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# Graph-based measurements of the decline of syntactic complexity in speakers with dementia.

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**Introduction** Speakers with aphasia caused by Azheimer's Disease (AD) sometimes produce shorter sentences with less embeddings than non-brain-damaged speakers. There are many ways to measure this decline of syntactic complexity: simple ones like utterance length (MLU), or complex tree-based ones like counting complex syntactic structures (number of embedded clauses, etc.) and computing the depth of parsed syntactic trees (Yngve depth, etc.). Tree-based features require elaborate syntactic structures (deep parses). We present a representation that allows predictions based on only part-of-speech tags (shallow parses), expressed in a graph structure.

**Ex.** *Und eh laut eh dirigieren kann sie auch durch mehrere eh eh Räume* ("she can even give loud directions through several rooms")

## Word counting complexity measures

Represent length in morphemes, words, clauses.

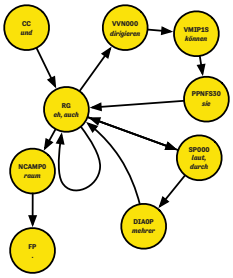
Require rudimentary parsing.

## Graph-based complexity measures

Represent adjacency of part-of-speech tags.

Performance does not degrade.

Require "shallow" parsing



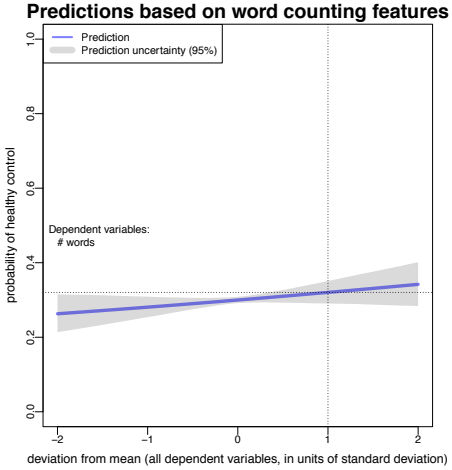

## Tree-based complexity measures

Classic syntactic trees.

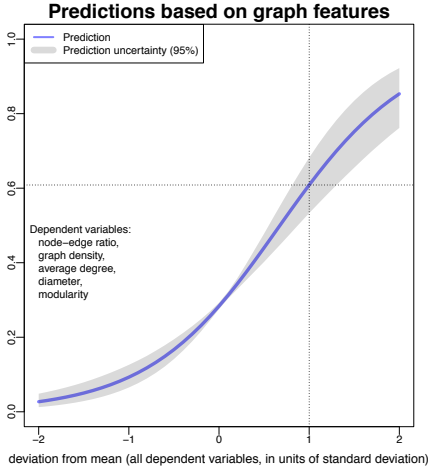
Performance degrades quickly when applied to spontaneous pathological speech, which is irregular and atypical.

Require "deep" parsing.

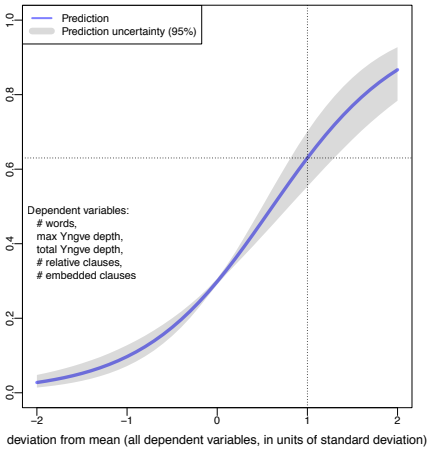
**Predictions based on word counting features**




**Predictions based on graph features**




**Predictions based on tree features**




**Methods & participants** We used speech data from 9 spontaneous conversations per speaker (duration=5m47s ±2m30s) spread over three different moments in time. Participants were NBD speakers (n=7) and AD speakers (n=9). The speech was automatically parsed using the Stanford Parser (Rafferty & Manning 2008) to generate tree features. Graph-based complexity measures were computed using the freeling POStagger and custom code for graph measures.

**Results** The counterfactual plots show that graph features predict a stronger relation than word counting features, and predicts similar to a model trained on tree features. Out-of-sample predictions are not very accurate for either of the three models alone:

| | Area under Curve |
|---|---|
| Word counting | 0.53 |
| Graph features | 0.57 |
| Tree features | 0.56 |

*Table 1: Performance of the models in isolation.*

**Conclusion** Graph-based measures require minimal linguistic preprocessing, but make stronger predictions than sentence length measures. They may be used if automatic parsing is unavailable or if the parsed sentences are highly irregular.

## References

Rangel, F., Rosso, P. (2016). *On the impact of emotions on author profiling*. Inf. Process. Manag. 52

Rafferty, Manning. (2008). *Parsing Three German Treebanks*, ACL Workshop on Parsing German.

https://goo.gl/G6HNMa (poster + data)