Main Concept, Sequencing, & Story Grammar (MSSG) Analyses of the Cinderella Story in Primary Progressive Aphasia
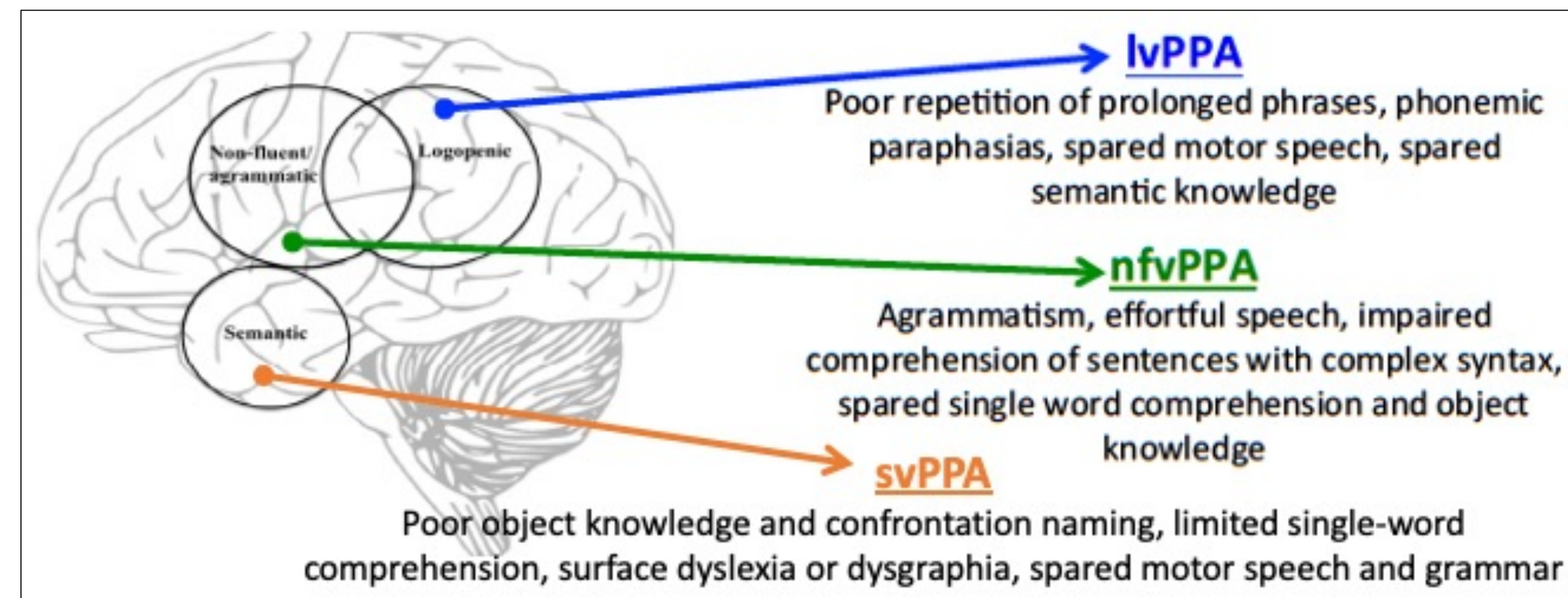
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Background

o *Primary Progressive Aphasia (PPA):* Language difficulty (aphasia) is the prominent deficit impacting daily living (primary) at onset and initial phases of progressive disease. Not marked by prominent cognitive, memory, or behavioral deficits at onset. Will eventually evolve into other dementias (e.g., FTD, Alzheimer's).
 ▪ Commonly recognized variants: logopenic, nonfluent/agrammatic, & semantic

lvPPA
Poor repetition of prolonged phrases, phonemic paraphasias, spared motor speech, spared semantic knowledge

nfvPPA
Agrammatism, effortful speech, impaired comprehension of sentences with complex syntax, spared single word comprehension and object knowledge

svPPA
Poor object knowledge and confrontation naming, limited single-word comprehension, surface dyslexia or dysgraphia, spared motor speech and grammar

o **Discourse production tasks are ecologically valid methods to assess everyday communication abilities and the impact of PPA.** Discourse tasks that require planning and sequencing (e.g., storytelling) may also provide an additional way **to monitor both language decline and emergence of other cognitive deficits as the disease progresses**

o *Purpose: Quantify & describe macrostructural characteristics of narratives produced by persons with PPA by providing descriptive statistical information & comparing to healthy controls (HCs).*

Methods

Participants & Transcripts:

o Participants were diagnosed with PPA by a team of neurologists and speech-language pathologists (SLPs) at UNM and UNMHSC. (Enrollment is ongoing.)
 ▪ 15 lvPPA, 7 nfvPPA, 1 svPPA
 ▪ Age: M = 73.6, SD = 9.5 (range 56 – 92 years)
 ▪ Sex: 10 F, 13 M
 ▪ Education: M = 16.5, SD = 1.9 (range 12 – 20 years)

o All participants completed the AphasiaBank protocol with standardized administration. Only the Cinderella storytelling was used in this analysis.
 ▪ Participant looks through wordless picture book of Cinderella
 ▪ Book is removed
 ▪ *"Now tell me as much of the story of Cinderella as you can. You can use any details you know about the story, as well as the pictures you just looked at."*

References:
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4. Fromm, D., Forbes, M., Holland, A., Dalton, S. G., Richardson, J., & MacWhinney, B. (2017). Discourse characteristics in aphasia beyond the Western Aphasia Battery cutoff. *American Journal of Speech-Language Pathology, 26*(3), 762-768.
5. Greenslade, K. J., Stuart, J. E., Richardson, J. D., Dalton, S. G., & Ramage, A. E. (2020). Macrostructural analyses of Cinderella narratives in a large nonclinical sample. *American Journal of Speech-Language Pathology, 29*(4), 1923-1936.
6. Richardson, J. D., Dalton, S. G., Greenslade, K. J., Jacks, A., Haley, K., & Adams, J. (2021). Main concept, sequencing, and story grammar (MSSG) analyses of Cinderella narratives in a large sample of persons with aphasia. *Brain Sci, 11*(1).
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Table 1. MSSG - Main concepts (MCs) for Cinderella.[7]

1. *Dad remarried a woman* with two daughters.
2. *Cinderella lives with stepmother and/or stepsisters.*
3. *Stepmother and/or stepsisters were mean to Cinderella.*
4. *Cinderella was a servant* to the stepmother and stepsisters.
5. *Cinderella has to do* all *the housework.*
6. The king thinks *the prince should get married.*
7. King announces *there is going to be a ball* in honor of son who needs to find wife.
8. *They got an invitation* to the ball.
9. *They are excited* about the ball.
10. *Cinderella* is told by the stepmother she *cannot go* to the ball unless/ because/ until (insert reason).
11. *The stepsisters tore her dress.*
12. *Stepmother and/or stepsisters went* to the ball.
13. *Cinderella was upset.*
14. *A fairy godmother appeared* to Cinderella.
15. *The fairy godmother makes {item(s)} turn in to {item(s)}.*
16. *The fairy godmother makes Cinderella into a beautiful princess.*
17. *Cinderella went to the ball* in the coach.
18. She knew *she had to be home by midnight* because everything will turn back at midnight.
19. *The prince and Cinderella danced* around the room.
20. *Prince falls in love with Cinderella.*
21. Cinderella realized *it is midnight.*
22. *She ran down the stairs.*
23. As she is running down the stairs *she lost* one of the *glass slippers.*
24. *Everything turns back to its original form.*
25. *Prince finds Cinderella's shoe.*
26. *She returned home* in time.
27. *The prince searched* door to door *for Cinderella.*
28. *Prince comes to Cinderella's house.*
29. *The stepsisters try on the glass slipper.*
30. *The slipper didn't fit the stepsisters.*
31. *He put the slipper on* Cinderella's foot.
32. *The slipper fits* Cinderella perfectly.
33. *Cinderella and the prince were married.*
34. *Cinderella and the prince lived happily ever after.*

MSSG – *Main Concepts* coding & scoring:[5-7]
o Transcripts were coded according to published guidelines. Possible codes are:
 ▪ Absent (**AB**): The participant did not produce any portion of the MC
 ▪ Inaccurate/Incomplete (**II**): attempted MC, but missing 1+ essential element & another essential element was incorrect.
 ▪ Inaccurate/Complete (**IC**): produced complete MC, but 1+ essential element was inaccurate.
 ▪ Accurate/Incomplete (**AI**): produced an accurate MC, but 1+ essential element was missing.
 ▪ Accurate/Complete (**AC**): produced all essential elements accurately.
o Codes were assigned a numeric value with **AB = 0, II = 1, IC = 2, AI = 2, AC = 3**.
o Scores summed to yield a **Story Composite (max = 102).**

MSSG – *Sequencing:*[5,6]
o After MC coding/scoring, line numbers were added to the transcripts to determine sequencing
 ▪ **3 points** = MCs stated in correct order
 ▪ **2 points** – MCs stated in incorrect order but marked by speaker as out of sequence
 ▪ **1 point** = MCs stated in incorrect order & not marked by speaker
 ▪ **0 points** = MC is absent
o Scores were summed to yield a **Sequencing score (max = 102).**
o Scores added to MC Story Composite to yield a **MC Composite + Sequencing score (max = 204)**

MSSG – *Story Grammar:*[5,6]
o Twenty-nine (of 34) MCs were pre-assigned one of six story grammar codes (and corresponding episode)
 ▪ setting (S), initiating event (IE), attempt (A), direct consequence (DC), mental state (MS), or conclusion (C)
o Five MCs were assigned options based on order, neighboring MCs, etc.
 ▪ MCs 10 (A or DC), 17 (DC or IE), 18 (DC or IE), 19 (A or DC), 20 (A or DC)
o Variables calculated:
 ▪ Essential Story Grammar Components - max score 35 (since MC 17 could receive 2 points)
 ▪ Total Episodic Components – max score 15 (5 episodes x 3 components [IE, A, DC])
 ▪ Episodic Complexity – max score 5
 ▪ MSSG Classification – MC+Sequencing by Total Episodic Components (visualization)

Results

Table 2. Preliminary t-test results for MSSG variables & MC codes

	Descriptive statics and t-tests		
	PWPPAs v. HCs		
MSSG variable	HC	PWPPAs	t
MC Composite	M=61, SD=17.1	M=31.08, SD=21.54	7.28 ***
Sequencing	M=62.5, SD=17.2	M=34.61, SD=21.54	6.76***
MC Composite + Sequencing	M=123.5, SD=34.2	M=65.69, SD=42.97	7.04***
Essential Story Grammar Components	M=21.4, SD=5.9	M=12.17, SD=7.38	6.52***
Total Episodic Components	M=11.6, SD=2.4	M=11.6, SD=2.4	6.14***
Episodic Complexity	M=4.1, SD=1	M=2.52, SD=1.8	6.14***
MC code	HC	PWPPAs	t
Accurate/Complete (AC)	M=18.3, SD=6.2	M=7.3, SD=6.8	7.46***
Accurate/Incomplete (AI)	M=0.58, SD=0.82	M=2.56, SD=1.59	8.35***
Inaccurate/Complete (IC)	M=0.46, SD=0.7	M=1.82, SD=1.56	6.26***
Inaccurate/Incomplete (II)	M=0.05, SD=0.23	M=0.39, SD=0.84	3.45***
Absent (AB)	M=14.6, SD=6.2	M=21.9, SD=7.4	4.86***

Note: ***$p < .001$

Figure 1. MSSG Classification for Cinderella

(a) (b)
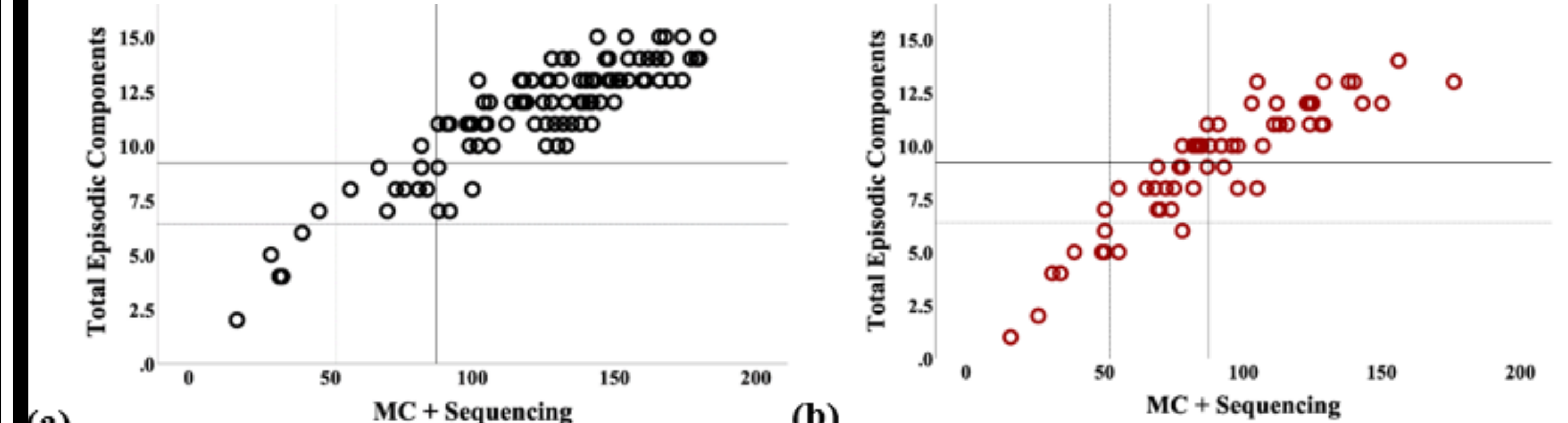
x axis: MC+Sequencing y axis: Total Episodic Components
Quadrants were defined by cutoff points at 1SD (solid line) & 2SD (dotted lines) below the mean for both variables.

(**a**) healthy controls (HCs) (**black**)
(**b**) persons with primary progressive aphasia (PWPPAs) (**red**)

Discussion

o This study extended previous MCA research in PPA and introduced MSSG research in PPA

o **PWPPAs had significantly lower MSSG variable scores than HCs**
 ▪ However, depending on measure, 6-8 PWPPAs (of 23) were within 1 SD of the control mean
  • Only lvPPA and nfvPPA, not svPPA

o **Significant differences also observed for all MC codes**
 ▪ Fewer accurate and complete (AC) concepts produced
 ▪ More inaccurate and/or incomplete concepts produced (AI, IC, II)
 ▪ More absent concepts (AB)

o **Overall, MSSG variables differentiated between HCs & PWPPAs.**

o Differences in informativeness, sequencing, and structure can be captured in a brief storytelling of Cinderella, and efficiently scored, without the need for detailed transcription, to provide valuable information for diagnosis and tracking.

o Future directions
 ▪ larger sample of PWPPAs, with more participants per variant
 ▪ additional investigation whether MSSG analyses can help to track emergence of cognitive deficits.