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Grammatical structures & errors in paragrammatism

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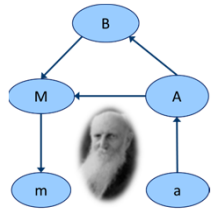
Agrammatism & paragrammatism as *distinct* disorders

- Kleist (1914):
  - **agrammatism** = simplified, shortened sentences lacking in grammatical morphemes; arising from **frontal lobe** damage **("motor representations")**
  - **paragrammatism** = grammatical disruption as a result of incorrect selection of both lexical and grammatical morphemes & disrupted word order; arising from **temporal lobe** damage **("sensory; auditory representations")**
  - BUT… **mixed presentations** were problematic

The Wernicke-Lichtheim ("House") Model (1885)



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Agrammatism & paragrammatism as *related* disorders

- Kleist (1916):
  - **sensory aphasia** shows both paragrammatism and agrammatism due to "irregular arousal" of sentence schemata
  - **motor aphasia** may show paragrammatism when "forced to deviate from telegram speech"
  - both due to **temporal lesions**, therefore both attributed to **lexical retrieval difficulty (Druks, 2017)**
    - **"amnesia for function words" (agrammatism)**
    - ***vs* incorrect selection of function words (paragrammatism)**

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Agrammatism & paragrammatism as *secondary artefacts* of non-syntactic functions

- **agrammatism**
  - **motor-speech impairments** (Bonhoeffer, 1902; Goldstein, 1913)
  - **diminished linguistic initiative**: "only those words are used that are most important… without any extra grammatical work" (Bonhoeffer, 1902)
  - **"economy of effort" hypothesis** (Isserlin, 1922; Lenneberg, 1973)
- **paragrammatism**
  - **auditory impairments**; failure to monitor (Kleist, 1914; Isserlin, 1922)
  - **lexical retrieval** difficulties (e.g., Butterworth, 1979)
  - transient **failures of control** (Butterworth, 1985)

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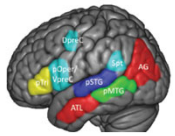
Agrammatism as an *adaptative* symptom

- Isserlin (1922; translation by Droller et al., 1985):
  - agrammatism as "**correct telegram speech**" with "occasional grammatical derailments" … "not faulty or imperfect" *vs*
  - paragrammatism as "**occasionally grotesque**", "absurd and **utterly unintelligible gibberish**" with "frequent **contamination of words**"
- Kolk, Heeschen & colleagues (1980s & 90s): Adaptation Theory
  - grammatical impairments in both BA and WA arising from **a timing deficit**
  - BA more likely than WA to attempt covert repairs, or "**corrective adaption**"
- Fedorenko et al. (2022)
  - revival of the "economy of effort" hypothesis

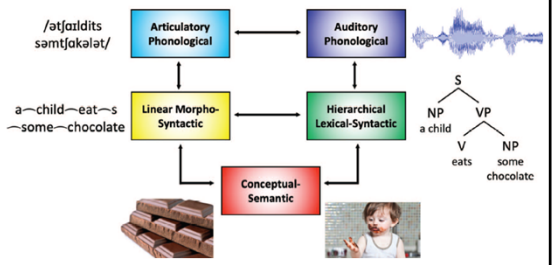
Paragrammatism as an *adaptative* symptom

- Ronfeldt (1999):
  - focus on conversational repairs in one individual with WA
  - **trade-off** between limited cognitive resources during language production and functional demands of the communicative situation
  - paragrammatisms arise from **attempts to avoid (or "camouflage") word retrieval difficulties (or phonological encoding difficulties)** in social communication in order to **maintain face**
    - **interactional advantages in holding the floor and/or gaining processing time**
  - frequency of repair belies hypotheses based on anosagnosia
    - "the difficulty seems not to be knowing how to repair, but performing it under real-time constraints"

Agrammatism & paragrammatism as *dissociable syndromes*



- **Matchin & colleagues** (2017; 2020a; 2020b) found a double dissociation:
  - **agrammatism** associated with IFG but not pSTG/MTG;
  - **paragrammatism** associated with pSTG/MTG but not IFG
  - proposed a **direct pathway** between conceptual semantics and linear syntax by which paragrammatic structures are produced



Motivation for the current study

- **variability within groups and individuals**: omissions & substitutions are mixed; performance also varies by type of task
- most research has focused on explanations of **agrammatism only;** contrasts of agrammatism and paragrammatism often address **comprehension** but not production, often with artificial tasks
- studies often focus on **just a few individuals**, **selected** for their grammatical behavior (but see den Ouden et al., 2019)
- in the current study, we aimed for a systematic **data-driven approach**, i.e. subjects not selected for grammatical characteristics, measuring behavior in an **ecologically valid task** (monologic narrative)

Methods: Participants

PwA from AphasiaBank	Broca (n=20)	Wernicke (n=20)	B *vs* W
WAB-R AQ	53.2	53.3	$p = .987$
Age (yrs)	64.7	70.9	$p = .067$
Education (yrs)	15.1	16.0	$p = .352$
Sex (% Female)	60%	60%	NS
TPO (yrs)	7.5	3.6	$p = .028$
WAB Fluency	3.3	7.3	$p < .001$

Task: Story retelling (10-20 utterances each)

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Methods: Utterance Coding

- utterances extracted from AphasiaBank
- **utterances "cleaned"** to identify the core utterance:
  - removed non-meaningful repetitions and repairs and other non-narrative words (e.g. "Well,…"); non-task utterances [+exc]
  - some utterances re-segmented, e.g., to separate main clauses or to capture embedding of quotes
- **attempted to record a gloss** for each utterance, but could not achieve sufficient reliability
- coded presence/absence of utterance components; parts of speech; **types of grammatical errors**

Sentence Components
Subjects, objects
Verbs (main, auxiliary)
Noun modifiers
Verb modifiers
Subordinate clauses
Other structures

Grammatical Errors
Incomplete sentences
Sentence fragments
Omissions
Substitutions
Additions
Misordering
Unclear

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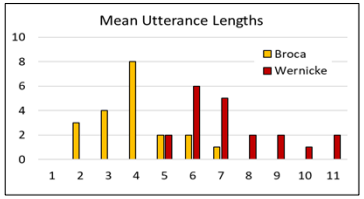
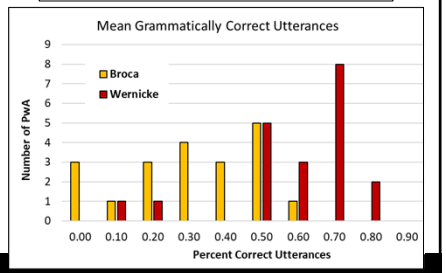
Results: Descriptive analysis

	Broca	Wernicke	B vs W
Total # utterances	311	373	
Mean # utterances	15.4	18.7	$p = .009$
Mean utterance length (wds)	3.43	6.90	$p < .001$
Mean grammatical accuracy	27.9%	56.2%	$p < .001$
Median grammatical accuracy	28.6%	60.6%	





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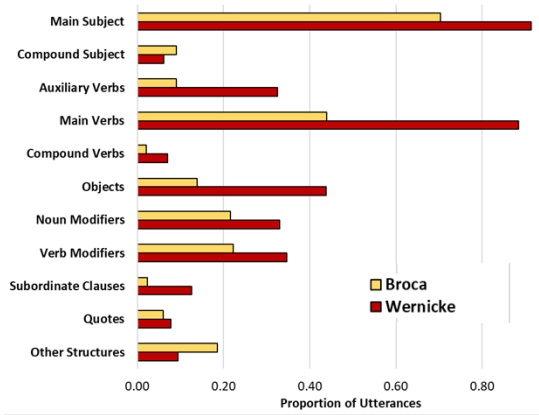
Results: Utterance Elements

- Overall, WA produced more of most elements except "Other structures"
  - **exclamations/interjections** (*oh my god*)
  - **counting** (*the man and one two*)
  - **onomatopoeia** (*boom this*)
  - **unintelligible strings** (*I got to /su/ /xxx/*)
  - **extraneous words** (*the other girl was a graceful little girl things*)



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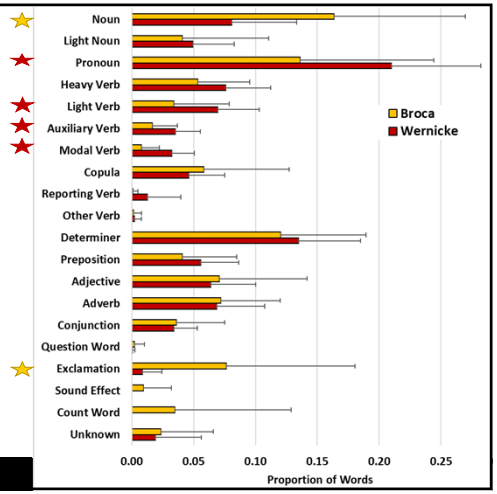
Results: Parts of Speech (% of words produced)

- **BA** produced significantly more **nouns** and **exclamations**
- **WA** produced significantly more **pronouns and light verbs**, and more **auxiliary** and **modal verbs**
- Both made use of **light nouns** (e.g. *thing*, *someone*) and **copula verbs** (e.g. *is*, *were*)



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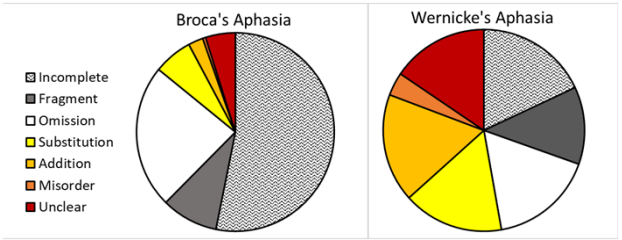
Grammatical error types

- error distributions were significantly different (χ^2 = 78.5, p < .0001)



- Most errors in BA involve **incomplete (53%)** or **fragmented (9%)** sentences or **omissions (23%)**
- In WA, errors are more evenly distributed across types, but **substitutions (16%)**, **additions (17%)**, and **unclear errors (16%)** are more frequent than in BA

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Sample errors

Error Type	Examples from BA	Examples from WA
Fragments	*She had...*	*He is a bad...*
Incomplete sentences	*For sweep and sweep* *Boyfriend and girlfriend*	*Bad bad bad* *All the horses and the little dogs and other things*
Omission	*Man is waving* *Cinderella "boo boo"*	*She was angel for /lEgwUd/* *They took and went to the at night*
Substitution	*Suddenly it is "hey"* *Cinderella were not sure*	*They were mad for Cinderella* *It have a coach*
Addition	*Cinderella's is something to do with it*	*That female was the oldest the witch* *The man he misses that he misses her*
Misordered	*One two is a I what*	*Finally a man who dancing and her were pretty woman*
Unclear	*It is /pYt/*	*This woman had /oZo/ make*

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% Errors in individuals with BA

%Incomp	%Omit	%Add	%Sub	%Mis	%Unclear
0.333	0.333		0.167		0.167
0.750	0.250				
0.167	0.500		0.250		0.083
0.400	0.400	0.200			
0.500			0.333	0.167	
0.429	0.571				
0.400	0.500		0.100		
0.700					0.300
0.273	0.364	0.273	0.091		
0.750	0.125				0.125
0.889	0.111				
0.583	0.417				
0.625	0.250		0.125		
0.800			0.200		
1.000					
0.667			0.333		
0.250	0.500		0.083		0.167
0.600	0.400				
0.824	0.176				

% Errors in individuals with WA

%Incomp	%Omit	%Add	%Sub	%Mis	%Unclear
0.167	0.333		0.167	0.167	0.167
			0.750		0.250
0.400	0.400		0.200		
0.400	0.400		0.200		
0.200	0.400		0.400		
0.333	0.333	0.167	0.167		
0.333			0.667		
0.125	0.250	0.125	0.500		
0.118	0.118	0.412	0.059		0.294
0.333			0.667		
0.333	0.167	0.167		0.167	0.167
0.429	0.286	0.286			
0.333		0.667			
0.200	0.100	0.200	0.100	0.100	0.300
	0.286	0.286	0.143		0.286
0.200	0.200	0.200	0.300		0.100
0.286		0.143	0.143	0.143	0.286
0.222	0.222	0.111	0.111		0.333

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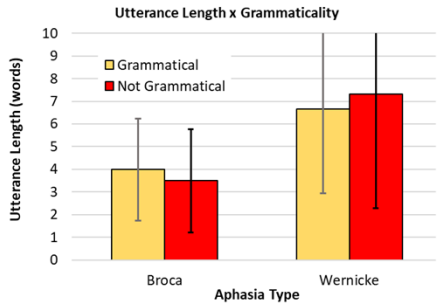
Effect of utterance length on grammaticality

- 2x2 ANOVA showed a small but significant interaction between Aphasia Type & Grammaticality (p = .038):
  - BA: **shorter utterances** more likely to be **ungrammatical**
  - WA: **longer utterances** more likely to be **ungrammatical**




```
> summary(ANOVA)
             Df Sum Sq Mean Sq F value Pr(>F)
Grp           1   1810  1810.3 140.944 <2e-16 ***
Acc           1      3     3.1   0.242 0.6232
Grp:Acc       1     56    55.8   4.342 0.0376 *
Residuals   664   8528    12.8
```


Summary of main findings

- **BA** showed **relative preservation of subject noun production** but frequent omission of main verbs (<half of utterances)
  - *Is this because verb production is specifically impaired, or because subjects come first in the sentence?*
- **WA** produced relatively more **light verbs** and **pronouns**, but **BA and WA** did not differ in use of **copulas** and **light nouns**
  - *While WA had more options to choose from, both BA and WA made use of highly frequent (but empty) sentence building blocks*

Summary of main findings

- **BA** made more **incomplete** & **omission errors,** while **WA** made more **addition and substitution** errors
  - **"agrammatic"** pattern observed for **95%** of those with BA
  - **"paragrammatic"** pattern observed for **30-65%** of those with WA
- **Shorter sentences** were more likely to be **ungrammatical for BA,** while **longer sentences** were more likely to be **ungrammatical for WA**
  - Grammatical errors in paragrammatism frequently arise from piling up phrasal chunks, often into "**sentence monsters**" (Kleist, 1914)

Sample sentence monsters

then eventually the female open the short as the male kept into the /fyut/ way and /hod/ed everything

other people are not their appearance because she is doing that

some were exciting and not approve

then the /kEnz/ of them do that

the poor little interest she cannot be

Other influences: frequent perseveration

/sxk3rxndId/
she was angel for /lEgwUd/
*she was for /fEndxl/ for someone else
*the other children for her are three children or whatever
*with her it was very closed walking in /JUnrxlIs/
/pEzxl/s are going for the party
*she was /fEn/ people for /prEzxld/ for the present
the present was supposed to be thirty or something
*she had a ranned from home she hurried
the people were
they found her letter
the other people /wEd/
*they found her for the /prEzxld/ and the calls this one so

Cinderella was a little girl that plays with the daughter
he plays with a young woman
at the days were longer she began
*she will played
she ran into a fox
the fox began
a fox
she bought sandals
the sandals would not fit
she went to this place until she found the sandals
then she got back to the sandals
she bought the sandals
the sandals became Cinderella's boyfriend
she became Cinderella's boyfriend

Discussion

- **overall patterns** of agrammatism & paragrammatism are fairly **distinct**, but with **significant overlap; strong role of frequency** and contextual priming (*e.g.*, use of light constructions; perseveration)
  - consistent with **usage-based approaches**, **structural priming** evidence
- both lexical retrieval and syntactic formulation are influenced by both **hierarchical (paradigmatic)** and **sequential (syntagmatic)** input
  - explanation requires an **activation-based approach**, allowing for multiple interacting sources of influence

Discussion

- **variability** within syndromes (and individuals) **is expected**, as in other impairments, notably word retrieval
  - also influenced by **"positive symptoms"**, *i.e.* the IwA's response to the deficit in a given task
- if such **strategies are implicit** (*e.g.*, Heeschen & Schegloff, 1999) they should be **available to both BA and WA** (*cf.* Ronveldt, 1999)
  - strategies by **WA** tend to be **verbal**, as allowed by relative fluency
  - strategies by **BA** are more often **non-verbal** (*e.g.* gesture) or verbal but **non-syntactic** (*e.g.* counting, onomatopoeia)

Ongoing and planned work

- analyze a corpus of speech from non-brain-damaged individuals using the same methods to provide **normative benchmarks**
  - To what extent are observed errors abnormal?
- **simulation studies** of agrammatism and paragrammatism to assess roles of various factors, e.g.:
  - lexical and syntactic **frequency** (chunking, *cf.* McCauley & colleagues)
  - contextual (lexical and syntactic) **priming** → perseveration, substitution errors