Automated Idea Density Measure for Discourse in Aphasia

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Objective

This project presents **a newly-implemented version of the automated measure for idea density in discourse** using CLAN[1].

CLAN's density measure is based on the rules used for CPIDR 3.2[2], which replicated Turner and Green's[3] rules for extracting propositions from text, based on Kintsch[4].

Using this new measure, we **replicated and extended the research** that used CPIDR to measure idea density in aphasia. [5,6]

Idea = proposition or assertion, usually corresponds to:
- verbs, adjectives, adverbs, prepositions, conjunctions, possessive pronouns, interrogatives/relatives, negatives

Examples:

We have bread.	1 idea
Luckily, we have bread.	2 ideas
Luckily, we have fresh bread to use for the sandwich.	5 ideas

Proposition density (PD) = # of ideas ÷ # of words

Low PD = noun-y style
High PD = lots of description, comparisons, and qualifiers

Background

Proposition density in oral discourse is:
- significantly reduced in aphasia discourse [5,6]
- significantly reduced in cases of TBI [7]
- significantly lower in probable AD than MCI and normal elderly[8]
- not significantly different in MCI and healthy elderly [8,9]
- not correlated with age, gender, or education in elderly with and without dementia[8]
- reliable for test-retest in elderly with and without dementia[8]

The CLAN density measure:
- runs on both Windows and MacIntosh computers
- can be downloaded freely from the web
- is slightly more accurate than CPIDR (correlation = .99)

Research Questions

With a large sample of PWA and 2 different types of discourse tasks – narrative and procedural:

1. Do PWA differ significantly from controls in proposition density (PD)?
2. Does PD correlate with severity of aphasia?
3. Do PD **as well as** established discourse measures – mean length of utterance (MLU), type-token ratio (TTR), total # utterances (TU) -- differ significantly across aphasia types?

Methods

Participants – 195 PWA, 168 Non-aphasic Controls (NC)
- from the AphasiaBank database
- native English speakers
- all completed both discourse tasks

	PWA (n=195)	Controls (n=168)
Mean age (sd)	62.2 (11.8) yrs	64.9 (17.1) yrs
Mean education (sd)	15.4 (2.7) yrs	15.3 (2.4) yrs
% males **% females**	57% 43%	48% 52%
Mean time post-onset (sd)	5.4 (4.9) yrs	--
Mean WAB AQ (sd)	76 (16.4)	--
Mean # words (sd) - narrative	329.1 (356)	303.2 (216.6)
Mean # words (sd) - procedural	42.9 (33.4)	87.8 (54.9)

WAB Aphasia types:

Anomic	77	Wernicke	13
Broca	35	Transcortical Motor	8
Conduction	37	AQ > 93.8	25

Methods, cont.

Tasks:

1. Personal Stroke and Coping Narrative:
   "Do you remember when you had your stroke? Please tell me about it."
   "Tell me about your recovery. What kinds of things have you done to try to get better since your stroke?"
2. Procedural Discourse:
   "Tell me how you would make a peanut butter and jelly sandwich."

Transcriptions were done using CHAT[1].
Analyses were done using these CLAN commands:

EVAL +e2 +t*PAR +g"Stroke" +re +u *.cha
EVAL +e2 +t*PAR +g"Sandwich" +re +u *.cha

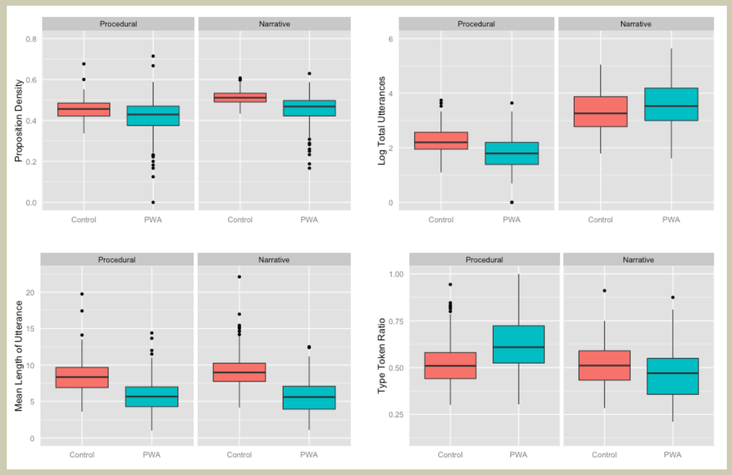
Propositions are counted based on **part-of-speech tagging** and **rules** to handle certain configurations of words.

Results

- Bartlett's test showed that assumptions of homogeneity of variances were roughly valid, with the exception of the Broca group who have an unusually large variance.
- All statistical tests were run both on raw data and logistic transformations of the raw data. Results did not differ so all data reported here will be based on raw data.
- For statistical significance, alpha=0.05.

1. **Significant differences between PWA and NC** (Hotelling's Test):

   * Proposition density – narrative and procedural – p<.001
   * Total utterances – narrative and procedural – p<.005
   * MLU words – narrative and procedural – p<.005
   * TTR – narrative p<.05 and procedural p<.005

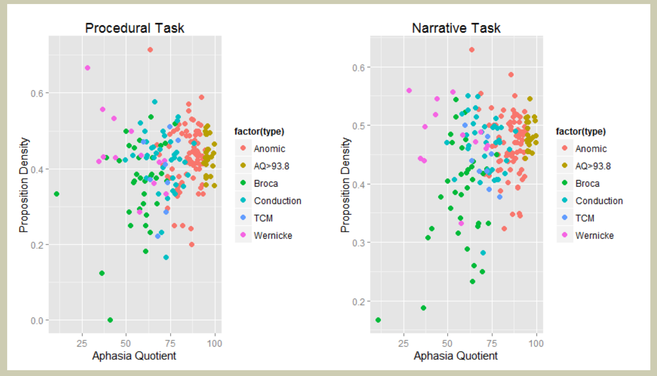


2. Correlations between AQ and Density (and other discourse measures) suggested a **weak, positive association between PD and AQ for both tasks**. However, further inspection of the data using linear regression revealed **that the relationship is not significant in the Procedural Task**, but **significant and negative in the Narrative Task** (after removing 2 influential outliers).

	Pearson's r	p-value
PD - narrative	0.288	<.05
PD - procedural	0.170	<.05
# utterances - narrative	0.225	<.005
# utterances - procedural	0.120	<.05
MLU - narrative	0.470	<.005
MLU - procedural	0.512	<.005
TTR - narrative	- 0.159	<.05
TTR - procedural	- 0.320	<.005

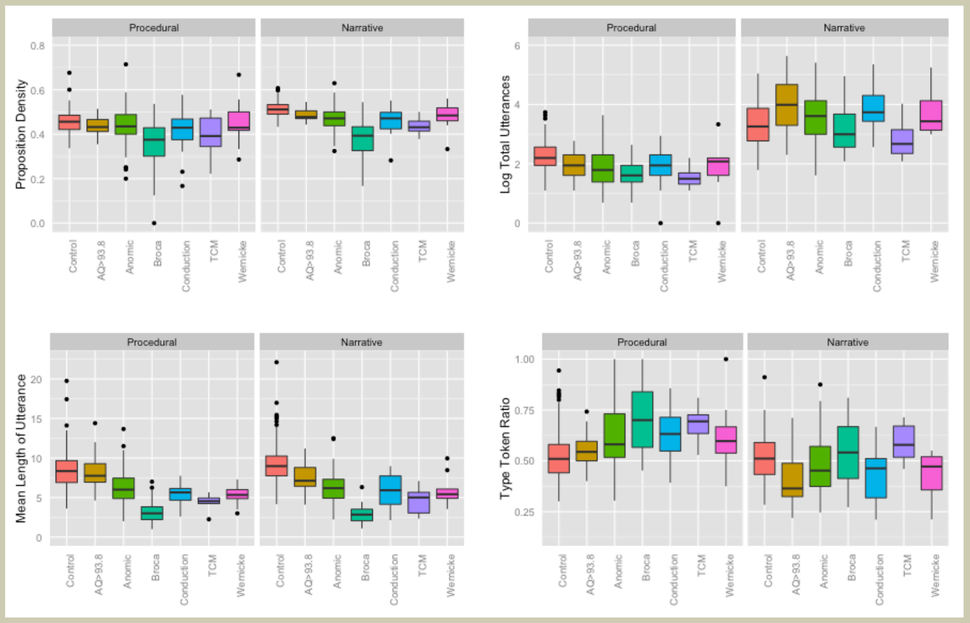
Results, cont.

Scatterplot for PD and AQ for both discourse tasks



3. Significant differences (based on Tukey's HSD tests) across aphasia types for procedural discourse (below the blue line) and narrative discourse (above the blue line)

	Ano	Bro	Con	TCM	Wer	>93.8	Cont
Anomic		PD MLU					PD TU MLU
Broca	PD MLU TTR		PD TU MLU TTR		PD MLU	PD TU MLU TTR	PD MLU
Conduction		PD MLU		TU TTR		MLU	PD TU MLU TTR
Transcortical Motor						TU MLU TTR	PD MLU
Wernicke		PD MLU					MLU
AQ>93.8	MLU	PD MLU TTR	MLU	MLU	MLU		TU MLU TTR
Controls	TU MLU TTR	PD TU MLU TTR	MLU TTR	TU MLU TTR	MLU		



Discussion and Future Directions

- PWAs and controls differed significantly on both discourse tasks for Density (PD) and all established discourse measures -- MLU, TTR, Total Utterances.
- AQ and Density have a weak, positive correlation for both discourse tasks, but linear regression revealed no significant association between Density and AQ for procedural discourse and a significant negative linear association between Density and AQ for narrative discourse, which disappeared when the Wernicke group was removed from the analysis.
- **Density is an idiosyncratic measure in relation to aphasia type**. High PD can occur with lower AQ (Wernicke) or higher AQ (Anomic). Low PD occurs mostly with Broca's aphasia where AQs can range from about 8 to 80 and many grammatical elements that contribute to PD may be reduced.
- Density works best in distinguishing participants with Broca aphasia from the other aphasia groups (except TCM).
- Multiple comparison testing showed that of all the measures, MLU best distinguishes the aphasia group from the controls.
- We recommend further research on the Density measure to better understand its value in aphasia with specific attention to its positive association with MLU and the potential muti-collinear relationship of AQ and MLU in predicting Density.

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