reported in Fig. 2, Panel A. The patterns of co-occurrence of cognitive and pragmatic deficit are reported in the two 4 × 4 tables in Panels B and C. The Fisher's exact test on count data was significant (p = 0.04) only for the Pragmatic Comprehension score, indicating a statistically reliable association between the cognitive deficit and the deficit in the comprehension of pragmatic aspects (42% of cases with co-occurrence), while the cognitive deficit does not seem to be associated with the pragmatic performance in production (33%). Interestingly, only 4% of patients with cognitive impairment showed a preserved performance in Pragmatic Comprehension, while 33% had a performance below cutoff in Pragmatic Comprehension even in the presence of intact cognition.

Similarly, data of patients falling below cutoff in ToM test and in Pragmatic Production and Pragmatic Comprehension are reported in Fig. 3, Panel A. Panels B and C show the patterns of co-occurrence of ToM and pragmatic deficits. The Fisher's exact test was statistically significant (p = 0.03) only for the Pragmatic Comprehension score, indicating a

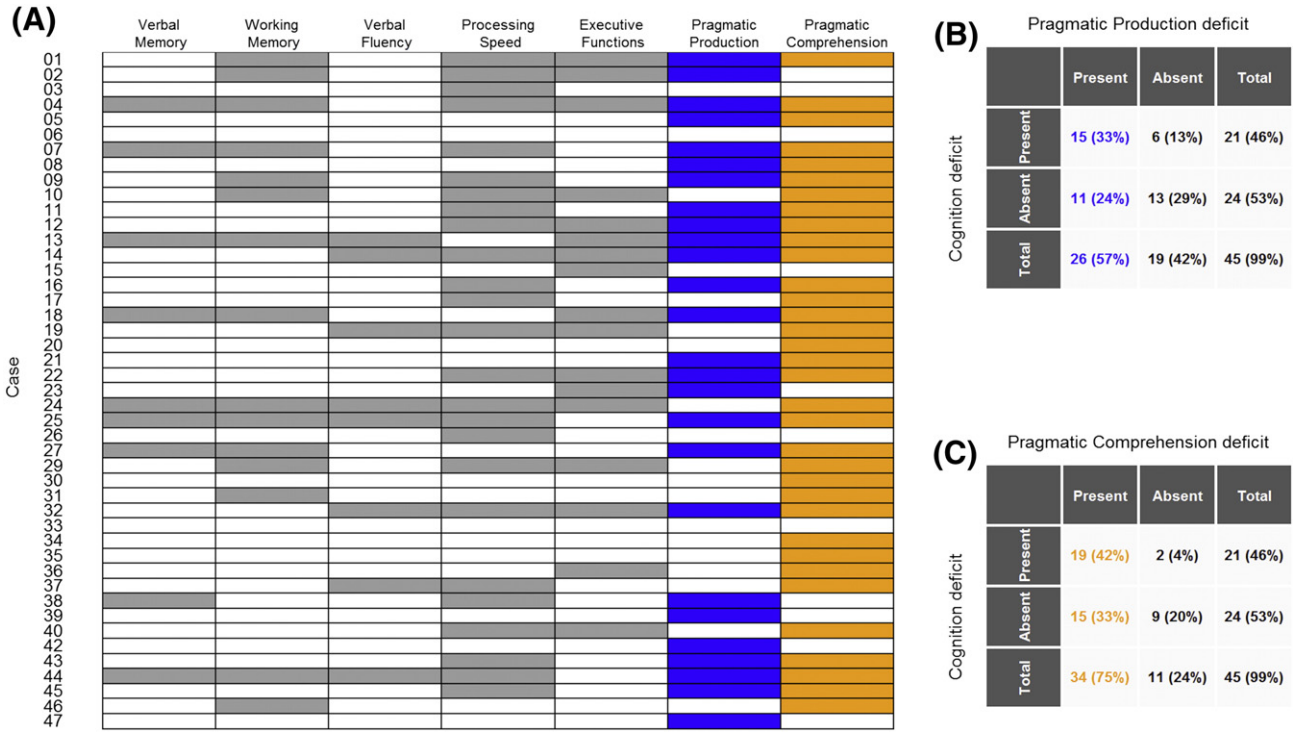


Fig. 2. Performance of patients in cognitive tests and co-occurrence of cognitive and pragmatic deficit. The figure in panel (A) shows the patients who scored below cutoff on BACS tasks (i.e. an equivalent score ≤1 based on normative data) and on Pragmatic Production and Pragmatic Comprehension composite scores in APACS (based on normative data). Each row denotes a patient, whose case number is reported in the left part of the figure. Each column denotes a BACS task or an APACS composite score. White cells indicate a performance equal to or above cutoff, whereas gray cells indicate a performance below cutoff. The table in panel (B) reports the total raw data (percentages enclosed in parentheses) of the co-occurrence of cognitive deficit (defined as the presence of an equivalent score ≤1 in at least two BACS tasks) and Pragmatic Production deficit. The table in panel (C) reports the total raw data (percentages enclosed in parentheses) of the co-occurrence of cognitive deficit and Pragmatic Comprehension deficit.

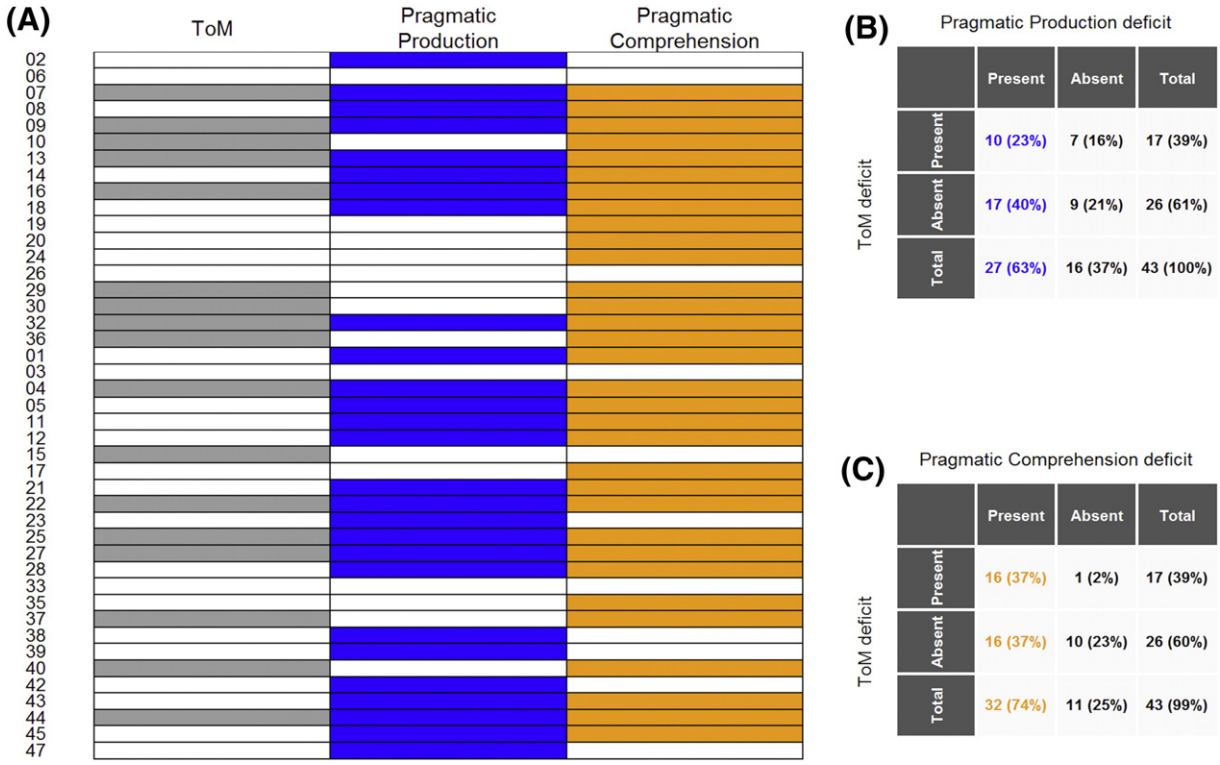


Fig. 3. Performance of patients in ToM tests and co-occurrence of ToM and pragmatic deficit. The figure in panel (A) shows the patients who scored below cutoff on the ToM test (calculated by delimiting the 5% of the worst scores of PST Total score from the control sample in Anselmetti et al. [50]) and on Pragmatic Production and Pragmatic Comprehension composite scores in APACS (based on normative data). Each row denotes a patient, whose case number is reported in the left part of the figure. Columns denote ToM test and APACS composite scores. White cells indicate a performance equal to or above cutoff, whereas gray cells indicate a performance below cutoff. The table in panel (B) reports the total raw data (percentages enclosed in parentheses) of the co-occurrence of ToM deficit and Pragmatic Production deficit. The table in panel (C) reports the total raw data (percentages enclosed in parentheses) of the co-occurrence of ToM deficit and Pragmatic Comprehension deficit.

statistically reliable association between the deficits in ToM and in Pragmatic Comprehension (37%), but not in Pragmatic Production (23%). Interestingly, only 2% of patients with ToM impairment showed a preserved performance in Pragmatic Comprehension, while 37% had a performance below cutoff in Pragmatic Comprehension even in the presence of intact ToM.

The relationship between pragmatics, cognition, and ToM was further explored by means of regression models, also taking into account the effects of psychopathology, IQ, age, years of education, and duration of illness.

The multiple regression investigating possible predictors of Pragmatic Production showed a significant effect only for cognition [Intercept = 0.94 (SE = 0.006), t = 160, $p < 0.001$*; BACS Total score = 0.013 (SE = 0.006), t = 2.2, p = 0.031*]. This model accounted for 9% of variance and indicated that, as the BACS Total score increases, the predicted Pragmatic Production score increases.

The multiple regression with Pragmatic Comprehension score as dependent variable revealed a significant predictive effect for intellectual level, ToM, and cognition [Intercept = 0.75 (SE = 0.014), t = 54, $p < 0.001$*; Total IQ = 0.051 (SE = 0.018), t = 2.8, p = 0.009*; PST Total score = 0.047 (SE = 0.016), t = 2.9, p = 0.006*; BACS Total score = 0.046 (SE = 0.019), t = 2.5, p = 0.018*]. This model explained 65% of variance in the dependent variable. Results showed a direct relation between Pragmatic Comprehension and all predictors, i.e. as IQ, ToM, and cognition measures increase, so does the predicted pragmatic score. See Fig. A.1 in the Appendix.

Psychopathological, clinical and demographic predictors were not significant.

3.5. Relationship between pragmatics and quality of life

The multiple regression investigating predictive effects of psychopathology, cognition, ToM, and pragmatics on quality of life showed a significant effect for both PANSS and APACS Total score [Intercept = 47 (SE = 1.7), t = 27, $p < 0.001$*; PANSS Total score = −4.5 (SE = 1.8), t = −2.5, p = 0.015*; APACS Total score = 3.4 (SE = 1.7), t = 2, p = 0.049*]. This model accounted for 20% of variance and indicated a positive relationship between quality of life and pragmatics (i.e. as the APACS Total score increases, the predicted QLS score increases), while as expected, an inverse relation was observed with psychopathology (i.e. as the PANSS Total

scores increases, the predicted QLS score decreases). See Fig. A.2 in the Appendix.

See Table A.3 in the Appendix for Pearson's correlations between APACS scores and the other domains of assessment.

4. Discussion

This study aimed at shedding new light on the pragmatic deficit in schizophrenia as a possible target of clinical assessment and intervention. We investigated pragmatic abilities in patients with schizophrenia as compared to controls by means of the APACS test, a comprehensive and reliable test suitable to detect pragmatic breakdowns in mental illness. The relation between pragmatics and psychopathological, cognitive, socio-cognitive, and quality of life aspects was also explored in the patients' group.

With respect to the frequency of the pragmatic deficit, results showed that pragmatic abilities are widely compromised in schizophrenia, as patients performed significantly worse than controls in all tasks. Although the individual pragmatic profiles are relatively heterogeneous, 96% of patients fell below cutoff in at least one pragmatic task, and 77% of patients were impaired in the global pragmatic measure. Deficits were observed in both modalities, with the main differences between patients and controls standing out in Pragmatic Comprehension, which resulted compromised in 77% of patients, while 60% of patients were impaired in Pragmatic Production. The largest effect sizes are reported for the Narratives task, measuring the understanding of different aspects of stories, and for Figurative Language 2, requiring the ability to infer non-literal meanings. Overall, our data match with previous studies on specific pragmatic phenomena, reporting impairment in discourse production [18,19] and in the comprehension of non-literal language [12,14,17,53]. To this literature, we add a more global characterization of the patients' pragmatic behavior, as well as an estimation of the frequency of the deficit, giving empirical support to the wide claim that pragmatics is the most visibly compromised linguistic domain in schizophrenia [3]. When compared to the results obtained by administering APACS to other pathological conditions, for instance amyotrophic lateral sclerosis (ALS) [54], the frequency of the pragmatic deficit in schizophrenia appears remarkably higher (77% versus 36%). Also the pattern of impairment across the APACS tasks differs, with the ALS group showing the largest effect sizes in discourse tasks, in both production (Interview) and comprehension (Narratives), while the schizophrenia group shows major breakdowns not only in discourse but also in the comprehension of non-literal language. Taken together, these findings seem to point to the specificity of the pragmatic deficit for schizophrenia, in terms of both prevalence and pattern of impairment across tasks.

Regarding the relationship between pragmatics and other psychopathological and cognitive domains, our data evidenced the interplay of cognitive and socio-cognitive abilities in providing a platform for pragmatic behavior, yet highlighted that pragmatics does not overlap with the other domains. The analysis showed a significant pattern of co-occurrence of deficits in both cognition and ToM with Pragmatic Comprehension, but not with Pragmatic Production. Moreover, while only 4% of patients with impaired cognition and 2% of patients with ToM deficit had preserved Pragmatic Comprehension, over 30% of patients showed a Pragmatic Comprehension deficit with no cognitive or ToM impairment. This suggests that pragmatic impairment is not merely a consequence of the cognitive deficit, but rather it is a specific domain, often but not necessarily associated with cognitive and socio-cognitive deficits. The regression analysis confirmed that both cognition and ToM affect the behavior in Pragmatic Comprehension, and evidenced also the role of the intellectual level. In contrast, for Pragmatic Production, only cognition was a significant predictor.

The cognitive substrates of pragmatics are the topic of a large literature emphasizing the relationship between pragmatics and either ToM [23] or executive functions [25]. Some authors stressed that the role of these components might vary across pragmatic phenomena, from metaphor to irony [11]. In a previous exploratory study [55], we showed that the involvement of cognitive and socio-cognitive components is indeed task-dependent, with differences among the tasks in APACS. Consistently, the data of the present study point to a difference between the production and the comprehension of pragmatic aspects, indicating that the former is more strictly related to cognition, with no significant influence of ToM, while the latter is intertwined with both cognition and ToM. These data are confirmed by the correlations (see Table A.3 in the Appendix), which evidence that the Interview is related only to cognition, while all comprehension tasks correlate with both cognition and social cognition measures. We can thus argue that the effect of cognition, probably driven by executive functions, is the main factor to promote pragmatically appropriate speech, especially the production of fluid utterances [56], while socio-cognitive abilities clearly arise in tasks requiring to infer non-literal meaning, along with cognitive abilities. The result of the IQ as a predictor of Pragmatic Comprehension stresses the importance of general cognitive functioning in inferential aspects of communication [15,57].

Granted some differences across pragmatic aspects, when we assume a global perspective on the pragmatics of communication, both ToM and cognitive profile are important, although with a partial independency of pragmatic skills from the cognitive and socio-cognitive profile. Indeed, the quest for a single cognitive substrate is possibly a naïve attempt, given the complexity of pragmatic behavior [58]. Interestingly, a similar debate on the cognitive substrates of pragmatics was done also for other pathological conditions [59], as well as in theoretical modeling [60]. In this view, it is interesting to compare, again, the results obtained here with evidence from the ALS population [54].

In ALS, the pragmatic deficit overlaps with cognitive and socio-cognitive deficit less frequently than in schizophrenia. Also, studies comparing patients with schizophrenia and patients with right hemisphere brain damage pointed out that a similar pattern of impairment at the behavioral level might be associated with different involvement of cognitive mechanisms, possibly lack of flexibility in patients with schizophrenia and lack of inhibition in neurological patients [58]. In this view, the pragmatic deficit in schizophrenia might be characterized by specific patterns of cognitive substrates as compared to other pathological conditions. Given the difference between schizophrenia, as rooted in neurodevelopment, and acquired pathologies, cognition and ToM may represent necessary though not sufficient building blocks for acquisition of good pragmatic abilities through development.

As a further aspect, the absence of relation with global psychopathology, measured as PANSS Total score, is notable. This is in line with some existing evidence [18] and supports our previous findings that pragmatics in schizophrenia is not directly related to positive or negative symptoms, but rather intertwined with specific clinical manifestations across symptoms dimensions, such as those captured by item P2 "Conceptual disorganization" and by item N5 "Difficulty in abstract thinking" in the PANSS scale [40]. However, the selection of a sample of clinically stabilized patients with a good response to treatment may have limited the evaluation of symptoms' influence.

As for the relationship between pragmatics and quality of life, the regression model showed that performance in pragmatics (measured as APACS Total score) predicts quality of life, together with symptoms, while no effect of cognition nor of ToM was evidenced. Although the role of pragmatics in social communication and thus social well-being is well ascertained [8], the possible effect on daily functioning is less explored. Data from neurological samples suggest that the competence in conversational discourse correlates with social integration and quality of life [61]. In schizophrenia, so far very few studies analyzed the impact of specific communication disturbances on real-world functioning [28–30,62]. Although sparse, the available evidence is in line with our findings. Given the correlational nature of the data of the present study, it is not possible to disentangle the specific direction of the effect involving pragmatics and quality of life, neither the possible contribution of other variables, which needs to be further investigated. However, the observation of a relationship between pragmatics and quality of life is of extreme interest for its potential clinical relevance: if pragmatic impairment determines a worse quality of life, targeted rehabilitation interventions could be developed to improve pragmatic abilities and, in turn, the patients' well being. To this respect, the Quality of Life Scale might offer a good perspective on global daily functioning, as it strongly correlates with objective functioning tools such as the Schizophrenia Objective Functioning Instrument (SOFI) [63]. As for the effect of symptoms in the regression model, this is not surprising, as recent data on a large sample confirm both direct and indirect influence of symptoms domain on functioning [64]. Yet, we did not observe any relation between quality of life, cognition, and ToM in our analysis. In line with our results on the co-occurrence of pragmatic deficit and both cognitive and ToM deficits, suggesting that the latter represent a platform on which pragmatic abilities are build, we can hypothesize that, when pragmatics is entered into the model, its effect may overweight those of cognitive functions and ToM.

The main aim of this work was to promote a clinical turn in the consideration of the pragmatic deficit. The frequency of impairment observed in our sample (77%), together with the results on the relationship between pragmatics and the other domains, shows that the pragmatic deficit might be considered a core feature of schizophrenia, i.e. a fundamental aspect of the illness, not simply resulting from symptoms or treatments. In line with the definition of core features [38], this study indicates that the pragmatic deficit is diffuse and independent from symptoms. Based on the selected sample of clinically stabilized chronic patients with good response to treatment, the impairment in pragmatics also appears to be stable through the illness course. Also, given that treatment dose was stable since at least 6 months and no significantly different effects on cognition are expected between antipsychotics classes [65], a pharmacological effect on pragmatic competence seems unlikely. Furthermore, compared to other pathological conditions with different etiopathogenesis, such as amyotrophic lateral sclerosis, schizophrenia shows a specific profile of pragmatic deficit. Finally, previous evidence suggests that a disruption in pragmatic competence may precede the illness onset [31,32] and may be directly linked to structural and functional brain anomalies reported in schizophrenia in the network devoted to pragmatic processing [66–69]. In sum, we argue that the pragmatic deficit could be considered strongly tied to the disorder's underlying biology and, as such, a core feature of schizophrenia. We believe that the current study provides a pivotal frequency estimation of the pragmatic deficit, in line with previous evidence documenting pragmatic breakdowns in a large range of communicative phenomena. Yet it is up to future investigations to confirm the role of pragmatic impairment in schizophrenia, overcoming the limitations of the present study.

First, it would be important to further explore the specificity of the pragmatic deficit in schizophrenia, by including a clinical control group, not present in this study. As we mentioned, the comparison with data obtained from the administration of the APACS test to neurological populations suggests that the pragmatic deficit is more diffuse in schizophrenia, possibly with specific areas of impairment (more prominent in figurative language comprehension) and a different co-occurrence pattern with cognitive and socio-cognitive deficits. Moreover, previous investigations on linguistic and pragmatic abilities comparing patients with schizophrenia and patients with bipolar disorder reported impairments in both groups, yet

more severe and generalized in schizophrenia than in bipolar disorder. A second aspect of major relevance revolves around the relation between pragmatic abilities and functioning. In this study, only a subjective measure of functioning was included, while future studies could consider more performance-based evaluations, such as the Brief UCSD Performance-based Skills Assessment (UPSA-B) [70] in relation to pragmatics. This would offer a broader picture of how the communicative deficit impacts on activities of daily living in the real world.

5. Conclusions

In this study we reported a diffuse pragmatic deficit in schizophrenia, connected with cognitive and socio-cognitive abilities, and associated with quality of life. Globally, this evidence could encourage to move beyond the sparse reports of impairment in specific communicative tasks and to promote a clinical perspective on the pragmatic deficit as a core feature of schizophrenia. When seen as a core feature, pragmatics would deserve a more serious consideration in the description of the pathology. A comprehensive and ecologically valid assessment of pragmatic abilities could have clinical and translational relevance, both as target to develop new rehabilitation programs and as measure of treatment outcome. In this view, APACS proved to be a feasible, valid, and reliable test with no practice effect, suitable to detect impairment in schizophrenia, and it could represent, being currently under translation in other languages, a viable tool for cross-national studies. In the broader perspective, the incorporation of pragmatic abilities in the assessment could contribute in shaping future research at the diagnostic level, to increase the accuracy of existing diagnostic tools, including automatic speech analysis [35,71,72], and at the rehabilitation level, following up on pioneering approaches to communication treatment [27,73], with the final aim of promoting the patient's social effectiveness and well-being.

Authors contribution

Study design: Bambini, Arcara, Cavallaro, Bosia. Data collection: Bechi, Buonocore, Bosia. Data analysis: Arcara. Data interpretation and manuscript writing: Bambini, Arcara, Bosia. Clinical supervision: Cavallaro, Bosia. All authors provided feedback on the draft and approved the final version of the manuscript.

Declaration of interest

None.

Appendix A

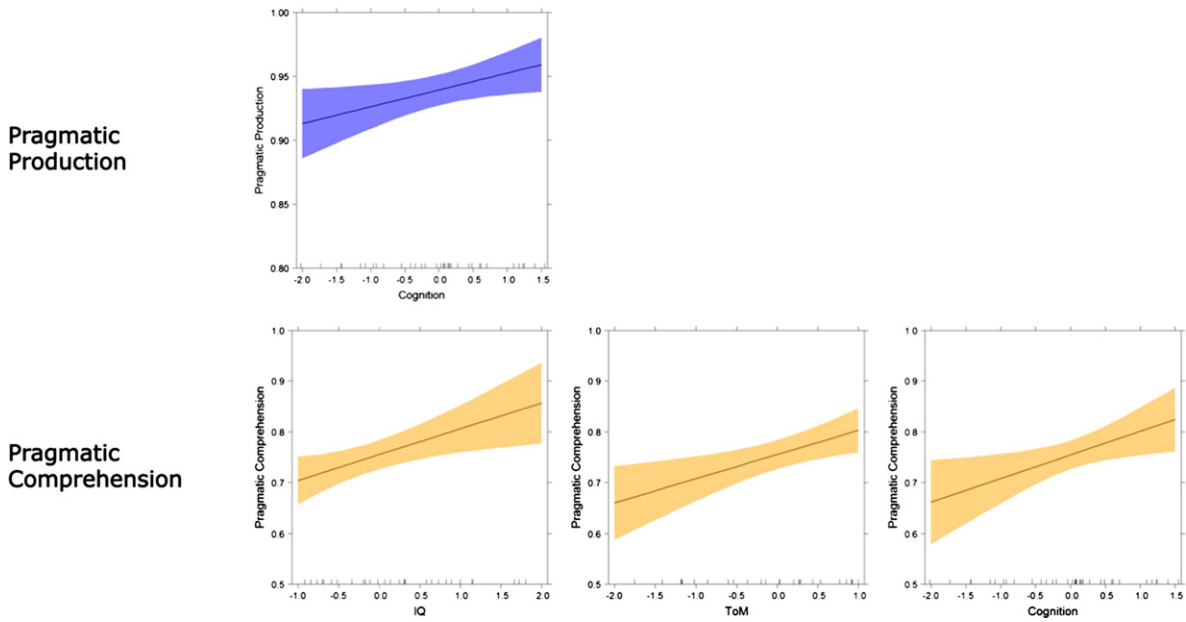


Fig. A.1. Effects of cognitive, socio-cognitive, and intellectual level predictors on APACS composite scores. The figure shows the partial effects of cognitive, socio-cognitive and intellectual level measures on APACS composite scores, as estimated by regression analysis. The figure displays the effects of the predictors that resulted significant in the analysis, namely cognition (as assessed with BACS Total score) for Pragmatic Production and IQ (as assessed with Total IQ), ToM (as assessed with PST Total score), and cognition (as assessed with BACS Total score) for Pragmatic Comprehension. The black line in each plot represents the predicted APACS composite score. The colored band around the line represents point-wise confidence bands around the prediction. Blue is used for Pragmatic Production, orange is used for Pragmatic Comprehension.

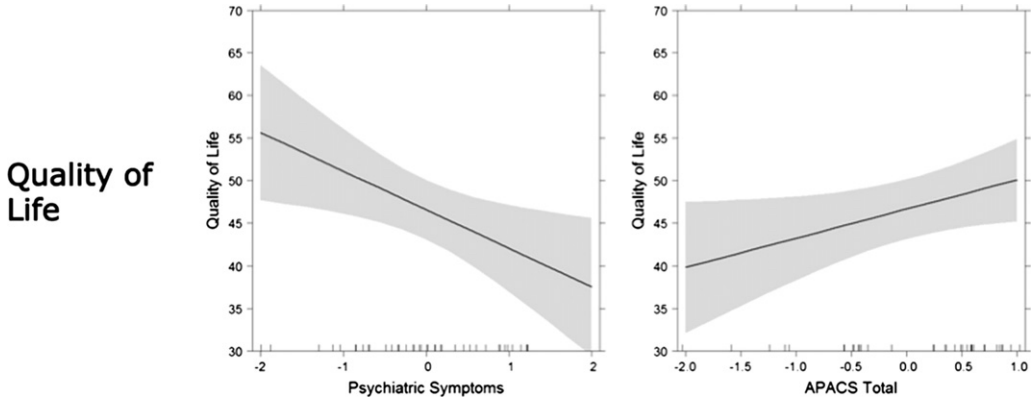


Fig. A.2. Effects of psychopathological and pragmatic predictors on Quality of Life. The figure shows the partial effects of psychopathological and pragmatic measures on quality of life (measured as QLS Total score), as estimated by regression analysis. The figure displays the effects of the predictors that resulted significant in the analysis, namely psychopathology (as assessed with PANSS Total score) and pragmatics (as assessed with APACS Total score). The black line in each plot represents the predicted QLS Total score. The gray band around the line represents point-wise confidence bands around the prediction.

Table A.3
Correlations between pragmatic performance and other domains.
The table reports pairwise Pearson's correlations between APACS task and composite scores and the other domains in the assessment, including social cognition (PST Total score), cognition (BACS Total score), psychopathology (PANSS Total score), quality of life (QLS Total score), intellectual level (Total IQ), age, years of education and duration of illness.

	Interview	Description	Narratives	Figurative Language 1	Humor	Figurative Language 2	Pragmatic Production	Pragmatic Comprehension	APACS Total	PST Total	BACS Total	PANSS Total	QLS Total	Total IQ	Age	Years of education	Duration of illness
Interview	1	0.08	0.37*	0.22	0.25	0.05	0.9*	0.26	0.47*	0.09	0.28	−0.39*	0.34*	0.07	−0.15	−0.24	−0.17
Description	0.08	1	0.28	0.2	0.31*	0.35*	0.52*	0.35*	0.44*	0.24	0.19	0.12	0.06	0.3	−0.05	0.16	−0.14
Narratives	0.37*	0.28	1	0.63*	0.54*	0.64*	0.45*	0.8*	0.82*	0.5*	0.6*	−0.1	0.31*	0.64*	0.01	0.08	0.03
Figurative Language 1	0.22	0.2	0.63*	1	0.55*	0.65*	0.28	0.84*	0.8*	0.54*	0.47*	−0.19	0.35*	0.49*	−0.11	0.2	−0.07
Humor	0.25	0.31*	0.54*	0.55*	1	0.5*	0.35*	0.84*	0.83*	0.48*	0.68*	0.01	0.15	0.55*	−0.3*	0.19	−0.25
Figurative Language 2	0.05	0.35*	0.64*	0.65*	0.5*	1	0.19	0.81*	0.75*	0.47*	0.43*	−0.02	0.23	0.68*	0.05	0.19	0.01
Pragmatic Production	0.9*	0.52*	0.45*	0.28	0.35*	0.19	1	0.38*	0.6*	0.2	0.32*	−0.28	0.32*	0.2	−0.15	−0.14	−0.2
Pragmatic Comprehension	0.26	0.35*	0.8*	0.84*	0.84*	0.81*	0.38*	1	0.97*	0.59*	0.67*	−0.08	0.3*	0.69*	−0.15	0.21	−0.12
APACS Total	0.47*	0.44*	0.82*	0.8*	0.83*	0.75*	0.6*	0.97*	1	0.56*	0.66*	−0.14	0.34*	0.66*	−0.17	0.14	−0.16
PST Total	0.09	0.24	0.5*	0.54*	0.48*	0.47*	0.2	0.59*	0.56*	1	0.48*	−0.13	0.11	0.45*	−0.25	0.05	−0.2
BACS Total	0.28	0.19	0.6*	0.47*	0.68*	0.43*	0.32*	0.67*	0.66*	0.48*	1	−0.05	0.13	0.63*	−0.24	0.15	−0.13
PANSS Total	−0.39*	0.12	−0.1	−0.19	0.01	−0.02	−0.28	−0.08	−0.14	−0.13	−0.05	1	−0.4*	0.06	−0.08	0.12	0.12
QLS Total	0.34*	0.06	0.31*	0.35*	0.15	0.23	0.32*	0.3*	0.34*	0.11	0.13	−0.4*	1	0.16	0.16	−0.24	−0.03
Total IQ	0.07	0.3	0.64*	0.49*	0.55*	0.68*	0.2	0.69*	0.66*	0.45*	0.63*	0.06	0.16	1	0.09	0.14	0.16
Age	−0.15	−0.05	0.01	−0.11	−0.3*	0.05	−0.15	−0.15	−0.17	−0.25	−0.24	−0.08	0.16	0.09	1	−0.08	0.78*
Years of education	−0.24	0.16	0.08	0.2	0.19	0.19	−0.14	0.21	0.14	0.05	0.15	0.12	−0.24	0.14	−0.08	1	−0.04
Duration of illness	−0.17	−0.14	0.03	−0.07	−0.25	0.01	−0.2	−0.12	−0.16	−0.2	−0.13	0.12	−0.03	0.16	0.78*	−0.04	1

References

[1] Bleuler E. Dementia praecox: on the group of schizophrenias (J.Zimkin, trans.). New York: International Universities Press; 1950.

[2] Andreasen NC. Thought, language, and communication disorders. Arch Gen Psychiatry 1979;36:1315, http://dx.doi.org/10.1001/archpsyc.1979.01780120045006.

[3] Covington MA, He C, Brown C, Naçi L, McClain JT, Fjordbak BS, et al. Schizophrenia and the structure of language: the linguist's view. Schizophr Res 2005;77:85-98, http://dx.doi.org/10.1016/j.schres.2005.01.016.

[4] DeLisi LE. Speech disorder in schizophrenia: review of the literature and exploration of its relation to the uniquely human capacity for language. Schizophr Bull 2001;27:481-96.

[5] Kuperberg GR. Language in schizophrenia part 1: an introduction. Lang Linguist Compass 2010;4:576-89, http://dx.doi.org/10.1111/j.1749-818X.2010.00216.x.

[6] Moro A, Bambini V, Bosia M, Anselmetti S, Riccaboni R, Cappa SF, et al. Detecting syntactic and semantic anomalies in schizophrenia. Neuropsychologia 2015;79:147-57, http://dx.doi.org/10.1016/j.neuropsychologia.2015.10.030.

[7] Barrera A, McKenna PJ, Berrios GE. Formal thought disorder in schizophrenia: an executive or a semantic deficit? Psychol Med 2005;35:121-32, http://dx.doi.org/10.1017/S003329170400279X.

[8] Cummings L. Pragmatic disorders. Dordrecht: Springer; 2014.

[9] Sperber D, Wilson D. Pragmatics. In: Jackson F, & Smith M, editors. Oxford Handb. Contemp. Philos.; 2005. p. 468-501.

[10] Harrow M. Abstract and concrete thinking in schizophrenia during the Prechronic phases. Arch Gen Psychiatry 1974;31:27, http://dx.doi.org/10.1001/archpsyc.1974.01760130013002.

[11] Langdon R, Davies M, Coltheart MAX. Understanding minds and understanding communicated meanings in schizophrenia; 200268-104.

[12] Kiang M, Light Ga, Prugh J, Coulson S, Braff DL, Kutas M. Cognitive, neurophysiological, and functional correlates of proverb interpretation abnormalities in schizophrenia. J Int Neuropsychol Soc 2007;13:653-63, http://dx.doi.org/10.1017/S1355617707070816.

[13] Schettino A, Lauro LR, Crippa F, Anselmetti S, Cavallaro R, Papagno C. The comprehension of idiomatic expressions in schizophrenic patients. Neuropsychologia 2010;48:1032-40, http://dx.doi.org/10.1016/j.neuropsychologia.2009.11.030.

[14] Rapp AM, Langohr K, Mutschler DE, Wild B. Irony and proverb comprehension in schizophrenia: do female patients "dislike" ironic remarks? Schizophr Res Treat 2014;2014:841086, http://dx.doi.org/10.1155/2014/841086.

[15] Pesciarelli F, Gamberoni T, Ferlazzo F, Lo Russo L, Pedrazzi F, Melati E, et al. Is the comprehension of idiomatic sentences indeed impaired in paranoid schizophrenia? A window into semantic processing deficits. Front Hum Neurosci 2014;8:1-14, http://dx.doi.org/10.3389/fnhum.2014.00799.

[16] Tavano A, Sponda S, Fabbro F, Perlini C, Rambaldelli G, Ferro A, et al. Specific linguistic and pragmatic deficits in Italian patients with schizophrenia. Schizophr Res 2008;102:53-62, http://dx.doi.org/10.1016/j.schres.2008.02.008.

[17] Mossaheb N, Aschauer HN, Stoettner S, Schmoeger M, Pils N, Raab M, et al. Comprehension of metaphors in patients with schizophrenia-spectrum disorders. Compr Psychiatry 2014;55:928-37, http://dx.doi.org/10.1016/j.comppsych.2013.12.021.

[18] Linscott RJ. Thought disorder, pragmatic language impairment, and generalized cognitive decline in schizophrenia. Schizophr Res 2005;75:225-32, http://dx.doi.org/10.1016/j.schres.2004.10.007.

[19] Perlini C, Marini A, Garzitto M, Isola M, Cerruti S, Marinelli V, et al. Linguistic production and syntactic comprehension in schizophrenia and bipolar disorder. Acta Psychiatr Scand 2012;126:363-76, http://dx.doi.org/10.1111/j.1600-0447.2012.01864.x.

[20] Haas MH, Chance SA, Cram DF, Crow TJ, Luc A, Hage S. Evidence of pragmatic impairments in speech and proverb interpretation in schizophrenia. J Psycholinguist Res 2014;469–83, http://dx.doi.org/10.1007/s10936-014-9298-2.

[21] Elvevåg B, Foltz PW, Weinberger DR, Goldberg TE. Quantifying incoherence in speech: an automated methodology and novel application to schizophrenia. Schizophr Res 2007;93:304-16, http://dx.doi.org/10.1016/j.schres.2007.03.001.

[22] Colle L, Angeleri R, Vallana M, Sacco K, Bara BG, Bosco FM. Understanding the communicative impairments in schizophrenia: a preliminary study. J Commun Disord 2013;46:294-308, http://dx.doi.org/10.1016/j.jcomdis.2013.01.003.

[23] Brüne M, Bodenstein L. Proverb comprehension reconsidered — "theory of mind" and the pragmatic use of language in schizophrenia. Schizophr Res 2005;75:233-9, http://dx.doi.org/10.1016/j.schres.2004.11.006.

[24] Champagne-Lavau M, Stip E. Pragmatic and executive dysfunction in schizophrenia. J Neurolinguistics 2010;23:285-96, http://dx.doi.org/10.1016/j.jneuroling.2009.08.009.

[25] Thoma P, Hennecke M, Mandok T, Wähner A, Brüne M, Juckel G, et al. Proverb comprehension impairments in schizophrenia are related to executive dysfunction. Psychiatry Res 2009;170:132-9, http://dx.doi.org/10.1016/j.psychres.2009.01.026.

[26] Gavilán JM, García-Albea JE. Theory of mind and language comprehension in schizophrenia: poor mindreading affects figurative language comprehension beyond intelligence deficits. J Neurolinguistics 2011;24:54-69, http://dx.doi.org/10.1016/j.jneuroling.2010.07.006.

[27] Joyal M, Bonneau A, Fecteau S. Speech and language therapies to improve pragmatics and discourse skills in patients with schizophrenia. Psychiatry Res 2016;240:88-95, http://dx.doi.org/10.1016/j.psychres.2016.04.010.

[28] Tan EJ, Thomas N, Rossell SL. Speech disturbances and quality of life in schizophrenia: differential impacts on functioning and life satisfaction. Compr Psychiatry 2014;55:693-8, http://dx.doi.org/10.1016/j.comppsych.2013.10.016.

[29] Bowie CR, Harvey PD. Communication abnormalities predict functional outcomes in chronic schizophrenia: differential associations with social and adaptive functions. Schizophr Res 2008;103:240-7, http://dx.doi.org/10.1016/j.schres.2008.05.006.

[30] Sparks A, McDonald S, Lino B, O'Donnell M, Green MJ. Social cognition, empathy and functional outcome in schizophrenia. Schizophr Res 2010;122:172-8, http://dx.doi.org/10.1016/j.schres.2010.06.011.

[31] Done DJ, Leinonen E. Pragmatic use of language by children who develop schizophrenia in adult life. Schizophr Res 2013;147:181-6, http://dx.doi.org/10.1016/j.schres.2013.03.005.

[32] Sullivan SA, Hollen L, Wren Y, Thompson AD, Lewis G, Zammit S. A longitudinal investigation of childhood communication ability and adolescent psychotic experiences in a community sample. Schizophr Res 2016;173:54-61, http://dx.doi.org/10.1016/j.schres.2016.03.005.

[33] Docherty NM, Gordinier SW, Hall MJ, Cutting LP. Communication disturbances in relatives beyond the age of risk for schizophrenia and their associations with symptoms in patients. Schizophr Bull 1999;25:851-62.

[34] Docherty NM, Gordinier SW, Hall MJ, Dombrowski ME. Referential communication disturbances in the speech of nonschizophrenic siblings of schizophrenia patients. J Abnorm Psychol 2004;113:399-405, http://dx.doi.org/10.1037/0021-843X.113.3.399.

[35] Bedi G, Carrillo F, Cecchi G, Slezak DF, Sigman M, Mota NB, et al. Automated analysis of free speech predicts psychosis onset in high-risk youths. Nat Publ Group 2015;1:1-7, http://dx.doi.org/10.1038/npjschz.2015.30.

[36] Rosenstein M, Foltz PW, DeLisi LE, Elvevåg B. Language as a biomarker in those at high-risk for psychosis. Schizophr Res 2015;165:249-50, http://dx.doi.org/10.1016/j.schres.2015.04.023.

[37] Murray RM, Lewis SW. Is schizophrenia a neurodevelopmental disorder? (Clin Res Ed) 1987;295:681-2.

[38] Horan WP, Harvey P-O, Kern RS, Green MF. Neurocognition, social cognition and functional outcome in schizophrenia. In: & Gaebel W, editor. Schizophr. Curr. Sci. Clin. Pract. Hoboken, NJ: John Wiley & Sons; 2011. p. 68-107, http://dx.doi.org/10.1002/9780470978672.ch3.

[39] Arcara G, Bambini V. A test for the assessment of pragmatic abilities and cognitive substrates (APACS): normative data and psychometric properties. Front Psychol 2016;7:70, http://dx.doi.org/10.3389/fpsyg.2016.00070.

[40] Bosia M, Arcara G, Moro A, Cavallaro R, Bambini V. Pragmatic abilities across symptoms dimensions in schizophrenia. Appl 2015;XLIV:473-85.
[41] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4th edition, text-revised. Washington, DC: American Psychiatric Association; 2000.
[42] Luzzatti C, Willmes K, De Bleser R. Aachener aphasia test (AAT) — Versione Italiana. Firenze: Organizzazioni Speciali; 1991.
[43] Kay SR, Fiszbein A, Opler LA. The positive and negative syndrome scale (PANSS) for schizophrenia. Schizophr Bull 1987;13:261-76.
[44] Kay SR, Opler LA, Lindenmayer J-P. Reliability and validity of the positive and negative syndrome scale for schizophrenics. Psychiatry Res 1988;23:99-110, http://dx.doi.org/10.1016/0165-1781(88)90038-8.
[45] Wechsler D. Scala d'Intelligenza Wechsler per Adulti-Riveduta. Firenze: Giunti O.S.; 1997.
[46] Keefe RSE, Goldberg TE, Harvey PD, Gold JM, Poe MP, Coughenour L. The brief assessment of cognition in schizophrenia: reliability, sensitivity, and comparison with a standard neurocognitive battery. Schizophr Res 2004;68:283-97, http://dx.doi.org/10.1016/j.schres.2003.09.011.
[47] Anselmetti S, Poletti S, Ermoli E, Bechi M, Cappa S, Venneri A, et al. The brief assessment of cognition in schizophrenia. Normative data for the Italian population. Neurol Sci 2008;29:85-92, http://dx.doi.org/10.1007/s10072-008-0866-9.
[48] Brüne M. Social cognition and behavior in schizophrenia. In: Brüne M, Ribbert H, & Schiefenhovel W, editors. Soc. brain. Evol. Pathol. Chichester, UK: Wiley and Sons; 2003. p. 277-313.
[49] Heinrichs DW, Hanlon TE, Carpenter WT. The quality of life scale: an instrument for rating the schizophrenic deficit syndrome. Schizophr Bull 1984;10:388-98, http://dx.doi.org/10.1093/schbul/10.3.388.
[50] Anselmetti S, Bechi M, Bosia M, Quarticelli C, Ermoli E, Smeraldi E, et al. "Theory" of mind impairment in patients affected by schizophrenia and in their parents. Schizophr Res 2009;115:278-85, http://dx.doi.org/10.1016/j.schres.2009.09.018.
[51] Baayen RH. Analyzing linguistic data a practical introduction to statistics using R. Cambridge University Press; 2008.
[52] R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2014.
[53] Sela T, Lavidor M, Mitchell RL. A possible contributory mechanism for impaired idiom perception in schizophrenia. Psychiatry Res 2015;229:1-11, http://dx.doi.org/10.1016/j.psychres.2015.07.021.
[54] Bambini V, Arcara G, Martinelli I, Bernini S, Alvisi E, Moro A, et al. Communication and pragmatic breakdowns in amyotrophic lateral sclerosis patients. Brain Lang 2016;153–154:1-12, http://dx.doi.org/10.1016/j.bandl.2015.12.002.
[55] Bosia M, Arcara G, Buonocore M, Bechi M, Moro A, Cavallaro R, et al. Communication in schizophrenia, between pragmatics, cognition and social cognition. In: & AM DS, editor. Biolinguistic Investig. Lang. Fac. Amsterdam John Benjamins. Amsterdam: John Benjamins; 2016.
[56] Blain-Brière B, Bouchard C, Bigras N. The role of executive functions in the pragmatic skills of children age 4-5. Front Psychol 2014;5:240, http://dx.doi.org/10.3389/fpsyg.2014.00240.
[57] Varga E, Schnell Z, Tényi T, Németh N, Simon M, Hajnal A, et al. Compensatory effect of general cognitive skills on non-literal language processing in schizophrenia: a preliminary study. J Neurolinguistics 2014;29:1-16, http://dx.doi.org/10.1016/j.jneuroling.2014.01.001.
[58] Champagne-Lavau M, Stip E, Joanette Y. Language functions in right-hemisphere damage and schizophrenia: apparently similar pragmatic deficits may hide profound differences. Brain 2007;130:e67, http://dx.doi.org/10.1093/brain/awl311.
[59] Martin I, McDonald S. Weak coherence, no theory of mind, or executive dysfunction? Solving the puzzle of pragmatic language disorders. Brain Lang 2003;85:451-66.
[60] Sperber D, Wilson D. Pragmatics, modularity and mind-reading. Mind Lang 2002;17:3-23.
[61] Galski T, Tompkins C, Johnston MV. Competence in discourse as a measure of social integration and quality of life in persons with traumatic brain injury. Brain Inj 1998;12:769-82, http://dx.doi.org/10.1080/026990598122160.
[62] Buck B, Penn DL. Lexical characteristics of emotional narratives in schizophrenia: relationships with symptoms, functioning, and social cognition. J Nerv Ment Dis 2015;203:702-8, http://dx.doi.org/10.1097/NMD.0000000000000354.
[63] Chen L, Phillips G, Johnston J, Kinon BJ, Ascher-Svanum H, Kollack-Walker S, et al. The relationship, structure and profiles of schizophrenia measurements: a post-hoc analysis of the baseline measures from a randomized clinical trial. BMC Psychiatry 2011;11:203, http://dx.doi.org/10.1186/1471-244X-11-203.
[64] Galderisi S, Rossi A, Rocca P, Bertolino A, Mucci A, Bucci P, et al. The influence of illness-related variables, personal resources and context-related factors on real-life functioning of people with schizophrenia. World Psychiatry 2014;13:275-87, http://dx.doi.org/10.1002/wps.20167.
[65] Selva-Vera G, Balanzá-Martínez V, Salazar-Fraile J, Sánchez-Moreno J, Martinez-Aran A, Correa P, et al. The switch from conventional to atypical antipsychotic treatment should not be based exclusively on the presence of cognitive deficits. A pilot study in individuals with schizophrenia. BMC Psychiatry 2010;10:47, http://dx.doi.org/10.1186/1471-244X-10-47.
[66] Catani M, Bambini V. A model for social communication and language evolution and development (SCALED). Curr Opin Neurobiol 2014;28:165-71, http://dx.doi.org/10.1016/j.conb.2014.07.018.
[67] Rapp AM, Langohr K, Mutschler DE, Klingberg S, Wild B, Erb M. Isn't it ironic? Neural correlates of irony comprehension in schizophrenia. PLoS One 2013;8e74224, http://dx.doi.org/10.1371/journal.pone.0074224.
[68] Catani M, Craig MC, Forkel SJ, Kanaan R, Picchioni M, Toulopoulou T, et al. Altered integrity of perisylvian language pathways in schizophrenia: relationship to auditory hallucinations. Biol Psychiatry 2011;70:1143-50, http://dx.doi.org/10.1016/j.biopsych.2011.06.013.
[69] Kircher TTJ, Leube DT, Erb M, Grodd W, Rapp AM. Neural correlates of metaphor processing in schizophrenia. Neuroimage 2007;34:281-9, http://dx.doi.org/10.1016/j.neuroimage.2006.08.044.
[70] Mausbach BT, Harvey PD, Goldman SR, Jeste DV, Patterson TL. Development of a brief scale of everyday functioning in persons with serious mental illness. Schizophr Bull 2007;33:1364-72, http://dx.doi.org/10.1093/schbul/sbm014.
[71] Foltz PW, Rosenstein M, Elvevåg B. Detecting clinically significant events through automated language analysis: quo Imus? Npj Schizophr 2016;2:15054, http://dx.doi.org/10.1038/npjschz.2015.54.
[72] Elvevåg B, Foltz PW, Rosenstein M, Delisi LE. An automated method to analyze language use in patients with schizophrenia and their first-degree relatives. J Neurolinguistics 2010;23:270-84, http://dx.doi.org/10.1016/j.jneuroling.2009.05.002.
[73] Bosco FM, Gabbatore I, Gastaldo L, Sacco K. Communicative-pragmatic treatment in schizophrenia: a pilot study. Front Psychol 2016;7:166, http://dx.doi.org/10.3389/fpsyg.2016.00166.