Neurobiology of multifunctional prosody: Scope and trajectory
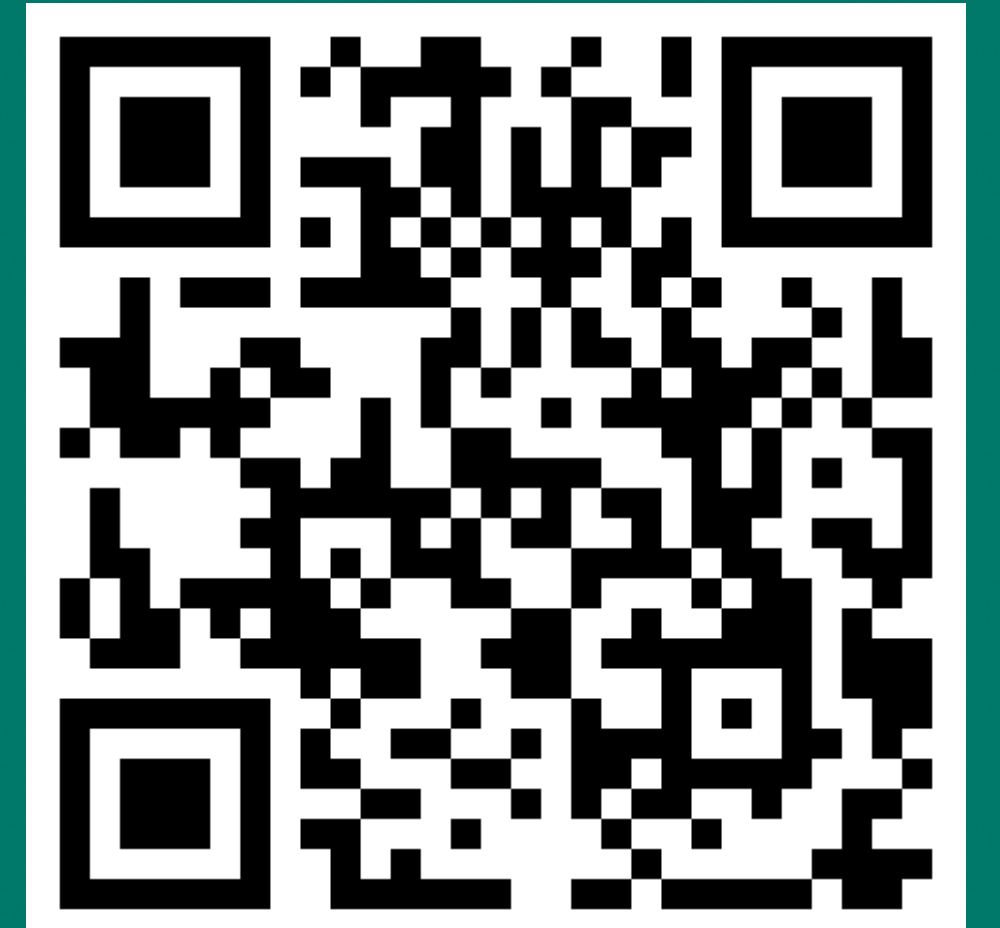
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What is prosody?

Prosody covers a variety of interconnected phenomena (e.g., stress, tone, rhythm and intonation), bridging sensation and cognition from attention to interaction [1-4]. Its multifunctionality makes it a key entry point to speech origins and linguistic processing. Yet neural mechanisms remain elusive, hindered by incomplete data and prosody's ill-defined status. Recent frameworks, such as the Morphospace Framework [5], might allow researchers to predict and map prosody's links to sensory, cognitive, and neural functions.

SCOPE

Attention orientation
Survival advantage
Shared across species

Salience detection
Social adaption

Formal features
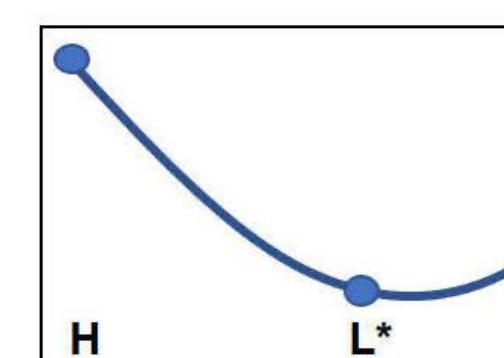Linguistic rules

Interactional aspects
Communicative roles
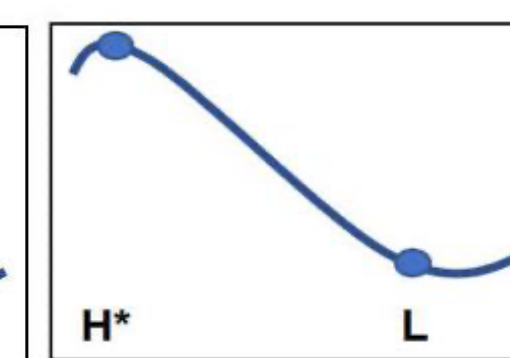Sophisticated in humans

GPT-5 mini

GPT-5 mini

[ˈándεn] 'duck'   [ˈàndεn] 'ghost'

Sven ate the **DUCK**.
(**WHAT** did Sven eat?)

SVEN ate the duck.
(**WHO** ate the duck?)

SIGNIFICANCE

Why it is important?

- Evolutionary roots: helps understand human cognition and communication
- Early development: informs language acquisition
- Clinical relevance: aids diagnosis and treatment
- Linguistic scope: reveals language processing mechanisms

Why it is challenging?

- Intertwined functions: sensory & cognitive integration and segregation
- Processing challenge: same acoustic variables
- Data gap: limited empirical evidence
- Neuroscience status: not searchable in meta-analytic platforms
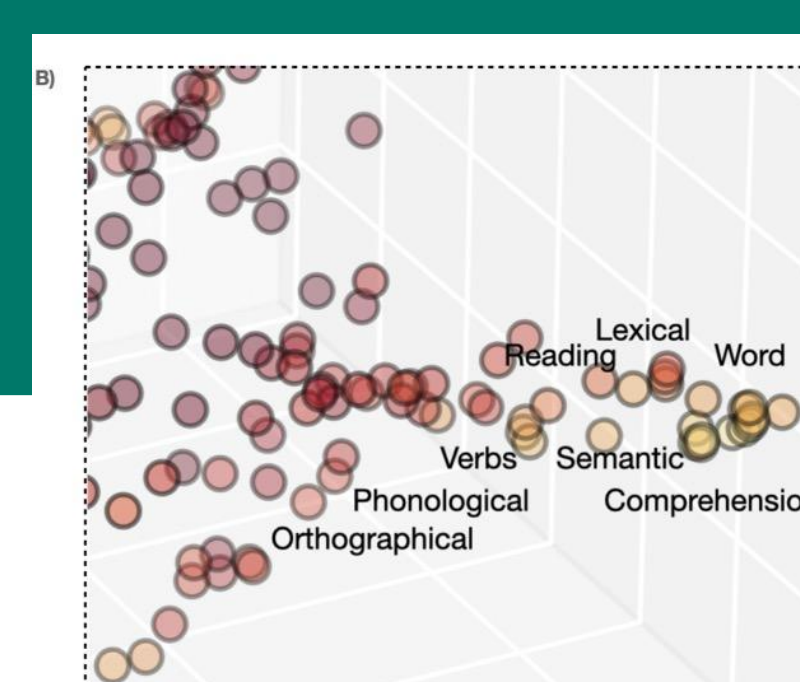
TRAJECTORY

Morphospace Framework

Clustering: Grouping brain functions by circuit similarities
Predictability: Forecasting functions from similarities
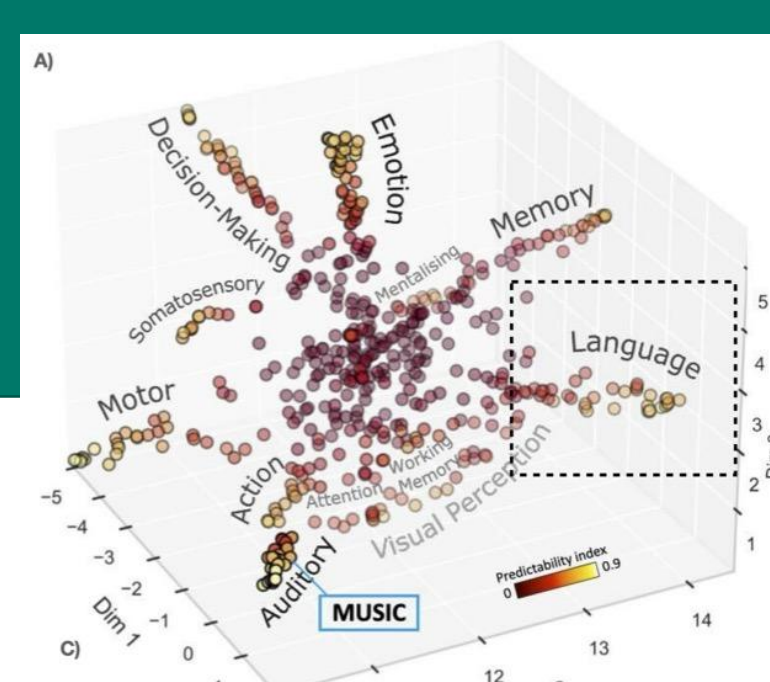
Brain-Cognition Morphospace

Gap: Cognitive maps omit prosodic features in language
Action: Map fMRI studies of prosody in the morphospace

Morphospace of prosody

Hypothesis: A central position, integrating loosely defined sensory and cognitive functions

Attentional network

Salience network

Multiple-Demand network

Images are used with permission from Pacella et al. (2024).

References:
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3. Zora, H., Tremblay, A. C., Gussenhoven, C., & Liu, F. (2023). Crosstalk between intonation and lexical tones: Linguistic, cognitive and neuroscience perspectives. Lausanne: Frontiers Media SA.
4. Zora, H., Bowin, H., Heldner, M., & Hagoort, P. (2025). Lexical and information structure functions of prosody and their relevance for spoken communication: Evidence from Psychometric and Electroencephalographic Data. Journal of Cognitive Neuroscience.
5. Pacella, V., Nozais, V., Talozzi, L., Abdallah, M., Wassermann, D., Forkel, S.J., & de Schotten, M.T. (2024). The morphospace of the brain-cognition organization. *Nature Communications, 15*, 8452.