Computational analyses of linguistic features with schizophrenic and autistic traits along with formal thought disorder

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0. Summary

Motivation: formal thought disorders (FTD), common symptoms in ASD/Schizophrenia, well-known but why/how?

Objective:

- find how schizotypal/autistic-traits correlated
- find suitable FTD elicitation conditions

Method: correlation analysis and regression analysis

Result:

- Schizotypal/autistic-traits are correlated along with FTD axis
- Long speech about negative memories is better elicitation
- Embedding/content-word features are symptom-specific

Dataset/code available at
https://sites.google.com/view/sagatake/resource

1. Formal Thought Disorder (FTD)

Symptoms in cognition affecting to language, thought content

- Disorder of form (disorganization), not content (delusion)
- One of Schizophrenia(SZ)'s main symptoms
- Observed in other mental/developmental disorders, e.g., ASD

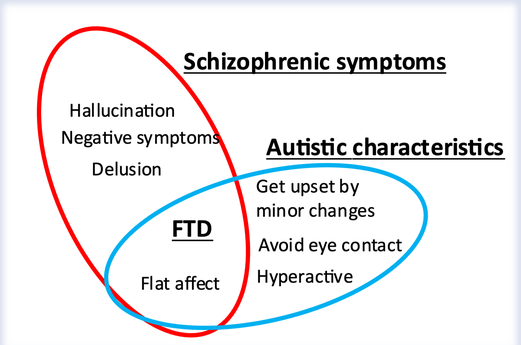
Negative thought disorder

Poverty of speech, etc.

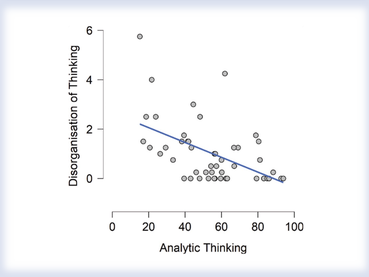
Positive thought disorder

Derailment, Illogicality, etc.

D. A. Trevisan et al., "Autism spectrum diorder and schizophrenia are better differentiated by positive symptoms than negative symptoms", frontiers in psychiatry, 2020

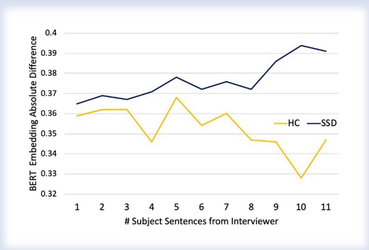


2. Related work: FTD-related estimation



Silva et al. 2021

- 1 min. picture-description task
- CDI (combination of part of speech) correlated with FTD severity



Tang et al. 2021

- 12 min. interview
- SZ's sent. embed. distance increased with #responses to a question

Difficult to compare effectiveness due to different speech durations and tasks

3. Data collection

Method: Audio + crowd-sourcing + questionnaire

Participant: 54 people from general population

Procedure: talk about a given theme for 30, 60, 180 seconds

- "Recent dream" or "favorite thing"
- "Negative memory"
- "Biggest mistake"

Questionnaires (partial):

- Schizotypal Personality Questionnaire (SPQ) for SZ-trait
  > Subscale: "Odd speech" related to FTDs
- 2nd edition of Social Responsiveness Scale (SRS2) for ASD-trait

4. Between questionnaire correlation (Q1)

Spearman correlation

	SPQ	OddSpeech	SRS
SPQ	1.00	0.28	0.01
OddSpeech		1.00	0.32

Results

a) SPQ didn't correlate with SRS
b) OddSpeech correlated with both of SRS and SPQ

OddSpeech (≅FTD) seems a bridge between SPQ and SRS

5-0. Prediction method and input features

Model: PLS regression, selected to eliminate multi-collinearity

Cross validation:

- Outer loop: leave-one-participant-out, for individuality effect
- Inner loop: 5-fold, to optimize #component, from 1 to 10

Feature groups:

- **Embedding** : BERT sent. diff. /cosine, content-word cosine
- **Content word** : ratio of content words (noun, verb, etc.)
- **Function word** : ratio of function words (pronoun, etc.)
- **Abstract** : ratio of content word, CDI-J, negation freq.
- **Temporal** : word per minute, punctuation ratio

Evaluation: Spearman's correl. with true scores and predictions

5-1. Task comparison (Q2)

Spearman true-pred correlation

	SPQ	OddSpeech	SRS
Dream	0.01 → -0.24	-0.24 → -0.24	0.34* → -0.54*
Favorite	-0.42* → -0.35*	-0.24* → -0.14	-0.25* → -0.27*
Negative	0.23* → 0.22*	0.20* → 0.26*	0.25* → 0.22*
Mistake	0.05 → -0.07	0.08* → 0.18*	0.30 → 0.15

Negative memory works well

- Minor et al. showed positive FTD symptoms are associated with affective systems in brain
- **"Negative" induce FTD more**

K. S. Minor et al., "Affective systems induce formal thought disorder in early-stage psychosis", Journal of Abnormal Psychology, 2016

5-2. Duration comparison (Q3)

30 sec
60 sec
180 sec

Spearman true-pred correlation

	30sec.	60sec.	180sec.
SPQ	0.01 → 0.08	0.21 → 0.20	0.15 → 0.06
OddSpeech	0.15 → 0.17	0.20 → 0.21	0.23 → 0.37*
SRS	0.27 → 0.30	0.36* → 0.07	0.24 → 0.19

divided 180 sec. speech into 0-60, 60-120, 120-180

0-60 | 60-120 | 120-180

Spearman true-pred correlation

	0-60sec.	60-120sec.	120-180sec.
SPQ	-0.15 → 0.09	0.00 → -0.02	0.24 → 0.20
OddSpeech	-0.08 → 0.03	0.07 → 0.14	0.37* → 0.40*
SRS	0.33* → 0.36*	0.02 → 0.02	0.28 → 0.27

OddSpeech performance increase as speech goes latter part

- Not because of algorithms but how long participants speak

5-3. Ablation study (Q4)

Feature-set effect

	SPQ	OddSpeech	SRS
full	0.23* → 0.18*	0.2* → 0.21*	0.26* → 0.25*
w/o embed.	0.23* → 0.12	0.22* → 0.19*	0.17* → 0.24*
w/o cont.	0.22* → 0.17*	0.23* → 0.23*	0.23* → 0.18
w/o func.	0.13 → 0.09	0.05 → 0.04	0.18 → 0.09
w/o abst.	0.21* → 0.19*	0.2* → 0.24*	0.28* → 0.19*
w/o temp.	0.24* → 0.19*	0.21* → 0.17*	0.28* → 0.28*

SPQ (SZ)

- Function-word and embedding

SRS (ASD)

- Function-word and content-word

OddSpeech (FTD)

- Function-word and temporal

Common: function word, FTD-specific: temporal

TAPAS SUPPORTED BY ANR-CREST