

Exploring the Intricacies of Linguistic Abilities in Spontaneous Speech Production Across Schizophrenia Spectrum, Bipolar and Major Depressive Disorders: A Network Analysis Approach

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INTRODUCTION

Language impairments are frequently observed in affective and psychotic disorders, but their specific patterns and underlying mechanisms are not yet fully understood. A transdiagnostic perspective offers an opportunity to identify shared and unique language-related alterations across diagnostic boundaries. To investigate this, natural language processing provides a cutting-edge, objective, and sensitive approach for analyzing language impairments on various linguistic levels. A network analysis approach is particularly well-suited for this purpose, as it captures complex cognitive, interactions between linguistic, and variables, psychopathological enabling deeper understanding of their interrelationships.

Fig. 1 Network plot: shows the domain-specific and cross-domain network connections (with 1,000 permutations, nonparametric bootstrapping); blue = positive correlation, red = negative correlation; thickness = weight of connection.





Psychopathology 29: SANS nFTD

METHODS

We included **N=372** participants (*n*=119 MDD, *n*=27 bipolar disorder, n=48 SSD and n=178 HC). Three dimensions were examined: (1) latent linguistic features (LLP), (2) psychopathology, (3) language-related and cognitive functions. Spontaneous speech was assessed using four pictures of the Thematic Apperception Test. Each participant provided approximately 12 minutes of spontaneous speech, from which various linguistic features (LLPs) were extracted using large natural language processing (NLP) models. LLPs encompassed a wide range of linguistic These markers across various linguistic levels. A variety of features were used to evaluate lexical diversity, syntactic complexity, semantic coherence, and speech disfluencies, including among others, type-token ratio (TTR), mean length of utterance (MLU), noun-verb ratio (NVR), and syntactic complexity (SynC) and diversity (SynD). Advanced network analysis was used to investigate transdiagnostic **networks** of different linguistic features, psychopathology and cognition.

30: SANS sum 3: Adverb ratio 31: SAPS pFTD 4: Auxiliary ratio 32: SAPS sum 5: Coordinating conjunction ratio 33: HAMD sum 6: Determiner ratio 34: HAMA sum • 7: Interjection ratio 35: YMRS sum 36: GAF 8: Noun ratio 9: Particle ratio 37: TLI Impoverished IO: Pronoun ratio 38: TLI Disorganization 11: Proper noun ratio 12: Subordinating conjunction ratio Cognition 13: Verb ratio 39: Semantic VF • 14: Filled pause ratio 40: Lexical VF I5: Noun-verb-ratio • 41: Alternating VF 16: Open-closed-ratio 42: Verbal episodic memory 17: Type-token-ratio 43: Recognition 18: Root overlap 44: Executive functioning • 19: Mean length of utterance 20: Simple sentence ratio • 21: Syntactic complexity 22: Syntactic diversity • 23: Mean dependance distance 24: Similarity mean (FastText) 25: Coherence mean (BERT) 26: Coherence mean (BioLord) • 27: Hohenheimer index

28: Probability negative

Fig. 2 Centrality plot: shows the centrality measures of the estimated network; betweenness = measures the extent to which a node lies on the shortest paths between others; closeness = reflects how quickly information spreads from a given node to others; strength = indicates the overall level of connectivity/influence a node has in the network; expected influence = combines edge weights and network structure to estimate a node's potential impact on the network.

RESULTS

Network analyses indicated varying degrees of domainspecific and cross-domain network connections. LLPs, such as TTR, NVR, and coherence mean, played a central role in the network structure. Psychopathological measures formed a cohesive cluster, while TLI Impoverished and semantic coherence acted as bridging variables, linking all domains. Executive dysfunction emerged as central link between cognitive and linguistic impairments, highlighting its crucial role in psychiatric symptomatology. Syntax measures, such as MLU and syntactic complexity emerged as key integrators, underscoring the interconnected nature linguistic, cognitive, and clinical features in a Of transdiagnostic framework.



Summary of Network

Number of nodes	Number of non-zero edges	Sparsity
44	288/946	0.6956

CONCLUSION

Our study highlights the interconnectedness of linguistic, cognitive, and psychopathological features within a transdiagnostic framework, emphasizing the need for a network-based, dimensional approach to mental disorders.

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