EasyChair Preprint

№ 6288

Behavioral assessment of speech perception and language comprehension in primary progressive aphasia

Heather Dial, Rachel Tessmer and Maya Henry

August 12, 2021

Behavioral assessment of speech perception and language comprehension in primary progressive aphasia

Heather R. Dial[1]*, Rachel Tessmer[1], and Maya L. Henry[1,2]

[1] Department of Speech, Language and Hearing Sciences, University of Texas at Austin, Austin, TX, USA
[2] Department of Neurology, University of Texas at Austin, Austin, TX, USA

***corresponding author, heather.raye.dial@gmail.com**

Introduction

Primary progressive aphasia (PPA) is a neurodegenerative disorder characterized by progressive loss of speech and language (Gorno-Tempini et al., 2011). Speech perception and language comprehension deficits are manifest in PPA, but relatively understudied. Recent work indicates deficits at sublexical (Hardy et al., 2017), lexical, and semantic levels (Vonk et al., 2019); however, few studies have systematically investigated levels of processing within the same PPA cohort. The current study sought to fill this gap.

Methods

Participants with logopenic (lvPPA, *n* = 18), semantic (svPPA, *n* = 13) and nonfluent (nfvPPA, *n* = 10) PPA and age-matched controls (*n* = 11) completed three constrained tasks designed to assess receptive speech and language processing at sublexical, lexical-phonological, lexical-semantic, and semantic levels (Dial and Martin, 2017). Tasks included: syllable discrimination (SylDisc, sublexical) and auditory lexical decision (AudLexDec, lexical) tasks with phonological distractors, and a single picture-word matching task (PWM, lexical-phonological, lexical-semantic, semantic) with phonological, taxonomic, and associated distractors. Phonological distractors differed by a single phonemic feature.

Due to pandemic-related limitations on in-person testing, a subset (*n* = 17) completed tasks remotely. Severity did not significantly differ across PPA subtypes (indexed by the Mini-Mental State Exam; Folstein, Folstein, & McHugh, 1975). Pure tone thresholds for in-person participants did not differ across groups.

Results

One-way permutation tests examining accuracy as a function of participant group revealed significant differences for SylDisc ($p = 0.047$), AudLexDec ($p = 0.018$) and PWM ($p < 0.001$). Post-hoc, independent-samples permutation analyses were conducted (Table 1). For SylDisc, individuals with lvPPA performed worse than svPPA and controls. For AudLexDec and PWM, controls performed better than individuals with all three PPA subtypes. Additionally, for PWM, individuals with lvPPA performed worse than nfvPPA, and individuals with svPPA performed worse than lvPPA and nfvPPA. For AudLexDec, individuals with lvPPA and svPPA were equally likely to reject words (false negative) and accept nonwords (false positive; proportion of false negative vs. false positive errors = 0.54 vs. 0.46 for lvPPA, 0.51 vs. 0.49 for svPPA), whereas individuals with nfvPPA were more

likely to accept nonwords (proportion of false negative vs. false positive errors = 0.31. vs. 0.69). For PWM, individuals with lvPPA were more likely to accept phonological and taxonomic distractors; individuals with nfvPPA were more likely to accept phonological distractors; and individuals with svPPA were more likely to accept taxonomic distractors and reject correct matches (Figure 1).

Conclusions

Distinct deficits were observed across PPA variants. Individuals with lvPPA had impaired performance on SylDisc, AudLexDec, and PWM, whereas individuals with svPPA and nfvPPA had impaired performance on AudLexDec and PWM. Errors on AudLexDec and PWM provided further insight into level(s) of deficits. Overall, the results indicate deficits in receptive processing at the: sublexical level in lvPPA; lexical-phonological level in all variants; and lexical-semantic and semantic levels in lvPPA and svPPA. This study provides a more precise characterization of the linguistic profile of each PPA subtype. The unique constellation of deficits observed in each PPA subtype holds promise for differential diagnosis and for informing models of intervention.

References

Dial, H. R., & Martin, R. C. (2017). Evaluating the relationship between sublexical and lexical processing in speech perception: Evidence from aphasia. *Neuropsychologia*, *96*, 192-212.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-Mental State”: a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189-198.

Gorno-Tempini, M. L., Hillis, A. E., Weintraub, S., Kertesz, A., Mendez, M., Cappa, S. F., ... & Manes, F. (2011). Classification of primary progressive aphasia and its variants. *Neurology, 76*, 1006-1014.

Hardy, C. J., Agustus, J. L., Marshall, C. R., Clark, C. N., Russell, L. L., Brotherhood, E. V., ... & Warren, J. D. (2017). Functional neuroanatomy of speech signal decoding in primary progressive aphasias. *Neurobiology of Aging*, *56*, 190-201.

Martin, N., & Saffran, E. M. (2002). The relationship of input and output phonological processing: An evaluation of models and evidence to support them. *Aphasiology*, *16*, 107-150.

Vonk, J. M., Jonkers, R., Hubbard, H. I., Gorno-Tempini, M. L., Brickman, A. M., & Obler, L. K. (2019). Semantic and lexical features of words dissimilarly affected by non-fluent, logopenic, and semantic primary progressive aphasia. *Journal of the International Neuropsychological Society*, *25*, 1011-1022.

Zahn, R., Huber, W., Drews, E., Erberich, S., Krings, T., Willmes, K., & Schwarz, M. (2000). Hemispheric lateralization at different levels of human auditory word processing: a functional magnetic resonance imaging study. *Neuroscience Letters, 287*, 195-198.

Acknowledgments
We wish to acknowledge our funding sources: NIH/NIDCD F32 DC016812 (Heather Dial) and NIH/NIDCD R01DC016291 (Maya Henry). We also want to acknowledge the hard work and dedication of our participants, as well as the members of the Aphasia Research and Treatment Lab.

Table 1. Accuracy (percent correct) on syllable discrimination, auditory lexical decision, and picture-word matching for each group (top panel) and results of post-hoc independent-samples permutation tests (bottom panel).

	Syllable Discrimination	**Auditory Lexical Decision**	**Picture-Word Matching**
Participant Group	*Mean (SD)*	*Mean (SD)*	*Mean (SD)*
lvPPA	84.3 (8.8)	81.4 (8.5)	91.7 (4.9)
svPPA	91.5 (5.6)	80.3 (7.9)	82.2 (9.2)
nfvPPA	87.5 (6.5)	79.2 (7.8)	95.2 (4.0)
Controls	89.4 (6.4)	89.4 (7.9)	98.8 (1.3)
Comparison	*p-value*	*p-value*	*p-value*
lvPPA vs. svPPA	**0.010***	0.708	**0.001***
lvPPA vs. nfvPPA	0.322	0.519	0.074^
svPPA vs. nfvPPA	0.136	0.765	**< 0.001***
lvPPA vs. Controls	0.098^	**0.011***	**< 0.001***
svPPA vs. Controls	0.439	**0.010***	**< 0.001***
nfvPPA vs. Controls	0.535	**0.012***	**0.013***

Note: lvPPA = logopenic variant primary progressive aphasia, svPPA = semantic variant primary progressive aphasia, nfvPPA = nonfluent variant primary progressive aphasia, SD = standard deviation. * indicates $p < 0.05$ (also presented in bold for emphasis), ^ indicates $p < 0.1$.

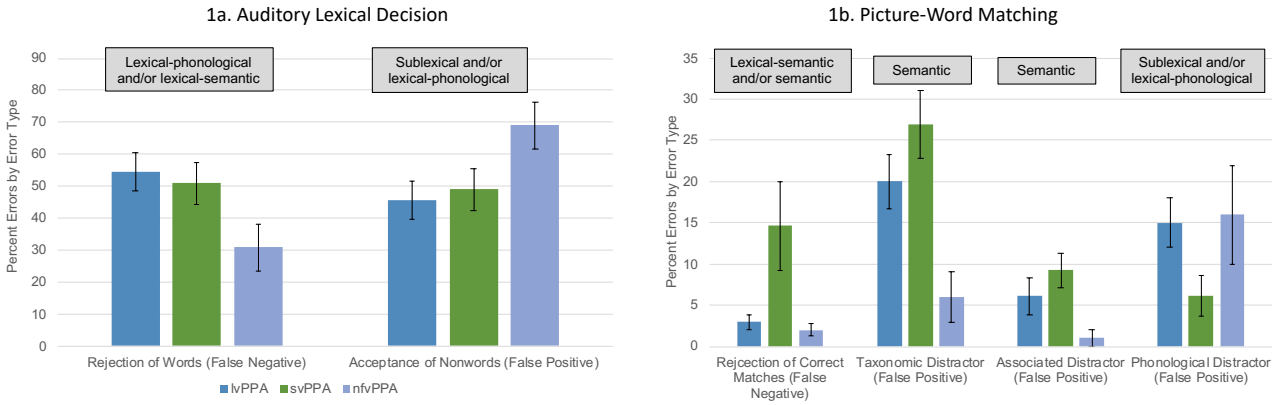

Figure 1a. Auditory lexical decision: error types (words, nonwords) and associated levels of deficits for each PPA subtype. False negatives reflect lexical-phonological and/or lexical-semantic deficits (Zahn et al., 2000), whereas false positives reflect sublexical and/or lexical-phonological deficits (Martin & Saffran, 2002).

Figure 1b. Picture-word matching: error types (correct matches, taxonomic distractors, associated distractors, phonological distractors) and associated levels of deficits for each PPA subtype. False negatives reflect lexical-semantic and/or semantic deficits. For false positives, the level of deficit leading to the error differs depending on the nature of the distractor. For taxonomic distractors, errors reflect a semantic deficit, whereas for phonological distractors, errors indicate sublexical and/or lexical-phonological deficits.

Note: Error bars reflect standard error. Text boxes depict level of deficit associated with a specific error type.