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Introduction

Studies exploring the relationship between brain structure and language function in primary progressive aphasia (PPA) provide important information about pathomechanisms of PPA and about functions of the healthy brain. However, existing studies mostly rely on small samples, are limited by the inclusion of only one PPA variant, and do not probe multiple aspects of language processing (e.g., Migliaccio et al., 2016), all of which limit their power to detect structure-behavior relationships and to identify commonly damaged areas across PPA groups that contribute to task performance. To address these issues, we explored structure-function relationships in a large cohort of PPA patients across multiple aspects of language processing.

Methods

We analyzed data from 61 controls and 118 PPA patients, including semantic (svPPA), logopenic (lvPPA), and nonfluent-agrammatic (nfvPPA) variants. We used multiple regression across PPA subtypes to analyze the relationship between either voxel-based morphometry (VBM) or cortical thickness measures and several language tests: picture naming (Boston Naming Test), auditory word-picture matching and repetition (Point and Repeat task), category and phonemic fluency, and the reading and writing subtest of the Aachen Aphasia Test. Our analyses controlled for age, gender, scanner, and, for VBM analyses, total intracranial volume. We also examined which brain areas correlated with task performance overlapped with cortical atrophy in each PPA group.

Results

All PPA groups were impaired compared to controls on all language tasks ($p<.001$). Each task showed multiple associations with atrophy across patient groups ($p<.0001$, uncorrected; Figure 1). Picture naming and word-picture matching were associated with atrophy to bilateral temporal cortex and left frontal cortex, and subsets of these regions were also associated with category fluency, consistent with a semantic role for these regions. PPA patients shared atrophy within clusters of these task-associated regions in

both temporal lobes, suggesting a common contribution to naming problems. In contrast to naming and word-picture matching, phonemic fluency, repetition, and reading and writing were associated with atrophy to left medial frontal or a sparser left fronto-parietal network, indicating potential roles of phonological, working memory and attentional deficits. Task-associated regions often overlapped with patient atrophy, though some did not, indicating that not-yet-atrophied regions also play a critical role in task performance. Regions associated with picture naming, word-picture matching and category fluency overlapped with atrophy across all patients, though especially lvPPA and svPPA; other task-associated regions only overlapped with lvPPA and/or nfvPPA atrophy (phonemic fluency, repetition) or did not overlap (reading and writing).

Conclusions

Our results provide converging evidence on how gray matter atrophy in the language network contributes to deficits of PPA patients. We observe strong evidence concerning brain regions associated with language processing in common clinical tests that is consistent with previous research (Mesulam et al., 2018; Rogalski et al., 2011). Furthermore, we show that overlapping damage across PPA variants is likely to create similarities in group performance in many single-word language tasks. Likewise, although all PPA variants were impaired on all language tasks, their atrophy did not always overlap with task-associated regions, indicating a role for non-atrophied cortex in task performance.

References

Mesulam MM, Rogalski EJ, Wieneke C, et al. Primary progressive aphasia and the evolving neurology of the language network. Nat Rev Neurol. 2014;10(10):554-569.

Migliaccio R, Boutet C, Valabregue R, et al. The Brain Network of Naming: A Lesson from Primary Progressive Aphasia. PLoS One. 2016;11(2):e0148707. Published 2016 Feb 22.

Rogalski E, Cobia D, Harrison TM, et al. Anatomy of language impairments in primary progressive aphasia. J Neurosci. 2011;31(9):3344-3350.

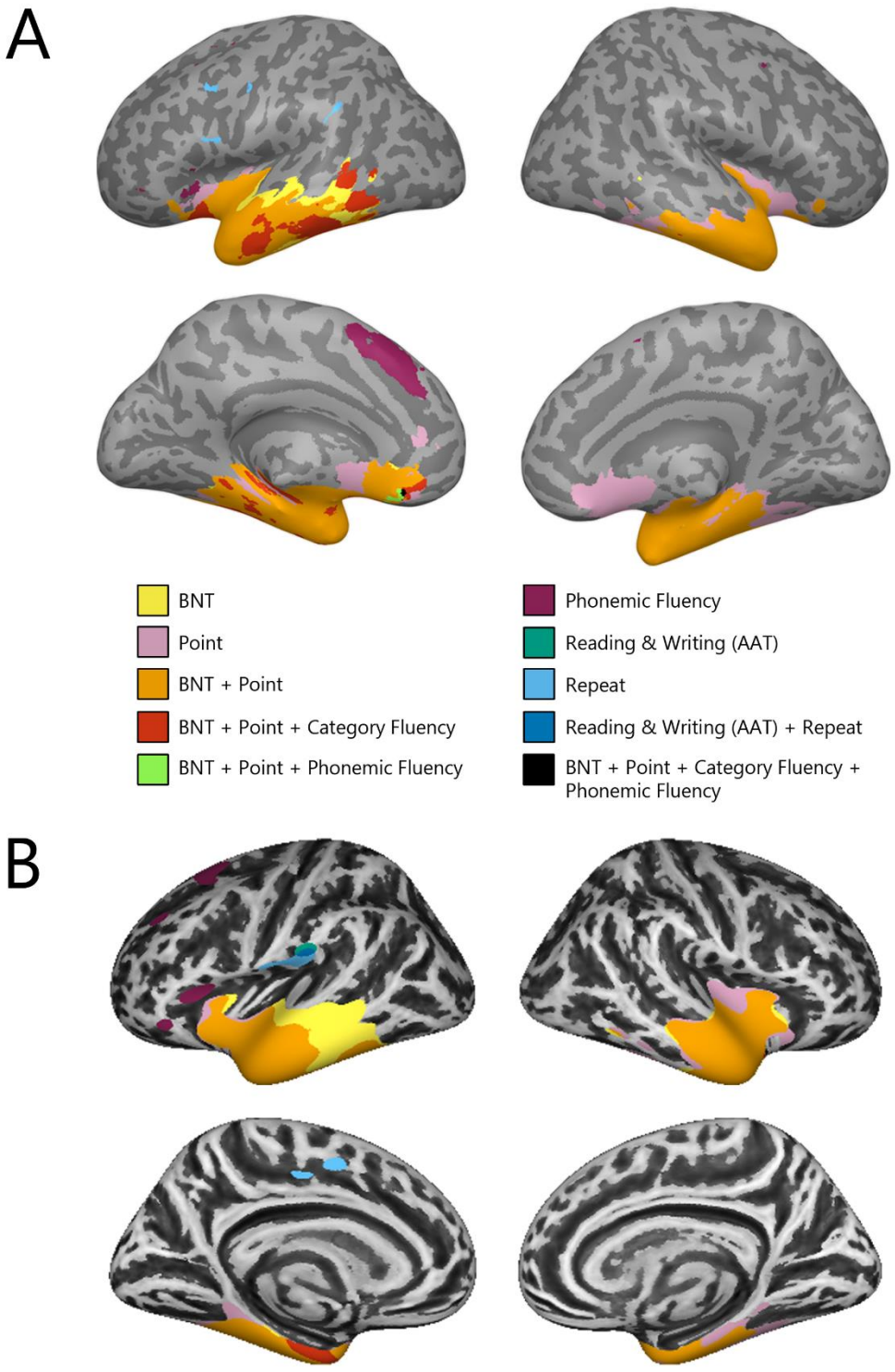

Figure 1. Correlations of behavior and structural brain measures across PPA subtypes. (A) Correlations with voxel-based morphometry (VBM) and (B) cortical thickness ($p < .0001$, uncorrected).