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Lexical characteristics of emotional narratives in schizophrenia: Relationships with symptoms, functioning, and social cognition

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Abstract

Prior research has suggested that complexity of speech, speech rate, use of emotion words, and use of pronouns are all potential indicators of important clinical components of schizophrenia, but little research has examined the relationships of these disturbances to cognitive variables impaired in schizophrenia, including social cognition. The current study examined these lexical differences to better characterize the cognitive substrates of speech disturbances in schizophrenia. Brief narratives of individuals with schizophrenia (n = 42) and non-clinical controls (n = 48) were compared according to their lexical characteristics, and these were examined for relationships to social cognition and real-world functioning. Significant differences between the groups were found in words per sentence (related to functioning, but not negative symptoms) as well as pronoun use (related to attributional style and theory of mind). Additionally, lexical characteristics effectively distinguished between individuals with schizophrenia from non-clinical controls. Language disturbances in schizophrenia appear related to social cognition impairments, real-world functioning, and are a robust indicator of clinical status.

Keywords

schizophrenia; language; narrative; cognition; social functioning

Introduction

Individuals with schizophrenia-spectrum disorders often suffer from an array of communication impairments, including derailment of speech, (loose associations between topics), tangentiality and incoherence (*DSM-5*; APA, 2013). These symptoms are most severe in acute phases of psychosis; however, subtle language disturbances persist in non-active phases of the disorder. While the speech of individuals with psychosis has been observed to be normal at the level of segmental phonology (Chaika, 1974; Lecours & Vanier-Clement; Cutting, 1985), individuals with schizophrenia show consistent deficits in other areas (Covington et al., 2005, for a review), including impaired prosody (Clemmer, 1980; Spoerri, 1966), more simplified syntax (Morice & Ingram, 1982; Morice & McNicol,

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1985; Morice & NcNiol, 1986), disorganization in higher-order language goals (e.g. scripts and frames, plots; Rodriguez-Ferrera et al., 2001), and less coherent speech in general (Deese, 1978; Deese, 1984). Language disturbances in schizophrenia can be trait-like and stable over time, and can also be found in first-degree relatives of those with schizophrenia-spectrum disorders (Docherty et al., 2003).

Until recently, less attention has been paid to lexical characteristics (e.g. specific word types used) in the speech of individuals with schizophrenia, although three areas have shown promise: general speech rate and richness, and use of emotion words and pronouns. First, speech rate (words per second) predicts negative symptoms and can distinguish participants with flat affect (fewer words per second) from non-flat patients and non-clinical controls (Cohen et al., 2008; see also Hong et al. 2013). Disconnected speech also predicts socially inappropriate behavior, while verbal under-productivity predicts quality of life (Bowie, Gupta & Holshausen, 2011) and functioning (Bowie & Harvey, 2008). These relationships persist above and beyond the influence of cognitive, symptom, and demographic variables (Holshausen et al., 2014).

First, with regard to emotion words, Cohen et al (2009) found that individuals with schizophrenia with anhedonia use significantly more negative emotion words when describing positive events than non-clinical controls, though the combined sample of individuals with schizophrenia (regardless of presence or absence of anhedonia) appear to not differ from controls (St-Hilaire, Cohen & Docherty, 2008). This same pattern has been identified in individuals with schizotypy as well (Najolia et al., 2011). Secondly, several parts of speech involved in abstraction have been identified as indicators of cohesion (Graesser et al., 2004), cognitive complexity (Tausczik & Pennebaker, 2007) or metacognition (Buck et al., 2015). Social process words have been indicated as predictors of total symptoms and metacognition in schizophrenia as well (Minor et al., in press). Finally, individuals with schizophrenia show differences in use of pronouns, identifying referents non-verbally when possible and using pronouns without the support needed to identify their referents (Rochester & Martin, 1979), as well as frequently referring to themselves during prolonged speech (Hoffman et al., 1985).

While these findings have provided important insights, little work has been done to adapt these powerful lexical tools to better understand social cognition, a core cognitive process that underlie schizophrenia. Defined in an NIMH workshop as “the mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviors of others” (p. 1211; Green et al., 2008), social cognition has been demonstrated to be consistently impaired in individuals with schizophrenia (Penn et al., 1997; Savla et al., 2013). These deficits are separable from neurocognition and related to functional outcome in this population (Couture et al., 2006; Fett et al., 2011). One central goal in developing research in this area is identifying and distinguishing it from other related domains (Green et al., 2008), including metacognition (Lysaker et al., 2005). Recent work has utilized lexical techniques to distinguish between these two domains, and found that while the synthetic process of metacognition is primarily related to cognitive process words, the discrete process of social cognition appears to be negatively related to pronoun rate (Buck et al., 2015). One reason for this might be

difficulties in representing the mind of one's listener. For example, to use a pronoun correctly a speaker must represent the listener's understanding of the discourse topic in order to provide the information needed to identify the pronoun's referent (e.g. who exactly "she" represents in a sentence). At present, no research has characterized which social cognition variables these lexical variables might predict.

The present study will extend prior work by comparing the lexical characteristics of emotion narrative of individuals with schizophrenia to non-patient controls, and examine specific social cognitive domains these lexical variables predict. First, we will compare schizophrenia and control groups according to lexical variables of interest from previous work in this area: word counts, affective words, pronoun use, as well as social and cognitive process words, with the hypothesis that the groups will significantly differ in each of these areas (expecting higher values among controls for all except for pronoun categories). Second, it is hypothesized that use of pronouns, social words, and cognitive mechanism words will be related to social cognition. Third, an exploratory analysis will examine relationships between lexical characteristics and clinical and functional variables in the schizophrenia sample. Finally, one question related to the study of these lexical characteristics is the extent to which they distinguish between individuals with schizophrenia and controls in a continuous fashion (rather than being the result of clusters, subgroups or other confounding factors). Thus, an exploratory analysis will examine the extent to which the characteristics that significantly differ between groups can reliably predict group membership using a receiver-operating characteristic (or ROC) curve.

Methods

Participants

Participants meeting DSM-IV criteria for either schizophrenia or schizoaffective disorder were recruited from UNC Hospitals and community mental health facilities in the Raleigh-Durham region. Interviewers – all advanced graduate students and staff with experience working with a severe mental illness population – confirmed diagnosis by administering the Structured Clinical Interview for DSM-IV Patient Edition (SCID-P; First et al., 1996). In order to participate, individuals also had to report difficulties interacting with others per the Social Functioning Scale (Birchwood et al., 1990), as they were participating in a study evaluating the efficacy of social cognition and interaction training (SCIT), a 20–24 week psychosocial intervention targeting deficits in social cognition (Roberts et al., 2014). These assessments were collected at the baseline visit of the SCIT study.

Of 137 referred participants, 66 met screening criteria and were assigned to the study. Exclusion criteria included currently meeting criteria for a substance use disorder, being outside the age range of 25 to 60, or having an IQ < 80. Specifically the interview data were collected as a part of a psychometric validation study of the Narrative of Emotions Task (NET, Buck et al, 2014; a measure of the richness of content of emotional narratives) and have not been previously examined for their lexical characteristics. Because the emotional narrative interview was added to the protocol after the commencement of the SCIT study, the present study includes the subset of participants that completed the NET interview (n =

44). Because of interviewer error and resultant skipped items, two participants were excluded from the analyses (n = 42).

A control group consisting of fifty English-speaking non-psychiatric controls from the Raleigh-Durham area was recruited with flyers and Internet postings. All non-psychiatric controls were between the ages of 20 and 65 years old and reported no first-degree relatives with a psychotic disorder, bipolar disorder, or autism, nor did they meet criteria for substance dependence or low IQ (<80). Because of interviewer error resulting in skipped items, two participants were excluded from the analyses (n = 48).

Measures

Narrative of Emotions Task Interview—Participants were administered the interview of the Narrative of Emotions Task (NET; Buck et al., 2014). The NET consists of an interview prompting participants to define a range of simple (happy, afraid, angry, sad), complex (surprised, suspicious), and self-conscious (guilty, ashamed) emotions (following methods of Losh & Capps, 2006 and dichotomies of Stipek, Recchia & McClintic, 1992), as well as two non-emotional states (tired and sick). They were asked to define the emotion or state of being (e.g. “What does happy mean?”), provide a narrative account involving the emotion (e.g. “Tell me about a time when you felt happy.”), and explain why the described event elicited the target emotion (e.g. “Why did that make you feel happy?”). For all lexical analyses, only tasks that involved individuals narrating emotional events (and not those involving defining terms) were examined.

Lexical software—Linguistic Inquiry Word Count Software, 2007 Edition (LIWC; Tausczik & Pennebaker, 2010) is a computerized assessment tool of written language (Pennebaker, Booth & Francis, 2007). It totals relative frequency (as in a percentage) of various categories of words using a dictionary of over 4,000 words assigned to 83 categories. All variables from the LIWC (with the exception of word count and words per sentence) are reported as percentages of total words uttered. For the present study, we examined word count, words per sentence, pronoun use, emotion word use (i.e. words with an associated emotional valence, e.g. sweet, ugly, fearful, ecstatic), social process words (i.e. words related to interpersonal interactions, e.g. mate, husband, buddy, talk), and cognitive process words (i.e. words involved in distinguishing between abstract concepts and ideas, e.g. cause, know, ought, should, exclude) (Tausczik & Pennebaker, 2010 for a review). Word count and words per sentence were chosen, as they are indicators of general amount and complexity of uttered speech. Pronouns and type of pronouns were chosen as they draw upon individuals’ representation of others’ minds (as mentioned above) and because they provide information about focus of attention in speech (Tauscik & Pennebaker, 2010).

Emotion perception—Emotion perception was assessed using two related measures. The Face Emotion Identification Test (FEIT; Kerr & Neale, 1993) asks participants to identify the emotions expressed by 19 faces depicting six basic emotions (happy, sad, afraid, angry, surprised, and ashamed), and scores are totaled as number correct out of 19. The Face Emotion Discrimination Task (FEDT; Kerr & Neale, 1993) asks participants to determine whether two paired faces are expressing the same or different emotions out of a total of 30

pairs, with performance indexed as number correct out of 30. These two measures are significantly correlated with one another, $r = .43$, $p < .01$ and were combined using z-score transformation to provide an aggregate measure of emotion perception.

Theory of mind—Theory of Mind was assessed with two measures. In the Hinting Task (Corcoran et al., 1995) participants are asked to interpret ten brief written stories that require them to identify and make inferences involving others' mental states. Scores range from 0 to 20 on the Hinting Task, with higher scores indicating better performance. The Awareness of Social Inference Test - Social Inference (TASIT; McDonald et al., 2003) consists of Yes/No questions related to four video-taped social vignettes requiring individuals to infer individual motives which may contradict verbal communication (e.g., sarcasm or "white lies"). The TASIT is scored based on number of correct responses out of 60 possible. The TASIT and Hinting Tasks are significantly related to one another, $r = .39$, $p < .01$, and thus were combined to provide an aggregate estimate of theory of mind skills.

Attributional Style—The Ambiguous Intentions Hostility Questionnaire, Ambiguous Items (AIHQ, Combs et al., 2007) consists of five second-person vignettes of negative social situations with ambiguous causal circumstances (e.g., "you are walking by a group of young people who laugh as you pass by"). Participants rate the following on Likert scales: the level of intention on the other's part, how angry it would make them feel, and how much they would blame the other. These are standardized and totaled for an overall "blame index." Following the interview, two independent raters compute a hostility bias related to interpretation of the other's action (a five point Likert scale) and an aggression bias related to the individual's response to the action.

Social functioning—The Social Skills Performance Assessment (SSPA; Patterson et al., 2001) is an observer-rated assessment of social skill performance in two three-minute role-play conversations with a confederate. Scores range from 1 to 5 on each subscale, with higher scores indicating better performance. Items assess a range of social skill domains, including speech fluency, clarity, interest, focus, affect, and social appropriateness. An overall total score from the combined performance on both role-plays was calculated for the present analysis.

Role functioning—The Role Functioning Scale (RFS; McPheeters, 1984) is an interviewer-rated assessment of functioning based on a semi-structured interview covering four domains: independent living, work performance, as well as immediate and extended work social relationships. Scores on this scale range from 1 to 7, with higher scores indicating better functioning.

Psychiatric symptoms—The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) is an interview-based measure comprised of 30 items assessing for positive and negative symptoms of schizophrenia, as well as general psychopathology symptoms. Interviews were completed by graduate students or trained staff with experience working with a schizophrenia-spectrum population.

Procedure

Advanced graduate students and staff with experience working with this population conducted all interviews comprising NET, social cognition, and functioning measures, which were completed at the baseline visit of the SCIT study. All interviewers were trained to a level of ICC > .70 against a gold-standard rater criterion. NET interviews were recorded and later transcribed. Transcribers were undergraduate research assistants from the University of North Carolina at Chapel Hill. For training, transcribers were given practice transcripts and were informed about their errors. As sentence separation is not inherently clear from spoken language, reliability in the words per sentence variable was examined across transcribers. Overall ICC = .967 from a random sample of six NET transcripts. Responses to initial definition questions were removed, as well as all interviewer speech, leaving a transcript that included the verbatim speech of individuals sharing 10 narratives related to various emotions or bodily states (mentioned above). These transcripts were examined and formatted for processing by the Language Inquiry Word Count Software, 2007 Edition (LIWC; Tausczik & Pennebaker, 2010).

Data analytic plan—Independent samples *t*-tests were used to compare groups across the LIWC categories (two-tailed, as these are non-directional hypotheses) and simple Pearson correlations were used to examine the relationships between linguistic variables and each hypothesized corresponding variable. Specifically, all pronoun categories and affect words were correlated with the social cognition measures in the combined sample. Relationships to social cognition were examined in the combined sample as these variables are hypothesized to be continuous in both populations and indicative of the cognitive and clinical deficits relevant to a diagnosis of schizophrenia. This avoids methodological problems that may arise when continuous variables are treated as categorical as in a median split (MacCallum et al., 2002). The present study will report the correlations in each sample as well as the combined samples in order better grasp the relationships across clinical groups between these variables (particularly in light of the fact both lexical characteristics and social cognition differentiate schizophrenia and control groups). Also, in the current sample symptom and functioning measures were collected only on individuals with schizophrenia. Thus, affect words and word counts were correlated with clinical and functional measures in the clinical sample only.

Finally, a receiver operating characteristic (ROC) area under the curve (AUC) was examined to determine the effectiveness of significantly differing measures at distinguishing between the clinical and non-clinical groups. To account for the high number of analyses, only characteristics significant at $p < .01$ were examined in the ROC curve analyses.

Results

Demographic differences

The control sample had a higher mean of years in school (M = 13.43, SD = 1.16) than the schizophrenia sample (M = 12.24, SD = 1.34), $t = 4.49$, $p < .001$. In addition, there were significant differences between the groups with regard to marital status (chi square = 25.05, $p < .001$). Finally, the control group demonstrated significantly higher performance on the

WASI-2 (M = 110.94, SD = 15.04) than the schizophrenia group (M = 100.36, SD = 15.54). To account for the differences related to general intelligence, all analyses were repeated controlling for the influence of WASI. The groups did not differ with regards to gender, race or age.

Lexical variables

Results of all independent samples *t*-tests can be found in Table 1. There was a wide range of word totals available for LIWC analysis in both the schizophrenia (range = 1,899, minimum = 227, maximum = 2,126) and control groups (range = 1,299, minimum = 241, maximum = 1,540). The two groups significantly differed in words per sentence, $t = 5.87$, $p < .001$, and overall pronoun use, $t = 5.31$, $p < .001$. Controls used more words per sentence, while individuals with schizophrenia demonstrated a higher frequency of pronouns. Specific group differences in pronoun use were highest for first-person singular pronouns. In particular, individuals with schizophrenia used significantly more personal pronouns ($t = 3.68$, $p < .01$), and more first-person singular pronouns ($t = 3.73$, $p < .01$). There were no significant differences between the groups in other pronoun categories (first person plural, second person, third-person singular, third-person plural, and impersonal pronouns).

There were no significant differences between the groups in positive or negative emotion words overall as well as with regard to the use of these words in positive, negative, and neutral emotional contexts, or any interactions between item type and lexical category. The significant analyses (WPS, pronouns, personal pronouns, and first-person singular) were repeated controlling for WASI performance (ANCOVA), and all remained statistically significant.

Relationships with social cognition

Pronouns and emotion words—These correlations can be found in Table 2. Greater rate of pronouns (and specifically personal pronouns and first-person singular pronouns) were associated with poorer theory of mind ability and an increase of hostile or aggressive attributional style as measured by the AIHQ total. Positive emotion words showed no relationship with any of the social cognition variables. Greater use of negative emotion words, however, was correlated with poorer theory of mind and greater hostile or aggressive attributional style. Analyses were repeated after controlling for the influence of WASI: The relationships of AIHQ with personal pronouns ($r = .19$, $p = .07$) and first person singular pronouns ($r = .19$, $p = .07$) were reduced to trend level and the relationship of personal pronouns to theory of mind score was no longer statistically significant ($r = -.12$, $p = .27$). All other significant correlations remained significant.

When examining each of these correlations separately for the schizophrenia and control groups, there were slightly different patterns in the relationships between language and social cognition. In the schizophrenia group, only the use of first-person singular pronouns predicted theory of mind abilities ($r = .34$, $p = .03$), while all other relationships were not statistically significant. In the control group, emotion perception composite was significantly related to second-person pronouns ($r = -.30$, $p = .046$) while theory of mind was significantly predicted by negative emotion words ($r = .43$, $p = .003$) and use of first person

pronouns (r = −.44, p = .002). These correlations were re-examined controlling for WASI score, and all remained significant.

Relationships with clinical and functional variables in patient group

Words per sentence and word count—These correlations can be found in Table 3. Words per sentence showed only a trend-level relationship to negative symptoms, and no significant relationships with any other psychiatric symptoms; however, greater words per sentence predicted greater overall role functioning and at better performance on the social skills role-play. Overall word count was related to negative symptoms, as fewer words per sentence were associated with negative symptoms. Analyses were repeated after controlling for the influence of WASI, and the relationships of word count to negative symptoms (r = −.19, p = .28) and words per sentence with SSPA total (r = .11, p = .52) were no longer statistically significant. The relationship of WPS to overall role functioning remained highly significant, r = .42, p = .01.

Emotion words—Positive emotion words showed no significant relationships with any symptom of functioning variables. Negative emotion word use showed a trend-level negative relationship with SSPA performance. These correlations can be found in Table 3.

Prediction of group membership

To examine which lexical characteristics predict group membership, receiver operating characteristic curves were examined on variables that distinguished the groups at $p < .001$ (i.e., overall pronoun frequency and words per sentence). The area under the curve in predicting group membership was .823 ($p < .001$) for words per sentence and .790 ($p < .001$) for pronoun use, indicating acceptable to good sensitivity and specificity in identifying individuals with schizophrenia and non-clinical controls using these lexical characteristics. To provide a comparison point of reference in this analysis, other social cognitive domains of interest for this population were included as predictors of group membership, including AIHQ total (AUC = .663, p = .010) and an aggregate measure of social cognition[1] (AUC = .741, $p < .001$), as well as overall word count. Overall word count did not successfully distinguish the groups (AUC = .552, p = .40).

Discussion

The present study examined the lexical characteristics of the emotional narratives of individuals with schizophrenia in order to characterize differences in language use from non-patient controls and examine correlates with these lexical differences. Generally, results suggest that lexical characteristics are related to some domains of social cognition, predict functional outcome, and may be useful in distinguishing between individuals with schizophrenia and non-clinical controls.

[1]AIHQ was separated from emotion perception composite and theory of mind composite in this analysis consistent with Mancuso et al. (2011) and Buck et al. (Unpublished manuscript, currently under review) that suggest attributional style constitutes a separable factor from right-or-wrong measures of social cognition like emotion perception and theory of mind measures.

The differences between the groups in lexical characteristics are consistent with a number of studies indicating that individuals with schizophrenia differ from controls with regard to their communication and use of language (Covington et al., 2005). However, the present study showed no evidence that individuals with schizophrenia differ from controls in their use of a greater number of negative emotion words (Cohen et al., 2009). Instead, groups differed with regard to the number of words used per sentence (though they use approximately the same number of words overall) as well as higher use of pronouns, and in particular first-person singular pronouns. Importantly, these differences remained even after controlling for general neurocognition.

It was hypothesized that because pronoun use involves the use of representation of others' minds (e.g. knowledge of if the listener knows to whom one is referring) that these variables would be related to social cognition. This hypothesis was supported when examining the relationships of these variables across groups, as greater use of pronouns, personal pronouns, and specifically first-person pronouns predicted impaired theory of mind and an increase in hostile or aggressive attribution bias. Increased use of negative emotion words was also significantly related to theory of mind impairment and attributional biases. These relationships were not fully explained by general differences in neurocognition. However, when examining within each group, fewer relationships remained significant, suggesting that social cognition and lexical characteristics may both distinguish controls from patients yet may be less effective in indicating social cognition impairments within a clinical group.

Overall word count predicted negative symptoms, but this relationship was attenuated when controlling for neurocognition. Notably, words per sentence was a strong indicator of real world functional outcome and a trend level predictor of better performance in a social skills role-play. This is generally consistent with prior research that rate of speech is an important lexical characteristic, but diverges from prior work suggesting that it is indicative of negative symptoms. Instead, the present results suggest that the tendency to use more complex sentences when sharing emotional narrative may be associated with functioning in vocational and social settings.

Finally, words per sentence and overall pronoun rate effectively identified group membership in most participants. Overall, this pattern suggests that linguistic characteristics have promise as sensitive and specific indicators of diagnostic status. These characteristics distinguished between groups at comparable levels to oft-studied cognitive variables (e.g. social cognition and overall neurocognition).

The current study is limited by the nature of the task and the sample size. First, this task required individuals to provide brief narrative episodes with minimal prompting. Eliciting multiple narratives in each emotional context would generate more data upon which more stable conclusions could be drawn. Second, it is an interactive task, as a research assistant interviewed participants. It is impossible at present to differentiate general lexical characteristics from lexical characteristics in the context of interaction with another person. Third, the task is one specifically focused on emotional narratives, and thus it is likely contextual cues inflate frequency of affective words. While each group was administered an identical protocol, this does not affect inferences based on group comparisons, but should

caution generalizing mean values beyond the present study. Future research should examine if these characteristics are specific to narratives, emotional narratives, or dyadic interaction. For example, it could also be the case that these relationships are driven by a shared factor of negative affect, as previous work has suggested a relationship between depressive symptoms and self-focused attention (Sloan, 2005).

Conclusions

The present study could be instrumental in developing a cognitive model of lexical differences in schizophrenia. Specifically, it appears that increased rate of pronoun use in emotional narrative is related to social cognition impairments and biases, while overall words per sentence is a strong indicator of real-world functioning. Future research should continue to examine these lexical characteristics, in other language contexts and other similar populations (e.g. those in prodromal period or at risk). First, this work provides partial insight into specific ways in which cognitive impairments might lead to poor outcomes. Second, these language measurements may provide easy-to-use and sensitive examinations of clinical domains, and thus should be further examined for use in clinical settings. Continued use of computerized language measurement could provide both theoretical and measurement tool advancements in the understanding of the cognition underlying schizophrenia.

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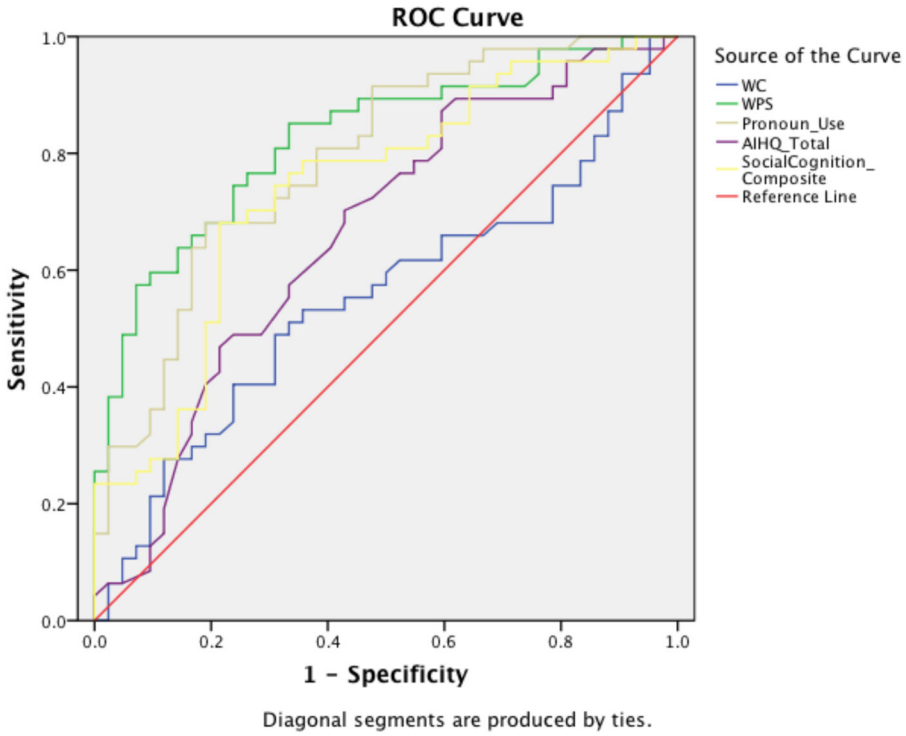

Figure 1.

Receiver operating characteristic (ROC) curve using overall lexical score to predict group membership (non-clinical control or schizophrenia-diagnosed participant), using words per sentence, pronoun use, overall word count, and the comparison measures of social cognition: AIHQ total and social cognition composite.

Table 1

Independent samples *t*-tests on language variables.

	Group			
	SCZ (n = 42)	**CTRL (n = 48)**	***t***	***p***
Word counts				
Word count	599.33 (327.90)	647.52 (319.92)	−0.71	.48
Words per sentence (WPS)	13.27 (4.31)	21.90 (8.62)	**−5.87**	**.00*****
Affect words				
Positive emotion words (%)	2.54 (1.11)	2.66 (0.88)	−0.61	.54
Negative emotion words (%)	3.20 (1.31)	2.80 (1.06)	1.62	.11
Pronoun use				
Pronouns total (%)	23.71 (2.58)	20.99 (2.28)	**5.31**	**.00*****
Personal pronouns (%)	17.18 (2.90)	15.10 (2.47)	**3.68**	**.00*****
First-person singular (%)	12.96 (2.56)	10.97 (2.50)	**3.73**	**.00*****
First-person plural (%)	0.45 (0.46)	0.63 (0.90)	−1.19	.23
Second-person (%)	0.95 (0.97)	0.81 (0.82)	0.77	.44
Third-person singular (%)	1.94 (1.19)	1.67 (1.24)	1.03	.31
Third-person plural (%)	0.88 (0.80)	1.02 (0.72)	−0.87	.39
Impersonal pronouns (%)	6.53 (1.62)	5.89 (1.48)	1.96	.05^
Content categories				
Social processes (%)	8.51 (2.63)	7.82 (2.36)	1.31	.20
Cognitive processes (%)	19.90 (2.60)	19.48 (2.00)	0.87	.39

^ $p < .10$;

* $p < 0.05$;

** $p < 0.01$;

*** $p < .001$

All percentages are percentages of total word spoken in entire interview.

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Table 2

Pearson correlations of LIWC pronoun and affect categories with measures of social cognition in the schizophrenia (n = 47) and control (n = 42) groups, as well as the full sample (n = 90).

\	EP Composite			ToM Composite			AIHQ Total		
	Scz	**Con**	**Full**	**Scz**	**Con**	**Full**	**Scz**	**Con**	**Full**
Affect words									
Positive emotion words (%)	−.11	.12	.00	−.19	.28^	.05	−.16	−.16	−.18
Negative emotion words (%)	−.04	−.00	−.06	−.11	**−.43***	**−.30****	.21	.19	**.24***
Pronoun use									
Pronouns total (%)	.06	−.03	−.10	−.02	−.23	**−.33****	.19	.05	**.25***
Personal pronouns (%)	.08	.05	−.03	−.00	−.20	**−.25***	.18	.06	**.22***
First-person singular (%)	.01	.00	−.08	−.16	**−.44***	**−.41*****	.21	.06	**.22***
First-person plural (%)	−.03	.18	.12	.03	.23	.20	.06	−.03	−.04
Second person (%)	−.04	**−.29***	−.16	−.01	−.01	−.05	−.12	−.12	−.09
Third-person singular (%)	.16	.21	.08	**.34***	.21	.17	.04	.20	.15
Third-person plural (%)	.05	.27^	.12	−.03	.27^	.13	.03	−.10	−.05
Impersonal pronouns (%)	−.04	−.04	−.12	−.03	−.04	−.12	−.01	−.03	.04

^ p <.10;

* p < 0.05;

** p < 0.01;

*** p <.001

Emotion Perception Composite = Z-transformed sum of performance on Face Emotion Identification Task (FEIT) and Face Emotion Discrimination Task (FEDT). Theory of Mind Composite = Z-transformed sum of performance on Hinting Task and TASIT (The Awareness of Social Inferences Test) – Social Minimal Subscale. When controlling for overall word count, all significant correlations remained significant.

Table 3

Pearson correlations of LIWC word count totals and affect words with measures of symptoms and functioning in schizophrenia sample (n = 42).

	Symptoms			Functioning		
	PANSS Positive	**PANSS Negative**	**PANSS General**	**SSPA Total**	**RFS Total**	**GSFS Total**
Word counts						
Word count	−.04	**−.31***	−.15	.25	.26	−.06
Words per sentence	−.01	−.27^	−.03	**.31***	**.46****	−.02
Affect words						
Positive emotion	.17	−.12	−.10	−.20	−.26	−.21
Negative emotion	.10	.24	.17	−.27^	−.04	.18

^ p <.10;

* p < 0.05;

** p < 0.01;

*** p <.001

PANSS = Positive and Negative Syndrome Scale; SSPA = Social Skills Performance Assessment, RFS = Role Functioning Scale, GSFS = Global Social Functioning Scale. When controlling for overall word count, the relationship between WPS and RFS total remained significant, $r = .37$, $p = .02$.

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