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

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)

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)
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 IFC but not pSTG/MTG;
  - paragrammatism associated with pSTG/MTG but not IFC;
  - 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

<table>
<thead>
<tr>
<th>PwA from AphasiaBank</th>
<th>Broca (n=20)</th>
<th>Wernicke (n=20)</th>
<th>B vs W</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAB-R AQ</td>
<td>53.2</td>
<td>53.3</td>
<td>p = .987</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>64.7</td>
<td>70.9</td>
<td>p = .067</td>
</tr>
<tr>
<td>Education (yrs)</td>
<td>15.1</td>
<td>16.0</td>
<td>p = .352</td>
</tr>
<tr>
<td>Sex (% Female)</td>
<td>60%</td>
<td>60%</td>
<td>NS</td>
</tr>
<tr>
<td>TPO (yrs)</td>
<td>7.5</td>
<td>3.6</td>
<td>p = .028</td>
</tr>
<tr>
<td>WAB Fluency</td>
<td>3.3</td>
<td>7.3</td>
<td>p &lt; .001</td>
</tr>
</tbody>
</table>

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

Results: Descriptive analysis

<table>
<thead>
<tr>
<th></th>
<th>Broca</th>
<th>Wernicke</th>
<th>B vs W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total # utterances</td>
<td>311</td>
<td>373</td>
<td></td>
</tr>
<tr>
<td>Mean # utterances</td>
<td>15.4</td>
<td>18.7</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Mean utterance length (wds)</td>
<td>3.43</td>
<td>6.90</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Mean grammatical accuracy</td>
<td>27.9%</td>
<td>56.2%</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>Median grammatical accuracy</td>
<td>28.6%</td>
<td>60.6%</td>
<td></td>
</tr>
</tbody>
</table>

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)
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)

Grammatical error types

- error distributions were significantly different ($\chi^2 = 78.5, p < .0001$)
- Most errors in BA involve incomplete (53%) or fragmented (9%) sentences or omissions (33%)
- In WA, errors are more evenly distributed across types, but substitutions (16%), additions (17%), and unclear errors (16%) are more frequent than in BA

Sample errors

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

% Errors in individuals with BA

<table>
<thead>
<tr>
<th>%Incomp</th>
<th>%Omit</th>
<th>%Add</th>
<th>%Sub</th>
<th>%Mis</th>
<th>%Unclear</th>
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<tbody>
<tr>
<td>BA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WA</td>
<td></td>
<td></td>
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% Errors in individuals with WA

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<td>BA</td>
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<tr>
<td>WA</td>
<td></td>
<td></td>
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</table>
Effect of utterance length on grammaticality

- $2 \times 2$ 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 of main findings

- BA showed relative preservation of subject noun production but frequent omission of main verbs ($<\text{half of utterances}$)
  - 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

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

*Cinderella was a little girl that plays with the daughter*
be plays with a young woman
at the days were longer she began
*she was angel for /lEgwUd/ for someone else*
she ran into a fox
the fox began
*the other children for her are three children or whatever*
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

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