Grammatical Parallelism in Aphasia Revisited

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INTRODUCTION

- The concept of a central syntactic processor in Broca's area originated with finding of parallel syntactic deficits: people with nonfluent Broca's aphasia and expressive agrammatism showed deficits on reversible, noncanonical sentences relative to non-reversible sentences (Caramazza & Zurif, 1976)
- Syntactic comprehension deficits often assumed to be selective to Broca's aphasia, but many studies did not evaluate overall aphasia severity or lesion volume into the picture (Thompson et al., 2003; Cho-Reyes & Thompson, 2012)
- Lesion-symptom mapping studies of syntactic comprehension deficits typically highlight temporal-parietal cortex, not frontal cortex (Rogalsky et al., 2018; Pillay et al., 2017; Thothathiri et al., 2012)
- Grammatical parallelism in aphasia might alternatively stem from posterior temporal lesions and paragrammatism (Matchin & Hickok, 2020)

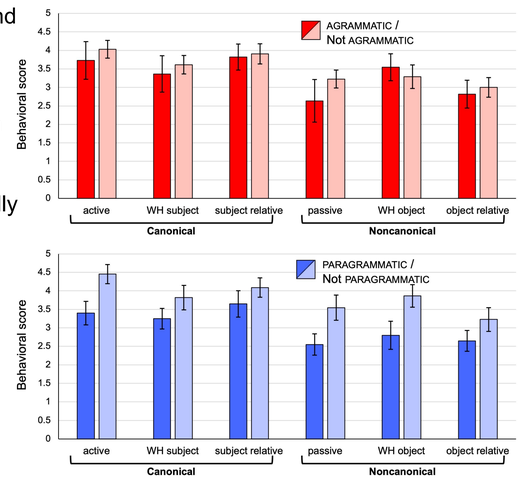
METHODS

- Three partially-overlapping groups of subjects (see Table 1 for details)
- **Primary measures. Syntactic comprehension (1-4)**
  1. **NONCANONICAL**: comprehension of passives, object clefts OR object relative clauses, object WH questions (combined from one of two protocols, Cho-Reyes & Thompson, 2012; Magnusdottiir et al., 2013)
  2. **NONCANONICAL$_{RES}$**: noncanonical with active sentence comprehension as a covariate
  3. **SEQUENTIAL COMMANDS**: a series of increasingly complex commands to manipulate objects in the environment (e.g. *with the book, point to the pen*)
  4. **SEQUENTIAL COMMANDS$_{RES}$**: sequential commands with auditory word recognition (pointing to objects in the environment) as a covariate
  5. **AGRAMMATISM/PARAGRAMMATISM:** categorical perceptual assessment of agrammatic and paragrammatic speech, using speech rate in words/min as a covariate (Matchin et al., 2020)
- Lesion-symptom mapping analyses using NiiStat at both the ROI and voxel-wise levels, in ROIs/voxels with at least 10% of lesion overlap
- Lesion volume incorporated as a covariate for lesion data and secondary behavioral analyses

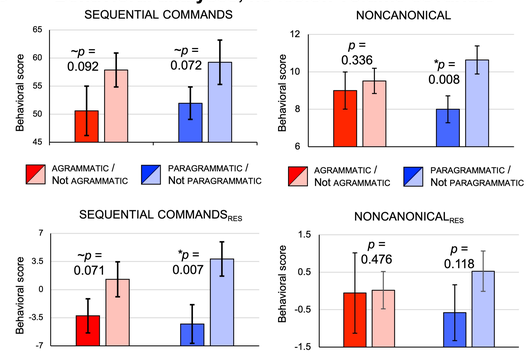
	Sequential Commands, Aud. Word Recognition	AGRAMMATISM and PARAGRAMMATISM	Noncanonical/canonical sentence comp.
Number subjs	218	53	130
Sex	133 male, 85 female	35 male, 18 female	83 male, 47 female
Mean age (years)	60.0 (SD 11.4)	58.9 (SD 12.2)	60.0 (SD 10.7)
Mean months post-stroke	43.0 (SD 48.4)	48.6 (SD 53.5)	45.3 (SD 50.4)
Mean education (years)	15.0 (SD 2.3), *N=210	15.8 (SD 2.3)	15.4 (SD 2.4), *N = 128
Mean lesion volume (mm^3)	120,855 (SD 97,488)	125,102 (SD 85,490)	111,267 (SD 92,645)
Mean WAB-R AQ	61.4 (SD 28.1)	68.2 (SD 16.7)	65.3 (SD = 26.9)

RESULTS

All canonical and noncanonical sentence structures

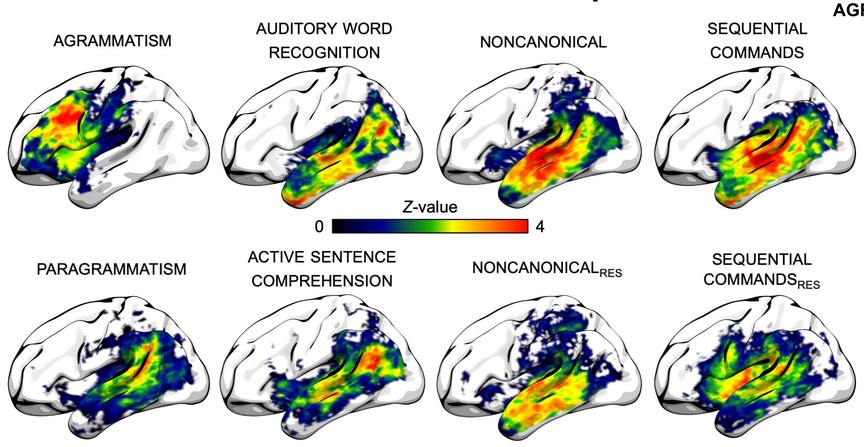


Behavioral analyses, no lesion volume covariate

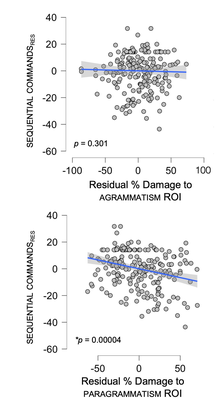


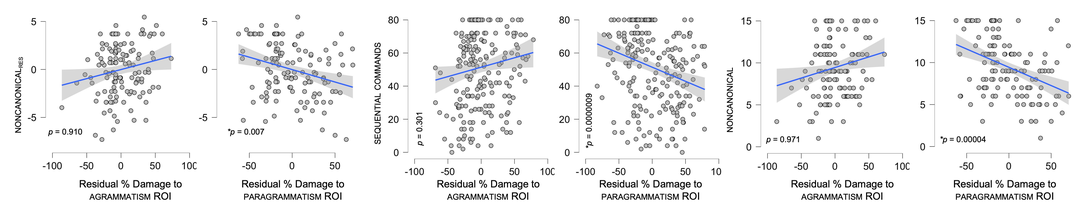
When lesion volume included as covariate, no relationship b/t **AGRAMMATISM** and syntactic comprehension measures. **PARAGRAMMATISM** retains relationship, albeit with reduced statistical strength

Unthresholded lesion maps



Correlations: syn. comp. w/ damage to AGRAM/PARAGRAM ROIs





DISCUSSION

- Weak evidence of relationship b/t AGRAMMATISM and SEQUENTIAL COMMANDS/$_{RES}$ performance, no evidence of relationship with NONCANONICAL/$_{RES}$
- PARAGRAMMATISM robustly associated with deficits on SEQUENTIAL COMMANDS$_{RES}$ and NONCANONICAL, weak associations with SEQUENTIAL COMMANDS and NONCANONICAL$_{RES}$
- No evidence of any AGRAMMATISM-syntactic comprehension relationships when lesion volume incorporated as a covariate
- Stronger PARAGRAMMATISM-syntactic comprehension relationship when incorporating lesion volume
- Evidence is much stronger for grammatical parallelism with PARAGRAMMATISM, not AGRAMMATISM, consistent with early ideas of Wernicke regarding parallel linguistic deficits in aphasia
- To test these ideas further, need better measures of syntactic comprehension not confounded with working memory and lexical access
- Need finer-grained measures of paragrammatic speech production deficits, as paragrammatic speech typically contains lexical-semantic and phonological difficulties

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