Language, meaning, and localization

Last year's words, next year's words

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Neurology® 2017;88:924–925

See page 970

For last year's words belong to last year's language
And next year's words await another voice.
—T.S. Eliot[1]

Neurologic practice is deeply rooted in the ideal of localization. Some would argue that neurology arose in the mid-18th century from the study of language localization, regarded as a uniquely human function. The classic aphasias, those described by Broca and Wernicke, were believed to represent exemplars of lesion-symptom mapping, but many features of language-onset dementias went unexplained by conventional aphasiology.[2] The description of aphasia syndromes in neurodegenerative diseases has largely overturned the static conceptualization of a brain language postcode.[3] While incremental and cumulative, these neural network–based conceptual changes have proven critical for elucidating the neural basis of communication, both in healthy speakers and those with neurologic disease. Greater understanding of the interconnectedness and functionality of language regions remains particularly important clinically, such as for decision-making around epilepsy or oncology surgery, and can assist in providing prognostic information for affected individuals and their families.

In this edition of *Neurology*®, Pillay et al.[4] sought to describe the linguistic processes and neural correlates underlying auditory description naming impairments relative to picture naming using a voxel-based lesion-symptom mapping (VLSM) approach. The authors argue for an important distinction between processing the meaning of a single word (as is the case in picture naming tasks) and processing the meaning of phrases. Multiword (or connected) speech requires understanding of individual words, as well as appreciation of syntax and paralinguistic features. The authors tested this principle in 51 stroke patients using 3 behavioral tests: (1) auditory description naming, during which participants named a verbally described object; (2) picture naming; and (3) auditory sentence comprehension, during which participants decided whether a spoken phrase accurately described a video. VLSM was used to link behaviors to lesions on a voxel-by-voxel basis, only including voxels lesioned in at least 3 patients.

Picture naming as a covariate to represent single-word semantic knowledge, deficits in auditory description naming, and auditory sentence comprehension were associated with lesions localized to the mid-to-posterior portion of the middle temporal gyrus (pMTG). Pillay et al.[4] worked on the assumption that auditory description naming and auditory sentence comprehension share a dependence on processes specific to spoken language comprehension compared to picture naming, which likely does not depend on the integration of connected speech. Their data also support a role for the inferior frontal lobe in spoken language comprehension. However, they were unable to demonstrate that damage in this region impaired comprehension more than picture naming. Rather, they highlight the central role of the lateral temporal cortex in multiword integration independent of frontal or parietal executive control systems.

These data complement earlier work examining semantic cognition in healthy and pathologic cohorts. A meta-analysis of regions associated with the executive component of semantic cognition revealed that the pMTG, as well as prefrontal cortex and dorsal angular gyrus, are consistently recruited during executively demanding semantic tasks, compared to tasks with low executive requirements.[5] Data from the 51 included studies suggested that pMTG activation was associated with deficits in receptive semantic processing and not expressive tasks.[5] Inhibitory transcranial magnetic stimulation directed to the pMTG also disrupts semantic functioning in paradigms that have increased executive requirements.[6] Similarly, resting-state functional MRI shows the interconnectedness among the pMTG, the inferior frontal gyrus (IFG), and the anterior temporal lobe,[7] with a breakdown in either the pMTG or IFG leading to deficits in executively demanding semantic judgments.[6,8]

Recent functional and structural neuroimaging work in neurologically healthy participants further supports the notion that pMTG plays a crucial role

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Go to Neurology.org for full disclosures. Funding information and disclosures deemed relevant by the authors, if any, are provided at the end of the editorial.

as connector in executively demanding language networks.[9] It links anterior temporal and prefrontal regions for semantic representation and control and connects with inferior frontal gyrus during tasks and at rest forming a semantic control network thought to be distinct from executive function. Davey et al.[9] proposed that the pMTG may enable a dynamic semantic retrieval process regulated by task and context.

Together, lesion-mapping and event-related neuroimaging studies suggest that the pMTG, alongside the IFG, forms part of an integrated hub that coordinates complex or integrated semantic information enhancing retrieval and interpretation of connected speech.[10] In their comprehensive review, Lambon Ralph et al.[10] propose a convergent framework for the understanding of the neural and computational bases of semantic cognition. They maintain the importance of the bilateral anterior temporal lobes, in keeping with the hub-and-spoke theory of semantic representation, but also recognize the contribution of other regions to the access, retrieval, and prioritizing of semantic knowledge. These regions include the pMTG, giving further strength to the notion of its contribution to semantic function. The findings reported by Pillay et al. will be of interest to aphasiologists and neurologists, as well as informing language localization mapping for surgical planning and post-stroke rehabilitation.

STUDY FUNDING

No targeted funding reported.

DISCLOSURE

Brodtmann serves on the scientific advisory board of the Brain Health Initiative, a United States–based firm, and on the editorial Board for *Neurology* and the *International Journal of Stroke*. Vogel is funded by an Australian NHMRC fellowship (#1082910). Go to Neurology.org for full disclosures.

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