COMPARING PHONEMIC FEATURES AND PRODUCTION PROCESSES IN PPA SUBTYPES

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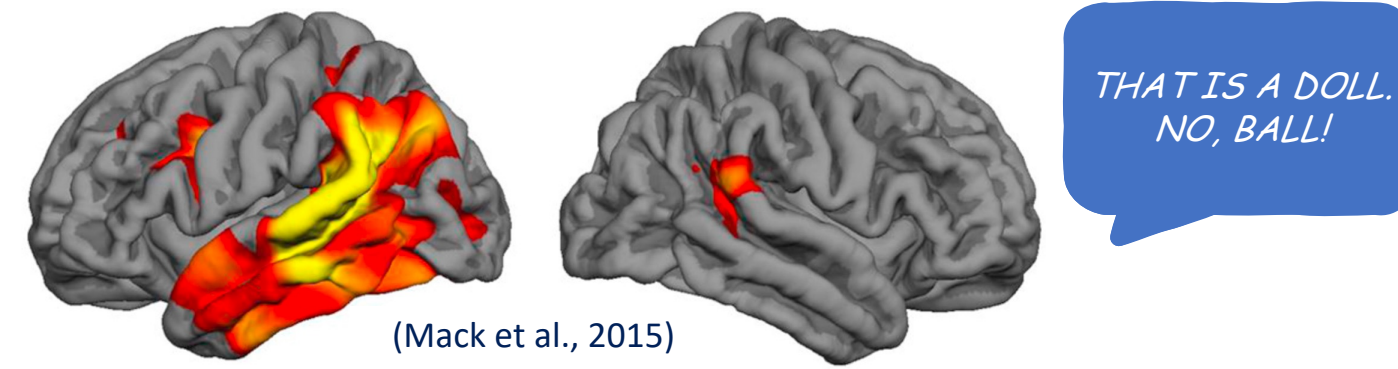
INTRODUCTION

Primary progressive aphasia (PPA) is an age-related neurodegenerative syndrome with isolated language impairment (Gorno-Tempini et al., 2011).

LOGOPENIC VARIANT PRIMARY PROGRESSIVE APHASIA (lvPPA)

Core features	• Impaired single-word retrieval in spontaneous speech and naming
	• Impaired sentences and phrases repetition
Other features	• Phonological speech errors
	• Spared single-word comprehension and object naming
	• Spared motor speech
	• Absence of frank agrammatism
Atrophy	• Left posterior perisylvian or parietal regions

THAT IS A DOLL. NO, BALL!

(Mack et al., 2015)

NONFLUENT/AGRAMMATIC PRIMARY PROGRESSIVE APHASIA (naPPA)

Core features	• Agrammatism in language production
	• Apraxia of speech
Other features	• Impaired comprehension of syntactically complex sentences
	• Spared single-word comprehension
	• Spared object knowledge
Atrophy	• Left posterior fronto-insular region

THAT IS A NOLL. NO, BALL!

(Mack et al., 2015)
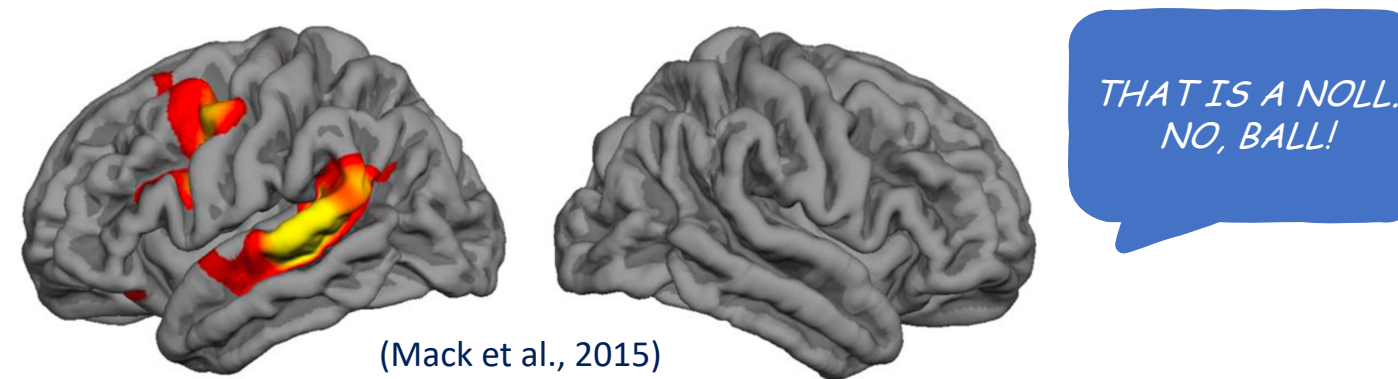
PHONEMIC FEATURES

Distinctive phonemic features are units of phonological and articulatory structure which distinguish one sound from another in language (Ardila, 1998).

- **Voicing**: Whether the vocal cords are vibrating (e.g., /s/ vs. /z/)
- **Place**: Where the sound is produced in the vocal tract (e.g., /t/ vs. /k/)
- **Manner**: How airflow is obstructed in the vocal tract (e.g., /t/ vs. /s/)

PRODUCTION ERRORS AND PROCESSES

Paraphasias can be assessed based on the nature of their production error patterns. These can be systemically detailed as processes, such as backing on a feature that is more forward in the mouth.

Detailing patient production error patterns and distributional acoustic patterns may provide more precise diagnoses and treatment targets and illuminate the underlying processes and cognitive systems of aphasia (Petroi et al., 2021).

KEY QUESTIONS OF FOCUS

1. How do lvPPA and naPPA pattern with respect to specific phonemic features?
2. How do lvPPA and naPPA pattern with respect to specific production processes?

METHODS

PROCEDURE

Baseline data were obtained from a larger treatment study involving language therapy and transcranial direct current stimulation (tDCS).

Phonological analyses were performed on patient productions from the **Western Aphasia Battery (WAB) Object Naming Task**.

OBJECT PRESENTATION — PARTICIPANT PRODUCTION "doll" "buh-" — TACTILE / PHONEMIC / SEMANTIC CUE
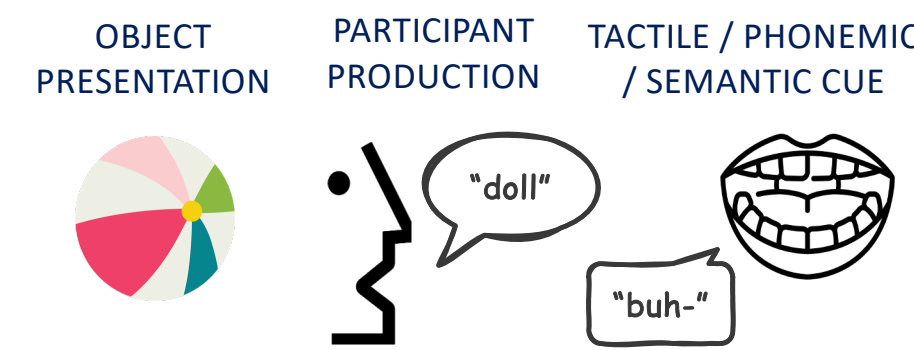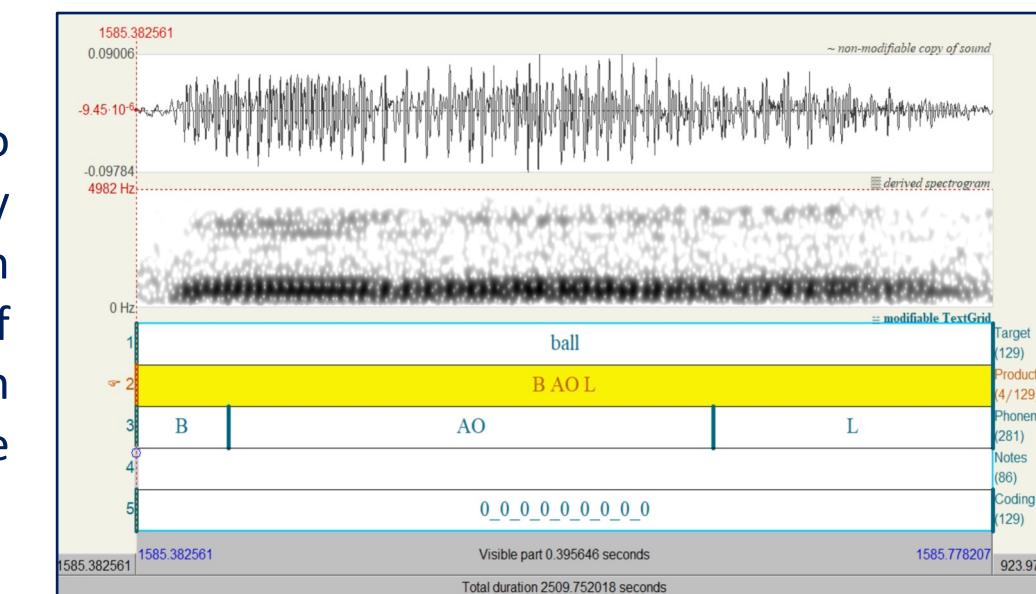
SUBJECTS

N = 10 native English-speaking patients with **lvPPA** (52-82 years old)
N = 10 native English-speaking patients with **naPPA** (61-78 years old)
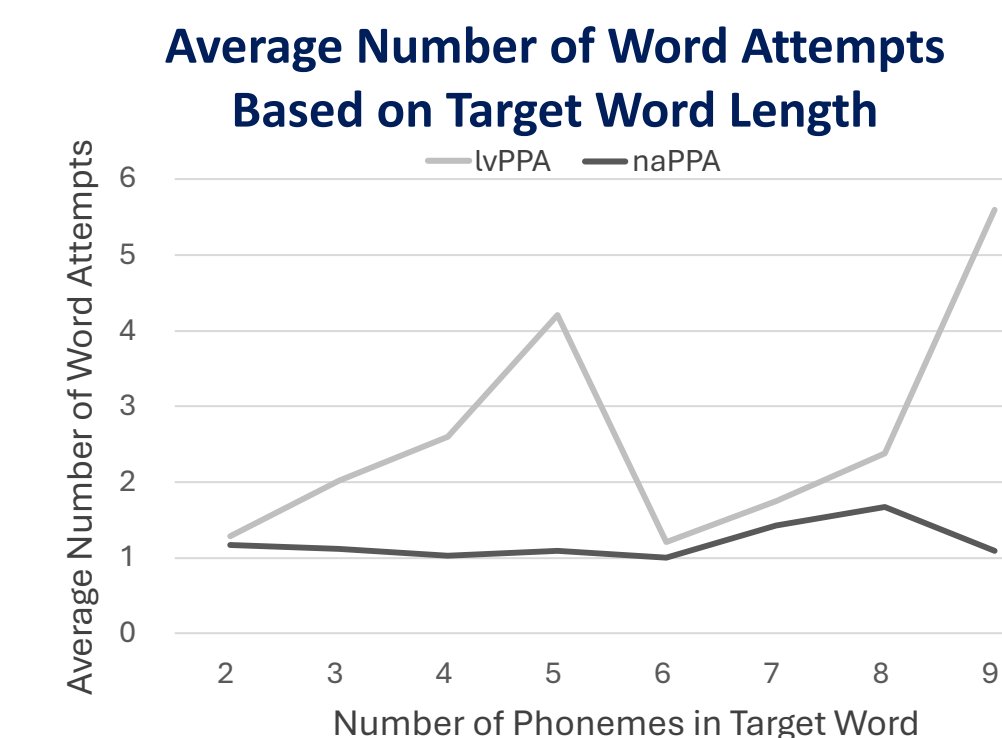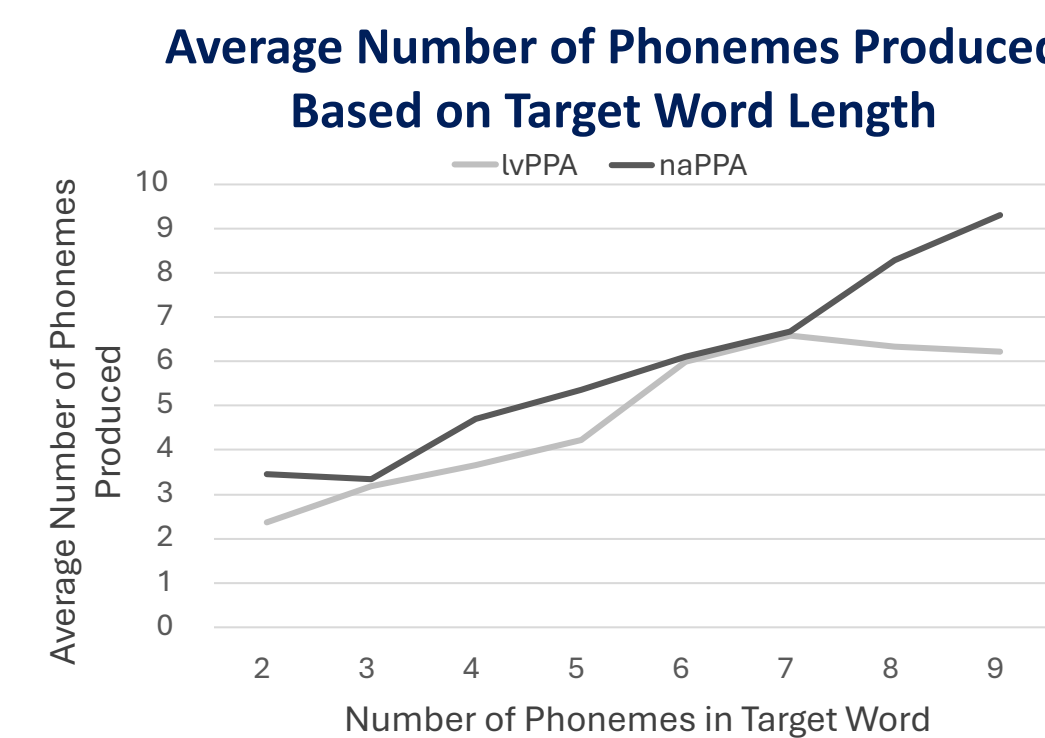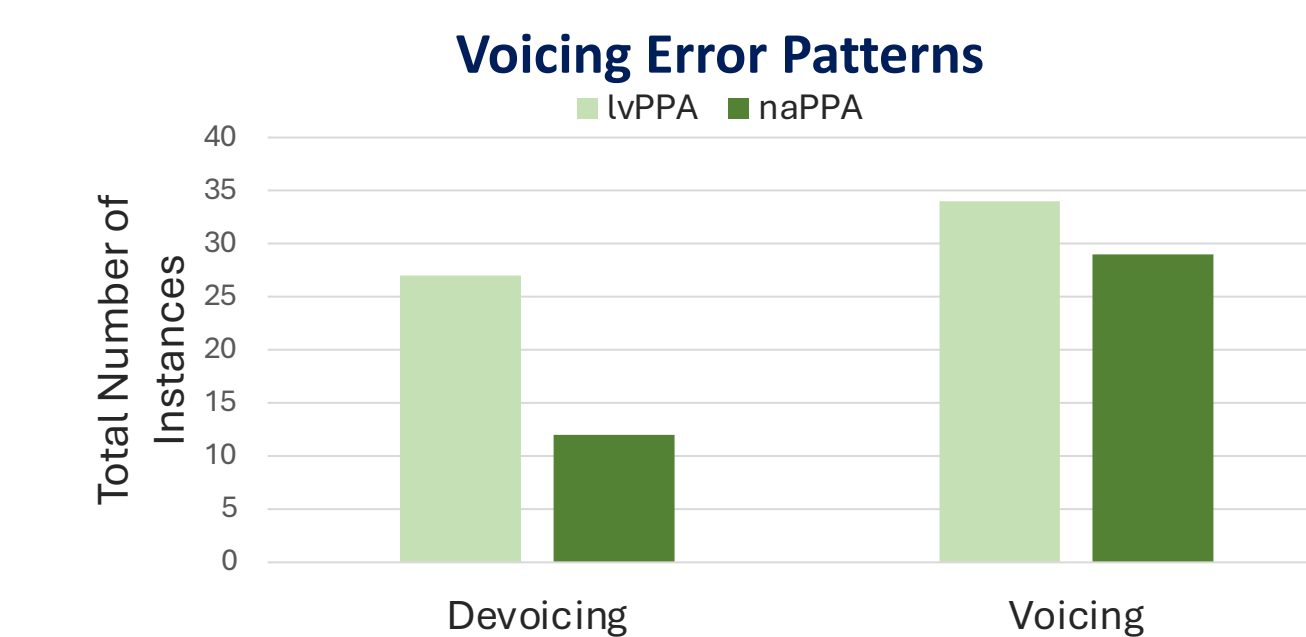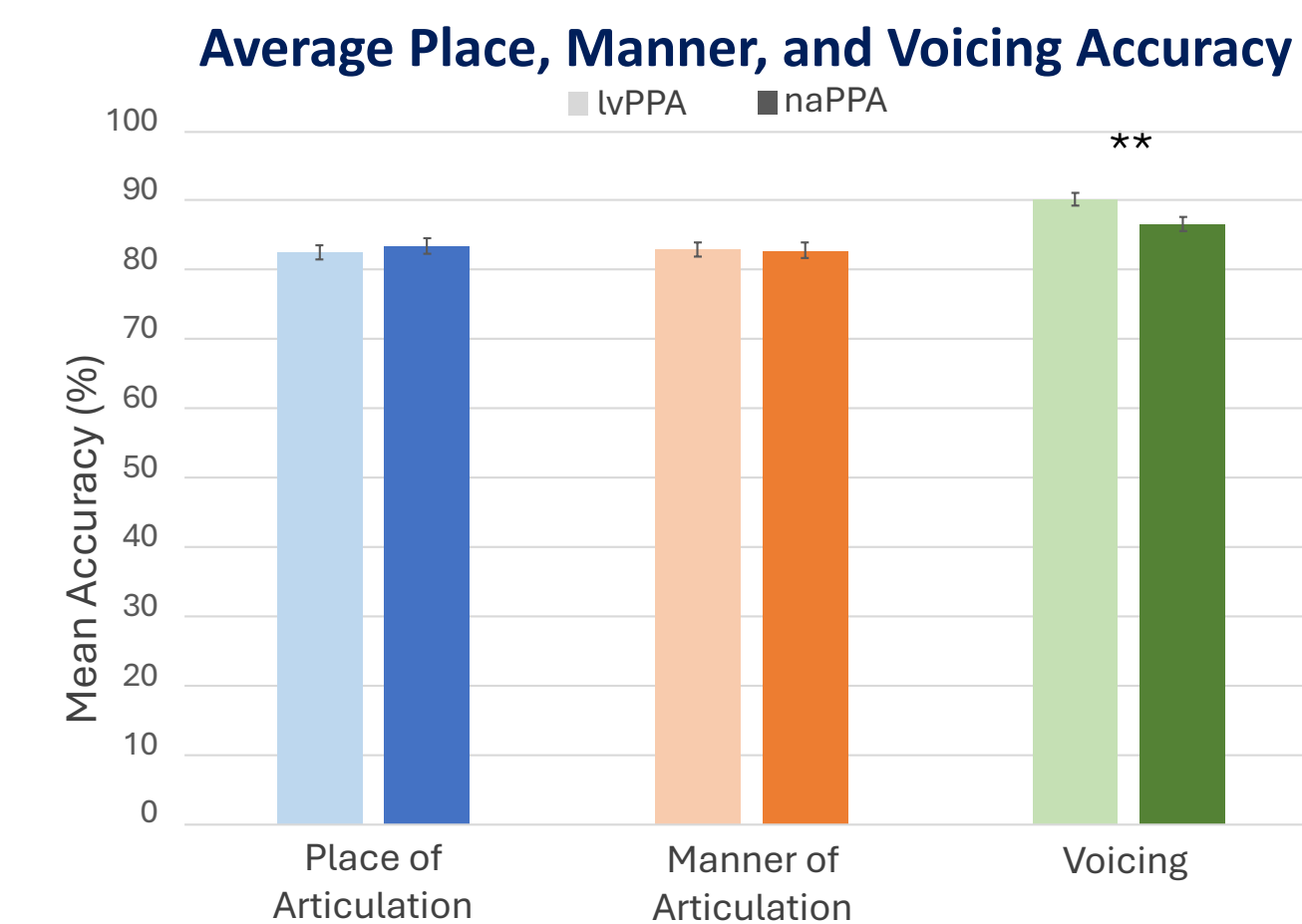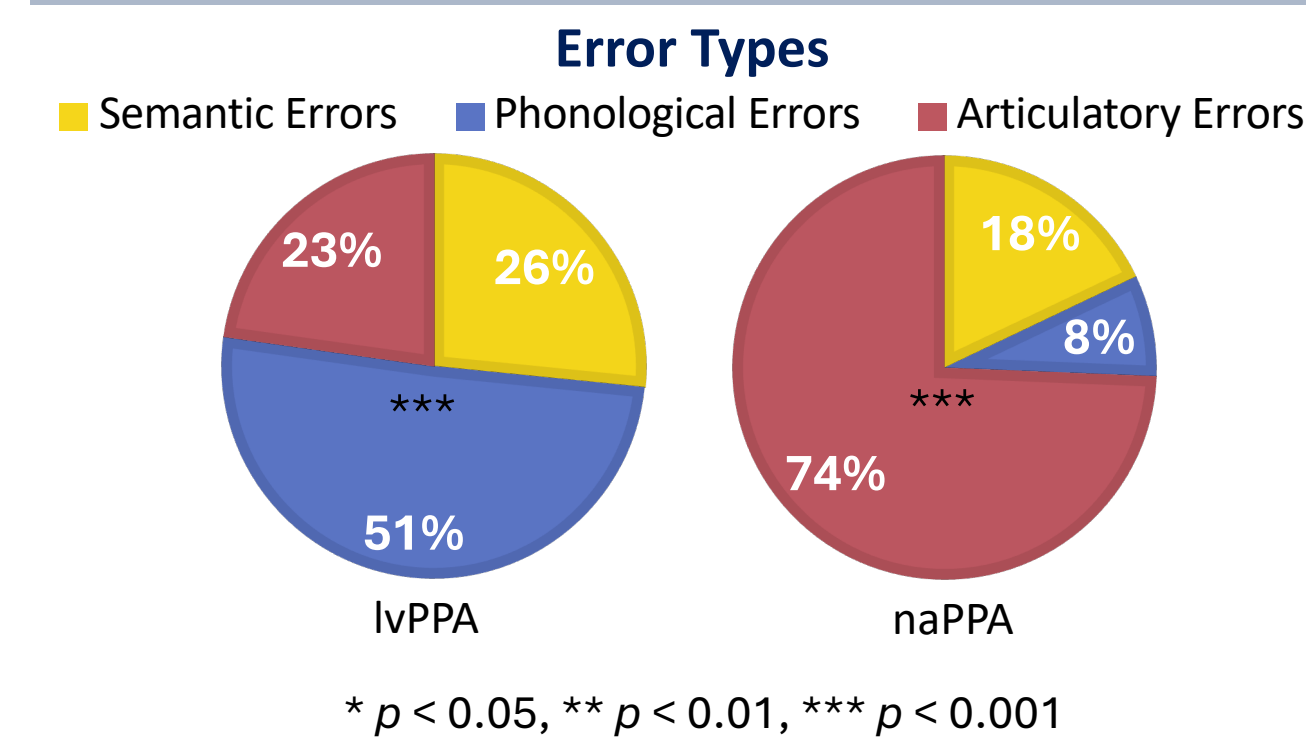
RECORDED SPEECH PRODUCTION ANALYSIS

The patient production data were phonemically transcribed, time-aligned, and segmented in Praat textgrids as a basis for quantifying phonological properties. Scripts extracted measurements, alignments, and coding variables to calculate feature accuracy scores, error frequencies, and other relevant acoustic and articulatory markers.

ANALYSES

Generalized linear models were used to assess accuracy and error frequency measures. **Mixed effects models** with fixed effects on diagnosis and number of phonemes in the target word and by-item and by-talker random intercepts were used to assess number of word attempts.
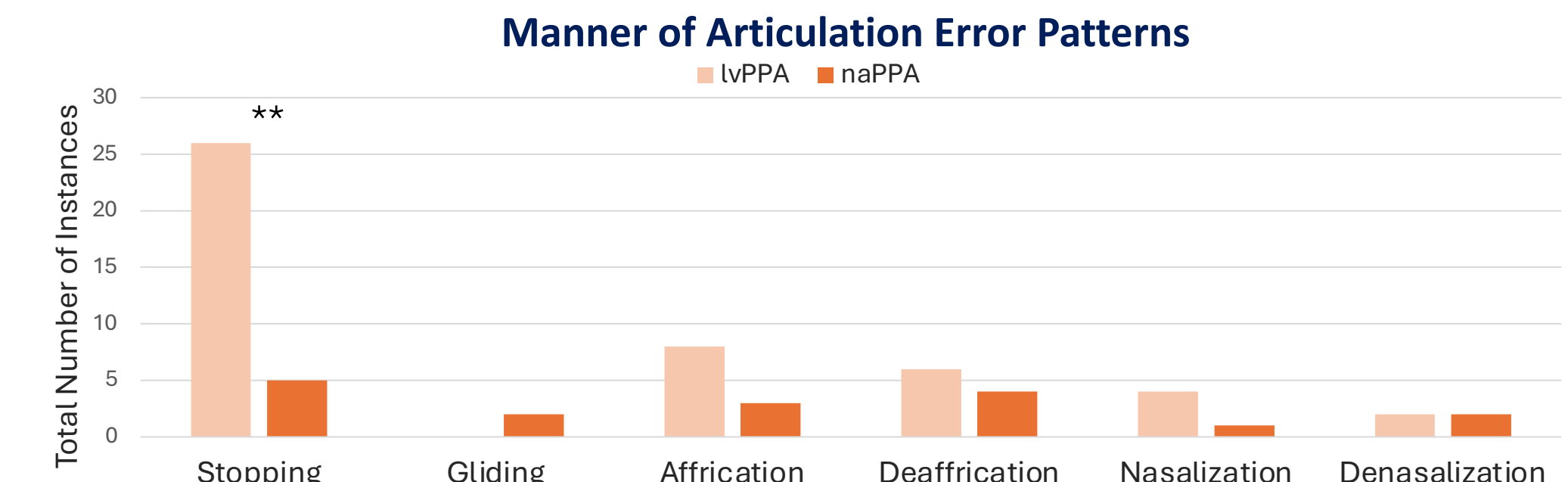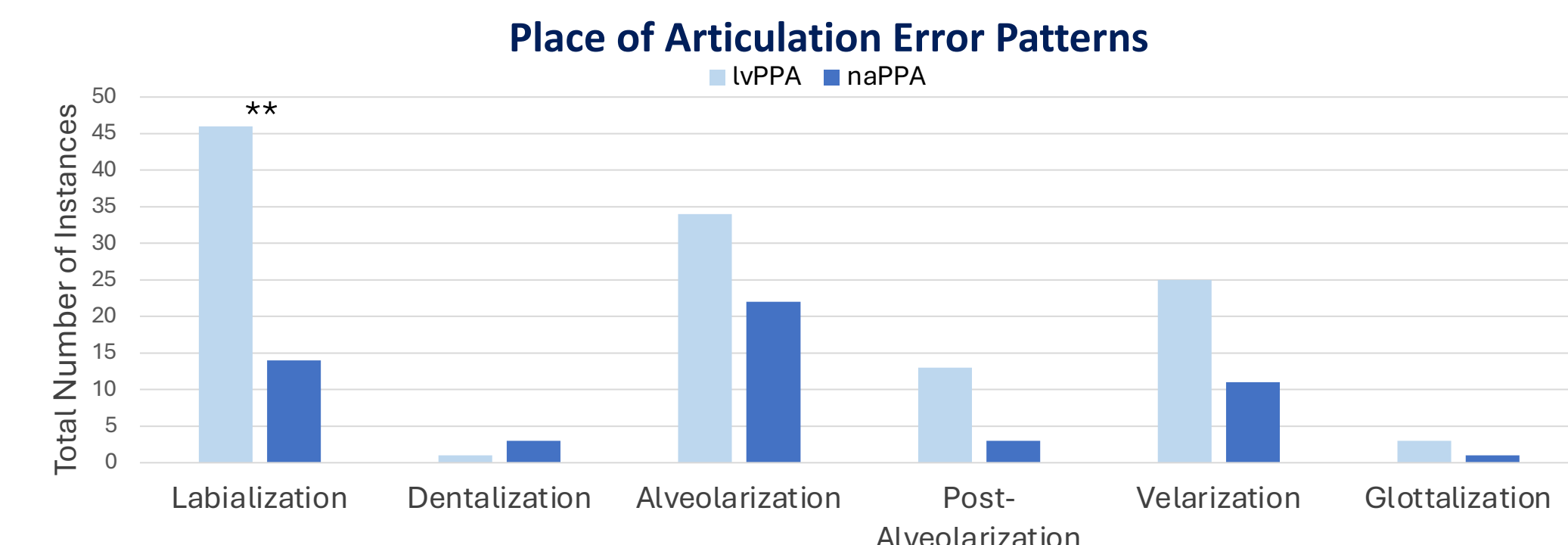

Praat segmentation of a speaker utterance "ball"

RESULTS

Error Types

Semantic Errors / Phonological Errors / Articulatory Errors

lvPPA: Articulatory 23%, Semantic 26%, Phonological 51% (***)
naPPA: Articulatory 74%, Semantic 18%, Phonological 8% (***)

* p < 0.05, ** p < 0.01, *** p < 0.001

Average Place, Manner, and Voicing Accuracy

(lvPPA / naPPA) — Place of Articulation, Manner of Articulation, Voicing (**)

Voicing Error Patterns

lvPPA / naPPA — Devoicing, Voicing

Average Number of Phonemes Produced Based on Target Word Length

lvPPA — naPPA

	b	SE	χ^2	df	p
Intercept	6.21	0.19			
Target Phonemes N	2.2	0.09	64.35	1	< 0.001
Diagnosis	-1.38	0.14	93.78	1	< 0.001
Interaction	-0.78	0.07	136.332	1	< 0.001

Average Number of Word Attempts Based on Target Word Length

lvPPA — naPPA

	b	SE	χ^2	df	p
Intercept	-0.6	0.12			
Target Phonemes N	0.06	0.06	64.35	1	< 0.01
Diagnosis	0.79	0.07	93.78	1	< 0.001
Interaction	0.16	0.03	136.332	1	< 0.001

Place of Articulation Error Patterns

lvPPA / naPPA — Labialization (**), Dentalization, Alveolarization, Post-Alveolarization, Velarization, Glottalization

Manner of Articulation Error Patterns

lvPPA / naPPA — Stopping (**), Gliding, Affrication, Deaffrication, Nasalization, Denasalization

DISCUSSION

PRODUCTION ATTEMPTS

Compared to naPPA patients, lvPPA patients showed a smaller increase in number of phonemes produced as number of phonemes in the target word increases. lvPPA patients showed a larger increase in number of word attempts with an increase in number of target phonemes, while naPPA patients reach a maximum of about two attempts regardless of further increase in word length.

PHONEMIC FEATURES

lvPPA and naPPA patients are comparable in **place and manner of articulation** accuracy, but lvPPA patients were significantly more accurate with respect to **voicing**. naPPA patients show similarity across place, manner, and voicing accuracy.

PRODUCTION ERRORS AND PROCESSES

naPPA patients exhibited mainly **articulatory** errors, whereas lvPPA patients displayed more **phonological** errors. Among place of articulation errors, lvPPA patients produced significantly more **labialization** errors. Among manner of articulation errors, lvPPA patients produced significantly more **stopping** errors. No other observations were found to be significant.

IMPLICATIONS

Identifying patterns of phonemic features and production processes between two variants of PPA can provide insight regarding correlation between specific language deficits and atrophied brain region. Findings can help support precise differential diagnoses as well as treatment targets.

FUTURE DIRECTIONS

More data are needed to confirm observations on phonemic features and production processes. Future studies will analyze post-treatment influences on accuracy and error patterns.

ACKNOWLEDGEMENTS & REFERENCES

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