Speech Analysis Software for Psychiatric Research
The Case of D-Level Rater

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COMPUTER ANALYSIS OF SPEECH FOR PSYCHIATRIC RESEARCH

Overview

Changes in speech can reflect a variety of cognitive impairments. Analysis of speech samples is therefore an indispensable part of psychiatric research.

With the advancement of computational linguistics, we are far past the stage of manually counting the linguistic features of interest to psychiatrists; in fact, we are able to compute within a reasonable amount of time many measures much more complicated than the traditional measures like sentence length, word length and type-token-related counts.

The University of Georgia CASPR Project is developing a battery of speech analysis software for psychiatric research, targeting various linguistic deviances associated with psychiatric conditions such as schizophrenia.

Computer-assisted vs. manual speech analysis

	Computer-assisted analysis	Manual analysis
Expertise	Little linguistic knowledge or computer expertise required	Professional training in linguistics required
Complexity	Designed by software developers to be easy for the end user	Laborious and complicated procedures for analysis, counting, and computing
Time	Seconds to minutes	Hours
Objectivity	Objective, computer cannot be influenced by expectations	Subjectivity involved with any human rater
Replicability	Always same output with same input	Exact replication of results is seldom possible

D-Level Rater

Background

The D-Level Scale (Developmental-Level Scale) (Rosenberg and Abbeduto 1987) is a syntactic complexity scale based on child language acquisition patterns. The most complex sentence types are those that children acquire last.

D-Level was used in the Nun Study to experimentally demonstrate the relationship between early low syntactic complexity and later development of Alzheimer's (Snowdon et al., 1996),

The D-Level Scale has been proven suitable as a syntactic complexity scale for psychiatric research. We have refined it based on linguistic evidence (Covington et al. 2006).

Implementation

CASPR's D-Level Rater relies on **parsing** (syntactic analysis) followed by **analysis of parser output.** Sentences are parsed by either the Stanford Parser (Klein and Manning 2002) or the OpenNLP Parser (Baldridge and Morton 2004). The D-Level rater automates the demanding and tedious process of rating each sentence in the text input as well as computing the frequencies of various grammatical structures.

This is separate from the D-Level measurement software developed by Voss (2005), which does not rely on a separate parser.

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D-Level Scale
(Covington et al. 2006)

Level

0 Simple sentence
The dog barked.

1 Non-finite object clause without overt subject
Try to brush her hair.

2 Coordinate structure
John and Mary left.

3 Finite object clause, object with clausal modifier, etc.
John knew that Mary was angry.

4 Small (nonfinite) clause as object, etc.
I want it done today.

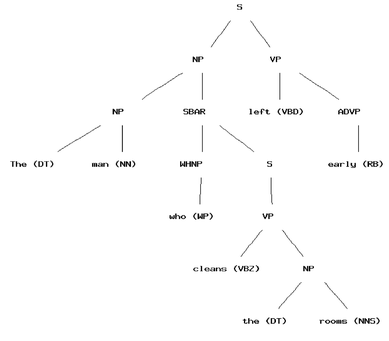
5 Finite or non-finite adjunct clause
They will play if it does not rain.

6 Clausal subject
The man who cleans the room left early.

7 More than one structure of levels 1-6
John decided to leave when he was told the truth.

Sample of parser output (Stanford Parser)

Sentence: **"The man who cleans the room left early."**
Level 6, clausal subject = SBAR in NP hanging from S



Schizophrenia Experiment

Experiment

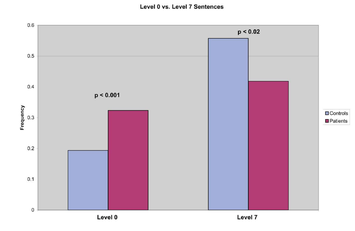
12 controls and 11 patients were recruited for the experiment at the University of British Columbia. All patients had a diagnosis of schizophrenia according to DSM-IV criteria and were stable outpatients with no recent changes to their medication. Controls were screened for a history of psychiatric illness, and all subjects were screened for a history of head injury, neurological disorder and substance abuse. Both the controls and the patients were right-handed native Canadian English speakers with no history of head injury or neurological disorder. Groups were matched for age, IQ as measured with the National Adult Reading Test (Nelson, 1982) and Quick Test (Ammons and Ammons, 1962), and parental socioeconomic status (Hollingshead Index, Hollingshead and Redlich, 1958).

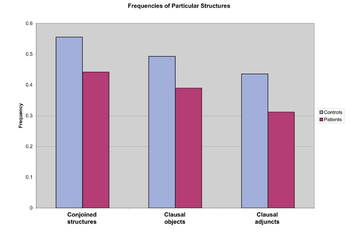
All the subjects were recorded describing pictures from the Thematic Apperception Test (TAT; Murray, 1971) using the administration procedure outlined in Liddle et al. (2002). These recordings were transcribed by typists unaware of each subject's psychiatric status. The transcripts were input into CASPR's D-Level Rater. After each sentence was rated, the frequency of each complexity level was computed for the transcripts.

Results

An unpaired two-tailed *t*-test was done on the rating results from the patients and the controls. Results show a significant increase in the patients' use of level-0 simple sentences ($p<0.001$) and a marked decrease in level-7 sentences ($p<0.02$).

Since Level 7 is a label that wraps around sentences with substructures at multiple D-Levels, D-Level Rater also provides the option to look into the frequency of substructures as defined for Level 1 to Level 6 sentences. Such analysis shows that in our experiment, increased syntactic complexity is mainly due to the fact that the controls use conjoined structures, clauses in objects and adjunct clauses more often than the schizophrenic patients.





Discussion

The lowered sentence complexity found in the Nun Study for Alzheimer's patients is replicated in schizophrenic patients. Results by CASPR's D-Level Rater in this experiment conform to manual analysis of sentence complexity in similar schizophrenia studies (e.g. Morice and Ingram 1982, DeLisi 2001). CASPR's speech analysis software is not only fast and easy-to-use, but it provides the possibility of discovering significant psycholinguistics features that elude traditional manual counting.

Future Work

CASPR is an ongoing project to develop new types of speech analysis software with more functionality and increased precision. Besides the D-Level rater, CASPR is also developing analytical software at phonetic, lexical, semantic, and discourse levels, which will benefit language related psychiatric research in various areas.

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