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Linguistic markers of demoralization improvement in schizophrenia: A pilot study

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Abstract

Background and objectives: Individuals with schizophrenia display language impairments involving pragmatics, semantics and syntax. Language impairments may show diagnostic specificity and could relate to the ability of engaging in psychotherapy. This pilot study sought to: (1) identify linguistic features that might differentiate individuals with schizophrenia from distressed controls without psychotic symptoms; and (2) examine the association between linguistic abilities and clinical changes during psychotherapy.

Methods: We recruited patients with schizophrenia and a comparison group of individuals with demoralization and distress due to cancer. Participants underwent Dignity Therapy (DT), an existentially-oriented brief psychotherapy focused on legacy and subjective dignity. Verbatim transcripts of the DT sessions were analysed using Natural Language Processing (NLP). In addition, we measured changes in levels of demoralization and dignity-related distress before and after DT, exploring the association with linguistic variables with network analysis.

Results: Patients with schizophrenia could be differentiated from those with cancer-related distress using only three out of 141 linguistic variables: total number of words, number of prepositional chains and conversational elements. Across groups, better levels of discourse coherence and higher number of arguments controlled by a predicate (verb "arity") were associated with larger improvements in demoralization and, indirectly, dignity-related distress.

Conclusions: Reproducible linguistic markers may be able to differentiate individuals with schizophrenia from those with less severe psychopathology, and to predict better uptake of psychotherapy independent from diagnosis. Future studies should explore whether linguistic

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features derived from NLP may be exploited as accessible diagnostic or prognostic markers to tailor psychotherapy and other interventions in schizophrenia.

Introduction

Patient vital signs are assessed before undergoing surgery and constantly monitored to derive information for patient prognosis. By analogy, individual language abilities convey fundamental insights on the inner state of the patient that could be leveraged to inform clinical reasoning and guide therapeutic choices.

Language is a core instrument of the psychiatric discipline, from diagnosis to treatment. Patients with schizophrenia-spectrum disorders, however, display varying degrees of linguistic impairments, a longstanding object of interest of psychiatrists[1–6] and linguists.[7,8] The linguistic impairments of schizophrenia present in different domains, including semantic[9,10] pragmatic[11–17] and syntactic abilities[3], and are crucially linked with cognitive and meta-cognitive deficits.[18] For instance, schizophrenic patients display difficulties describing life events and reconstructing narratives of related emotions[19], and creating organized and coherent self-defining personal narratives.[20] Quite relevant is the fact that language impairments are largely heterogeneous across patients, with some individuals displaying relatively intact abilities.[11,21,22]

Language impairments of schizophrenia may complicate clinical management and worsen clinical outcomes.[23–25] They hinder the uptake of psychosocial interventions and psychotherapy[26–29], which are increasingly recognized as important among patients with psychotic disorders to reach personal recovery.[30,31] Psychotherapeutic approaches may crucially depend on the linguistic abilities of the patient. Creating a "*common language*" and "*meaning-making*" are fundamental ingredients of all psychotherapies that largely depend on linguistic abilities[32,33] and contribute to build the therapeutic alliance and better clinical outcomes.[34] Poor linguistic abilities may also engender miscommunication outside psychotherapy, such as disagreement on treatment goals, on pharmacological and other aspects of clinical management.[33,35–38]

Research on linguistic abilities of schizophrenia has provided landmark insights on the relationship between psychopathology on language. To this end, studies employed various assessment tools, such as the Clinical Language Disorder Rating Scale (CLANG)[5] and the Thought, Language and Communication disorder rating scale (TLC)[1,2,39] that largely rely on psychiatrist's subjective ratings. These instruments enable identification of specific patterns of language anomalies that could differentiate psychosis from other psychiatric disorders.[6,40] Whereas, Natural Language Processing (NLP) and Latent Semantic Analysis (LSA) are reproducible AI-based linguistic analysis that can process large amounts of data and extract a rich set of indices with varying levels of human supervision. In particular, recent approaches based on Transformers Neural Network can identify the contextual representations of words, possibly improving the recognition of language disturbances. Few studies have used NLP in schizophrenia and suggest that language markers may be useful to recognize the presence of high-risk[41] or full-blown psychosis.[10,42] No study, however, has yet examined whether language abilities may predict or influence the response to psychotherapy among individuals with schizophrenia. If that were the case, language markers might provide useful information to personalize treatment, for instance by establishing the eligibility for specific types of psychotherapy, social skills training or other psychosocial interventions. Consideration of individual language abilities may prove particularly important for tuning interventions delivered by chatbots.In a recent qualitative study, cancer patients and individuals with psychiatric disorders and their therapist elaborated generativity documents during Dignity Therapy (DT) (Grassi et al., 2022). Verbatim transcripts of the sessions were analyzed using Interpretative Phenomenological Analysis. Surprisingly, despite participants were facing different problems, they presented similar themes (e.g. "Meaning making", "Resources", "Legacy", "Dignity"), highlighting that they may share some similar existential challenges that could be explored and addressed by DT. This study sought to investigate differences in morpho-syntactical linguistic abilities that may differentiate the way such themes were reported.

The aim of this pilot study was to examine the differences of language abilities between individuals with schizophrenia compared to demoralized cancer patients without psychosis, and to identify which features would be associated with changes in demoralization and distress across the sessions of a brief, existentially oriented psychotherapy.

Methods

Participants

This study analyzed data from a pilot study on the feasibility and application of DT in oncology and psychiatry, conducted between January and October 2019. Here, similar themes in both groups emerged from the DT, namely meaning making, social and personal resources, and legacy in terms of legacy of self and legacy for others[43] Furthermore, we identified as additional themes for individuals with psychiatric disorders, specifically dignity, stigma and illness experience. Patients were recruited from the Integrated Department of Mental Health and Addictions (DMHA) of the Local Health Trust in Ferrara and the University of Ferrara.

The group of patients with Schizophrenia-Spectrum Disorders (SSD) included 11 participants from the local Community Mental Health Centres and one from the Psychiatric Residential Facilities of the DMHA. Patients were recruited based on the following inclusion criteria: 1) diagnosis of schizophrenia or SSD according to DSM-5 criteria; 2) age of 18 or older; 3) absence of a Major Neurocognitive Disorder as defined by DSM 5; 4) absence of acute psychiatric

symptoms as indicated by a Brief Psychiatric Rating scale (BPRS) total score below 53 (markedly ill).[44]

The group of cancer patients comprised 12 patients recruited from the Psycho-Oncology outpatient Program, University Psychiatry Unit, DMHA. Patients were recruited based on the following inclusion criteria: 1) age of 18 or older; 2) absence of a Major Neurocognitive Disorder; 3) absence of a psychiatric diagnosis; 4) diagnosis of cancer at any stage (three patients had metastatic cancer). Long-term survivors were also included as diagnoses were made in the previous 12 years (of which, 6 in the previous four years). The most frequent diagnosis was breast cancer (7 out of 12).

The study was approved by the University of Ferrara Ethical Committee. All patients signed a written consent form before participating and did not receive any economical compensation.

Dignity therapy (DT)

Dignity Therapy (DT) consists of a semi-structured interview, which facilitates the exploration of significant aspects in the patient's life.[45] Three trained therapists conducted the DT for both groups. Each patient was interviewed by one of the three therapists for all the three sessions. The DT protocol consists of three sessions or more.[45] The first is an introductory meeting to discuss informed consent and explain the DT method. The second is dedicated to the DT semi-structured interview, which includes questions addressing significant life events and one's personal legacy. There is no constraint for strictly following the semi-structured interview questions, and the discourse content may digress. However, the therapist guides the patient through the main topics and elicit their subjective experiences with tactfulness and care. Interviews are tape-recorded and then transcribed verbatim by the therapist, who shapes them into a narrative *generative document* through a preliminary editing process. The third and last session is dedicated to the final editing of the generativity document jointly by the therapist and the participant. The final written legacy document is given back to the participant who is invited to share and discuss it with his/her loved ones. All participants completed the three DT sessions.

The choice of this type of psychotherapy aimed to facilitate the potential translation of findings to a real world clinical setting and was motivated by the following reasons. 1) Adopting a brief intervention would entail the need of limited linguistic material for analysis, and easier reproducibility; 2) DT elicits themes that are non-stigmatizing and widely acceptable, thus potentially increasing the generalizability of findings[43,46]; 3) By dealing with existential topics, a narrative and meaning-making approach, we argue that DT may be particularly useful to elicit individual symbolic and abstraction abilities that are reflected in language. These elements are crucial to engage in, and get benefit from psychotherapy.[47,48]

DT was initially developed for palliative care and oncologic diseases. We adapted this approach to individuals with chronic psychiatric disorders and noticed that similar existential themes were shared by the two groups[43], suggesting the feasibility and potential clinical utility of DT in psychiatry.

Clinical assessments

All participants were administered the Patient Dignity Inventory (PDI)[49] and the Demoralization Scale (DS)[50] before and after the DT sessions. Participants in the SSD group were also assessed with the Brief Psychiatric Rating Scale (BPRS)[51] at the first session to rate the severity of symptoms .

Analyses of language

Linguistic analyses were performed on verbatim transcripts of DT. We carried out a comprehensive language assessment covering properties related to the lexical, morpho-syntactic and syntactic structure of the discourse, as well as features measuring the level of semantic coherence (Table 2). More specifically we extracted features characterizing the lexical and (morpho) syntactic structure of transcripts using Profiling-UD[52] a multilingual web-based tool that was conceived to automatically carry out linguistic profiling of large collections of texts annotated according to the Universal Dependencies (UD) formalism.[53] Profiling-UD allows representing each text as a vector of more than 130 features encoding a variety of lexical and grammatical properties informed by literature on linguistic complexity, language acquisition and neurolinguistics. Characteristics include shallow features, such as the average length of words and sentences, morpho−syntactic information concerning the distribution of parts-of-speech (POS) and inflectional properties of verbs, as well as more complex aspects of syntactic structure such as the average depth of the whole parse tree, the average length of dependency links, the use of subordination. Many of these features have been successfully used in a variety of applications focused on modeling the "form" rather than the content of texts. Application included the automatic tracking of patterns of language acquisition in childhood[54,55], the evolution of written language competence in students[56,57], and prediction of behavioural and cognitive impairments based on the detection of relevant linguistic markers from clinical tests.[58,59]

To investigate the semantic dimension of the interviews we computed the *Discourse Coherence* by exploiting a Transformers Neural Network architecture.[60] Unlike previous models, Transformer Neural Network models produce full-sentence representations, without the need to apply vectors concatenation[61], thus are capable of generating distinct word representations based on the specific context of occurrence. More specifically, we employed a BERT model (Bidirectional Encoder Representations from Transformers;[62]) pre-trained for the Italian language, namely, "bert-base-italian-cased". The model can be found at[61] The index of *Discourse Coherence* was computed for each interview by extracting vector representations of all sentences, then computing the cosine similarity between each couple of contiguous sentences and averaging over all computed similarities.

Statistical analyses

First, we sought to identify the set of linguistic features that best classified oncologic and schizophrenic patients. We performed a regularized logistic regression analysis using the clinical group (SSD vs. oncologic) as the dependent variable

and all the parameters encoding the lexical, morpho-syntactic and syntactic structure of text as the predictors. The oncologic group was coded as 1, thus positive coefficients indicate greater value of the parameter in the oncologic group relative to the SSD group. The lasso function imposes a penalty to less relevant variables, shrinking their coefficients toward zero. It is a suitable approach for analyses with high number of variables and low sample size. The analysis was performed with 4.1.3 version of the *glmnet* package.[63] In a second step, we aimed at estimating the discriminative ability of a model based on linguistic features alone distinguishing patients from the two groups. ROC analyses were used to estimate sensitivity and specificity, if necessary by evaluating a more restricted set of variables based on stepwise selection. Additional models were evaluated, adding discourse coherence.

Second, we explored the association between linguistic variables and clinical outcomes, namely changes of demoralization and dignity-related distress, using network analysis. We combined both groups in the network analysis to examine the identify connections between linguistic abilities and changes in demoralization or dignity-related distress, regardless of diagnosis. A Gaussian Graphical Model (GGM) was used to estimate the conditional dependence relationship between each pair of variables while adjusting for all other variables in the model. Each factor is represented as a node, connected by edges of varying strength. The edge color indicates the direction of the association (i.e. red for negative, green for positive).[64] The syntactic and morpho-syntactic variables identified as discriminant in the regularized regression analysis were entered in the network, plus discourse coherence and clinical variables. Network analysis was conducted with the 1.9.2 version of the *qgraph* R package using the EBICglasso algorithm to identify the most significant associations.[65]

Results

Sample characteristics

Participant characteristics are summarized in Table 1.

Discriminant analysis based on linguistic factors

The LASSO regression analysis identified 11 linguistic variables with non-zero coefficients, which predicted group membership (Table 2 and Table S3). With the exception of document length ("n tokens"), these findings suggest the high discriminative role played by features modeling a variety of distinct phenomena pertaining to the morpho-syntactic and syntactic structure of a text. Among verb-related features, group membership was associated with those denoting: i) the complexity of the Italian inflectional paradigm in terms of properties such as mood, tense and person (see, in particular, the distribution of lexical verbs in conditional mood, i.e. "PCondVerb", and of auxiliaries in the third person plural, i.e. "AuxVerb3p"); ii) the richness of verbal predicates, which is calculated as the average number of instantiated dependency links sharing the same verbal head

Table 1 Sample characteristics.

Variable	Oncologic group (N = 12)		Psychotic group (N = 11)		Statistics	Hedges' g
	N	%	N	%		
Gender, female	12	100	4	36.4		
Age, mean (SD)	60.25	(7.25)	43.09	(10.8)	*p* < 0.001*	1.81
Years of education, mean (SD)	12.58	(4.5)	11.9	(4.2)	*p* = 0.566	0.15
Civil status						
Single	—	—	10	90.9		
Relationship	8	66.7	—	—		
Divorce/separation	3	25.0	1	9.1		
Widow	1	8.3	—	—		
Children	10	83.3	2	18.2		
Employment status						
Employed	6	50.0	5	45.5		
Unemployed	—	—	5	45.5		
Retired/disability pension	5	41.7	1	9.1		
Housewife	1	8.3	—	—		
Living situation						
Parents	—	—	6	54.5		
Own family	8	66.7	—	—		
Alone	4	33.3	3	27.3		
Friends/roommate	—	—	1	9.1		
Other	—	—	1	9.1		
BPRS total score, mean (SD)	—	—	26.36	7.43		
Location						
Community Psychiatric Service	—	—	6	54.5		
Psychiatric Rehabilitation Facility	—	—	5	45.5		

Table 2 Definition of the linguistic discriminant variables.

Variable	Linguistic level	Definition
N tokens	Raw text	Mean document length in terms of tokens (words)
PNoun	Morpho-syntactic	Percentage of nouns
PCondVerb	Morpho-syntactic	Percentage of conditional verbs (in the conditional mode)
AuxVerb3p	Morpho-syntactic	Percentage of auxiliary verbs in 3rd plural person
AvgVerbE	Syntactic	Mean number of dependent objects for each verb.
		For example, in the sentence "Jack eats an apple" the arity value is 2 because there is only one verb to which subject (Jack) and object (apple) depend. In the sentence "Jack eats an apple at the park", the arity value is 3 and corresponds to the three verb dependencies (Jack, apple and park).
		In general, a higher verbal arity is an index of sentence syntactic complexity.
VerbE5	Syntactic	Percentage of verbs with 5 dependencies. Feature related to verbal arity.
VerbE6	Syntactic	Percentage of verbs with 6 dependencies. Feature related to verbal arity.
PPrep2	Syntactic	Percentage of prepositional chains with a length of two.
		A prepositional chain consists of a noun which is modified by one or more recurring complements introduced by a preposition (for example "John greeted Tom's girlfriend" is a prepositional chain with length 1 which corresponds to the prepositional complement "Tom's" dependent from the noun "girlfriend". In a sentence such as "John greeted Tom's brother's girlfriend" there is a prepositional chain with length 2 since the prepositional complement "brother's" which depends to "girlfriend" is also modified by the prepositional complement "Tom's".
		In general, longer prepositional chains characterize texts with a higher syntactic complexity.
PAux	Syntactic	Percentage of syntactic relations linking an auxiliary or modal verb to the lexical? verb (*to have* and *to be* as used in sentences such as "I have read" or "I am listening")
PCC	Syntactic	Percentage of syntactic relations that link the head of a syntagma? with the preceding coordinating conjunction (example: in "Jack eats pizza and drinks beer" it's the relation between the conjunction "and" the verb "drinks", which represent the head of the syntagma "drinks beer", coordinated to the verb of the main sentence "eats". These dependencies usually indicate the use of coordination (between noun and verbal elements).
PVoc	Syntactic	Percentage of syntactic relations used to highlight linguistic elements expressed by the participants to a conversation. They are syntactic relations usually found in some kinds of texts such as emails, dialogues and conversations.
		For example, in the sentence "Dear, how are you?", "dear" is linked through a "vocative"? relation to the main sentence verb ("are") to which it depends.

(see "AvgVerbE", "VerbE5", "VerbE6"). At the syntactic level, group membership was associated with the presence of complex nominal structures (denoted by "PPrep2"), of coordinate structures and of specific constructions characterizing dialog-related features such as *addressitivity* (signaled by "PCC" and "PVoc", respectively).

We conducted stepwise logistic regression analyses to restrict the number of discriminative variables. Three variables were associated with group membership, namely n tokens (beta = 6.967e+11, $p < 0.001$), PVoc (beta = 8.212e+16, $p < 0.001$) and higher PPrep2 (beta = −5.064e+14, $p < 0.001$). The ROC analysis suggested perfect discrimination (AUC: 1.00; 95% CI: 1.00 − 1.00). Examining plots, it was apparent that PPrep2 and n tokens had homogeneous distribution in the groups (Fig. 1), while PVoc was extremely skewed with much lower values in the SSD group. To explore the different roles of the discriminative variables and discourse coherence, we examinedadditional models with

different combinations of the discriminating variables and discourse coherence: all had good to excellent discrimination accuracy, even without the total number of words (see Supplementary material). Eventually, we calculated correlations between age and linguistic discriminant variables (Table S5): age displayed a significant correlation only with PVoc ($R = 0.477$, $p = 0.02$).

Comparison of dignity related levels of distress and demoralization in the two groups and before and after DT sessions

Groups were similar in levels of demoralization (Hedges' $g = 0.0571$) and dignity-related distress levels (Hedges' $g = -0.164$) (Table S6). There were limited average changes of levels of demoralization and dignity-related distress before and after the DT sessions with small effect
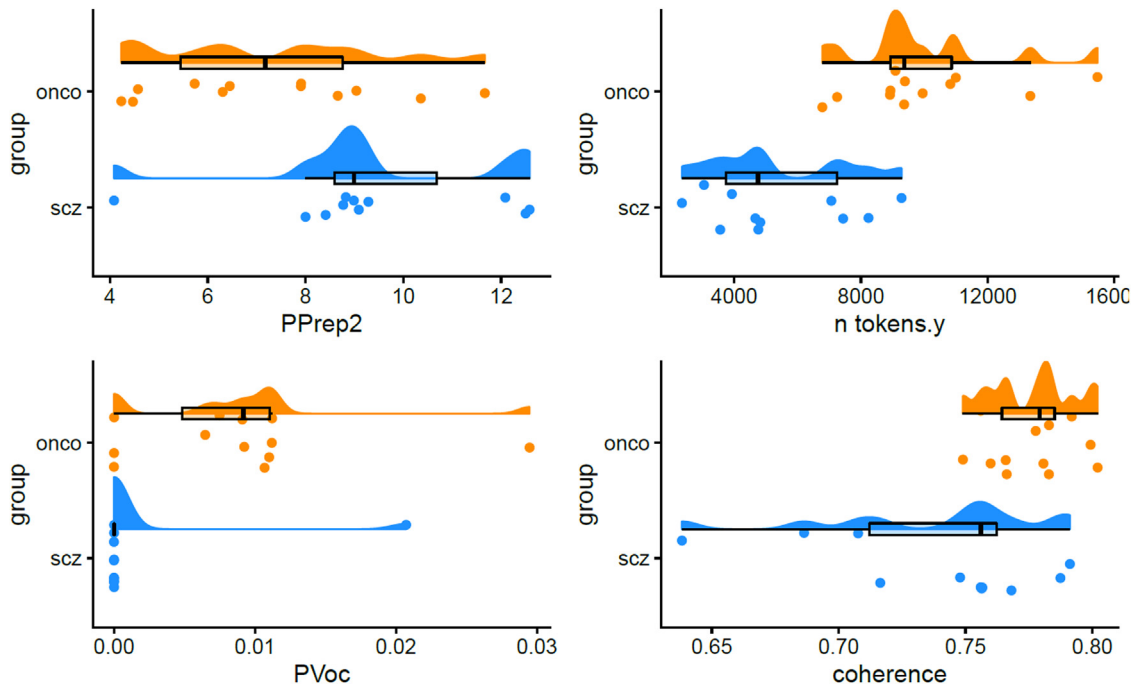
Fig. 1 Comparison between participants with schizophrenia and cancer for the discriminant variables.

sizes (DS Hedges' g = 0.096; PDI Hedges' g = 0.166) (Fig. 2 and Table S7).

Network analysis

In network analysis, changes of demoralization were connected positively with coherence, AvgVerbE and VerbE5 (Fig. 3). Moreover, changes of dignity-related distress were connected with changes of demoralization. Several connections between linguistic variables were also detected. When including age in the network (Fig. S8), there were no

differences in the connections between changes in demoralization and coherence, AvgVerbE and VerbE5, while different edges were observed between the linguistic variables.

Correlations between linguistic variables and clinical outcomes

We examined the bivariate correlations between changes of demoralization and linguistic variables (Fig. 4). In the whole sample changes of demoralization correlated with coherence ($p < 0.001$, R^2 = 41%), AvgVerbE ($p = 0.016$, R^2 = 25%)
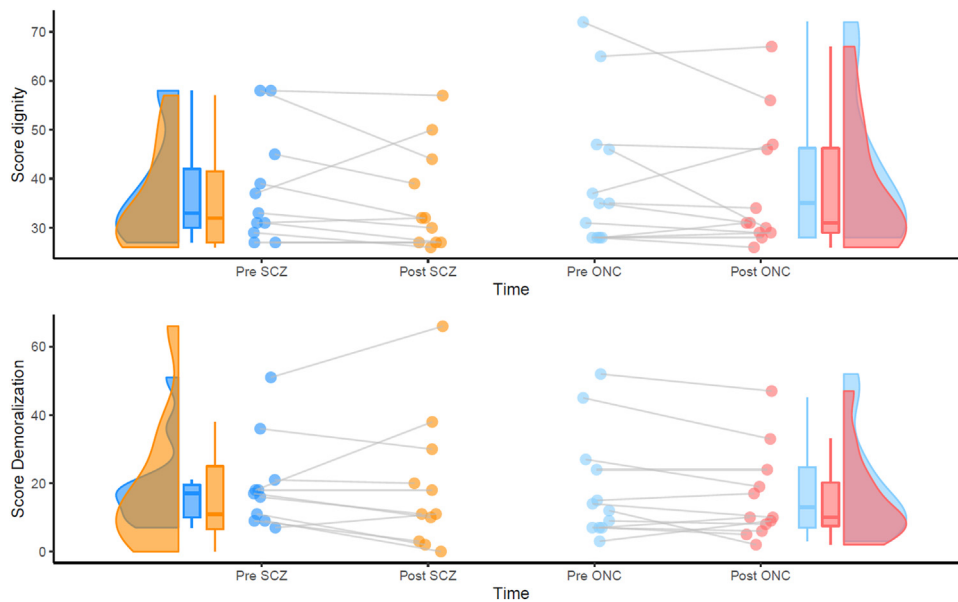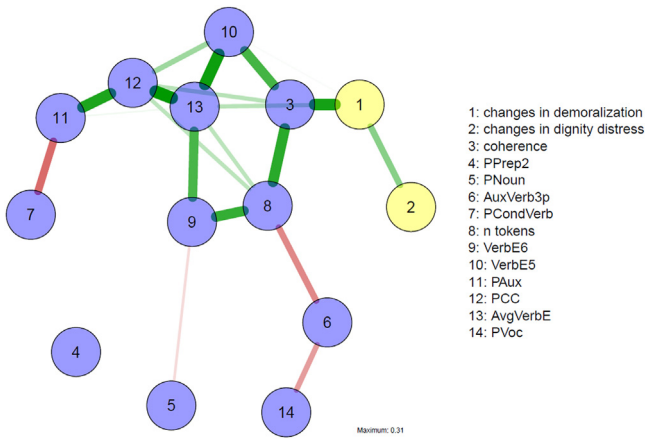

Fig. 2 Levels of demoralization and dignity-related distress in schizophrenic and oncologic patients before and after Dignity Therapy.

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1: changes in demoralization
2: changes in dignity distress
3: coherence
4: PPrep2
5: PNoun
6: AuxVerb3p
7: PCondVerb
8: n tokens
9: VerbE6
10: VerbE5
11: PAux
12: PCC
13: AvgVerbE
14: PVoc

Maximum: 0.31

Fig. 3 Relationship between changes of demoralization, changes of dignity-related distress and linguistic variables including coherence.

and VerbE5 ($p = 0.027$, $R^2 = 21\%$). In the schizophrenic group, changes in demoralization correlated with coherence ($R^2 = 0.576$, p-value = 0.007). In the oncologic group, changes in demoralization correlated with AvgVerbE ($R^2 = 0.463$, p-value = 0.015).

Discussion

This pilot study explored the role of linguistic abilities in schizophrenia and their association with clinical changes over psychotherapy. We found that specific language abilities differentiated between patients with schizophrenia and a comparison group of individuals with demoralization and cancer-related distress. Moreover, discourse coherence and complexity predicted greater improvements of demoralization across a brief existential psychotherapy in both groups. These preliminary results suggest that linguistic markers derived from Natural Language Processing may be leveraged to inform the suitability to psychotherapy in schizophrenia.

We found that better discourse coherence and verb *arity* (i.e. discourse complexity) predicted greater improvements of demoralization across DT in both groups. To our knowledge, no previous study explored the relationship between language and changes promoted by psychotherapy in schizophrenia. However, results are broadly consistent with those of few studies examining semantic abilities on patients with non-psychotic, mixed disorders. In particular, the use of first person pronouns increased among those displaying good outcomes after psychotherapy.[29] In a group of patients with affective and anxiety disorders, distress was associated with fewer first-person words and fewer words indicating negative emotions during psychotherapy. A decrease in the use of first-person words was also associated with greater post-treatment improvement.[66]

Language abilities, particularly discourse coherence and verb *arity*, may influence the uptake of psychotherapy because they are necessary for the narrative generation and meaning making processes that are at the core of psychotherapy.[67] Better semantic abilities may be particularly important for building a personal meaning of individual experiences to be shared with the therapist. Patients with schizophrenia and better discourse coherence may also have
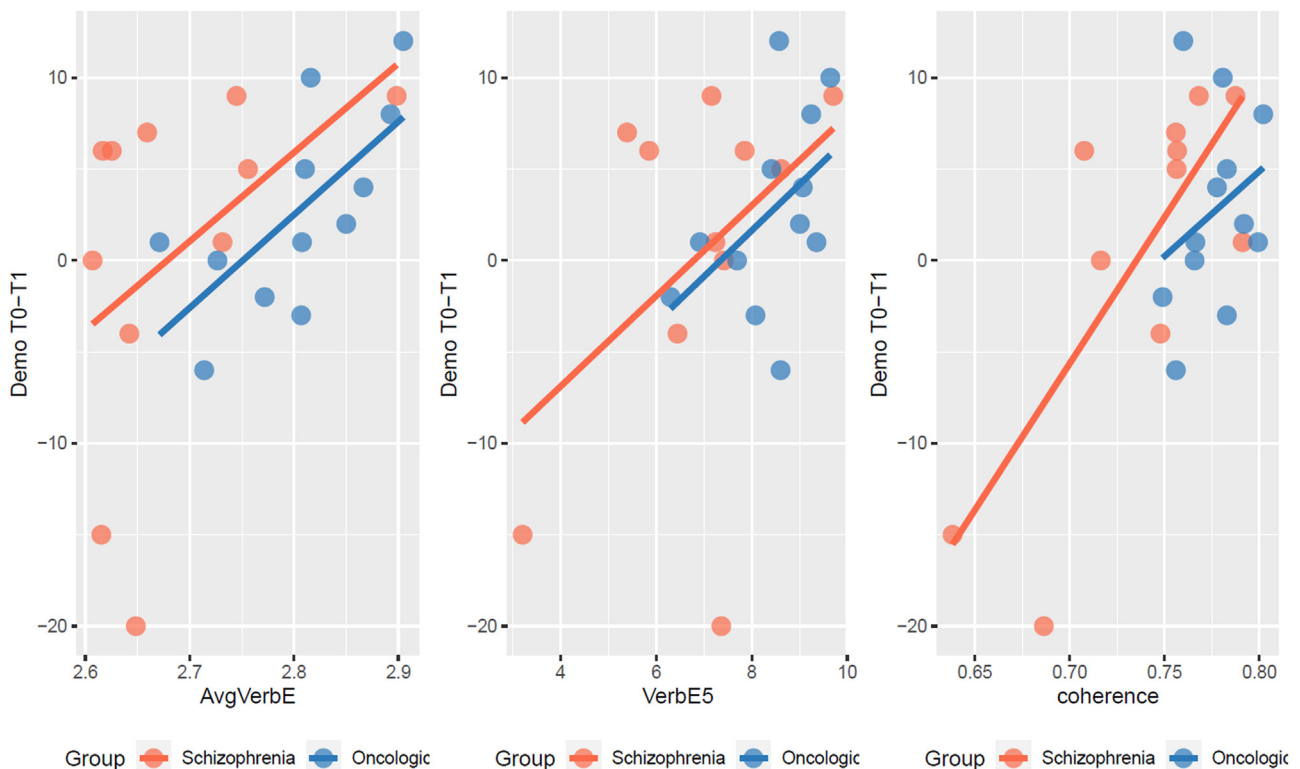
Fig. 4 Scatterplot showing correlations between linguistic variables and changes in demoralization.

advantages reconstructing narratives of life events and related emotions[19] that are important steps in the psycho-therapy process.[33,35] In the longer course, they may also promote self-disclosing[68] and a stronger therapeutic alliance.[69] Conversely, individuals with worse discourse coherence might benefit from interventions that specifically aim to foster linguistic abilities.[30,70−72] Semantic abilities seem not only relevant for brief, existential oriented psychotherapy as in this study, but may also be important for other types of interventions and relate to the so-called "common factors" of effectiveness.[73] Thus, if these findings were confirmed, NLP methods may be leveraged for early personalization of treatment.

Linguistic features, either syntactic or semantic indices of poverty of speech, were also able to differentiate patients with schizophrenia from individuals with cancer-related distress. It would be less surprising that participants with schizophrenia present with fewer total number of words [3]; however other linguistic features also displayed good discriminative potential. This finding is consistent with previous studies using NLP: in particular indices of worse morphology and coherence distinguished schizophrenic individuals from healthy controls with excellent accuracy in a recent study.[42] Semantic features and speech complexity seem already compromised in subjects at high-risk for psychosis[74] and could predict the onset of psychosis with excellent accuracy.[41] Previous works rely on static representations of words, while our Transformer Neural Network models generated distinct word representations based on the specific context of occurrence, which may be successfully employed in structured conditions. Overall, linguistic patterns are extremely promising biomarkers for SSD[75] that could aid in the diagnosis. In one study they showed even greater diagnostic reliability than Schneider first rank symptoms.[6]

The main strength of this study is a reliable method for linguistic analyses. Transformers models generated distinct, context-based word representations and allowed full-sentence representations. Another strength resides in the novelty of the application of a patient-centered, narrative psychotherapeutic approach with an existential framework in schizophrenia, which may favor the exploration of themes related to personal meaning.[43] However, this study has limitations. First, the longitudinal non-randomized design prevents establishing causal links between linguistic abilities and changes in psychological dimensions. Nonetheless, this pilot study would allow further research on the identified linguistic variables as psychotherapy outcome predictors or moderators. Second, analyses did not fully account for between-group sociodemographic differences, especially gender, which may have confounded the association with linguistic abilities. Follow up studies should take this into account when examining the discriminative effect of language markers. Third, we did not assess cognitive performance, which is a potential confounder. Thus, we cannot establish the extent to which cognitive abilities, particularly higher-order, symbolic ones, contribute to clinical improvements, possibly overshadowing the effects of language. Cognition is frequently impaired in patients with schizophrenia, although it may also be impaired in oncologic patients due to treatments and psychotropic drug use. Furthermore, cognition and language are inextricably linked[76,77] and linguistic

patterns may be closely related and represent indices of metacognitive abilities.[78] Fourth, this being a pilot study, we included a small number of participants and further research is required to increase the sample size and potentially highlight specific associations within different clinical groups. Fifth, DT does not directly address aspects related to psychopathology or thought content; however, this study was focused on identifying (morpho)syntactic and semantic features of schizophrenic language related to changes across this brief psychotherapy intervention. Sixth, three trained therapists conducted DT for both groups: further studies need to account for the possible therapist effects.

Conclusions

Semantic linguistic features are associated with better outcomes after existential psychotherapy sessions in schizophrenic patients. Moreover, syntactic and morpho-syntactic linguistic features were able to distinguish schizophrenic and oncologic patients. As linguistic abilities affect the way patients engage in psychotherapy, reliable and consistent methods to assess linguistic features should be considered to tailor the psychotherapy approach to the individual linguistic pattern.

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the local Ethical Committee. All participants received written informed consent before participating.

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Conflict of interest

None.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.ejpsy.2023.03.001.

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