



Reduced functional activation in the right Crus II is coupled with increased cerebral connectivity in processing linguistic violations—A study based on the auditory language localizer task

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Introduction

Linguistic function of the cerebellum

- The **posterolateral cerebellum** (esp. **right Crus II**) operates synergistically with the cerebral networks over many linguistic tasks (e.g., LaBel & D'Mello, 2023).
- The cerebellum was also activated in **language localizer tasks** (Fedorenko et al., 2024).

The present study

- Aim:** to characterize the nature of the cerebellar involvement in an auditory language localizer task, by conducting both **functional activation** and **generalized psychophysiological interaction (gPPI) analysis**.

Method

Participants

- 117 cognitively normal participants (age range 18–81).

Stimulus construction

- 30 Cantonese sentences / condition, all 12-syllable long (Table 1).

Condition	Example
Semantically valid	Cantonese. 表弟真係好掃洗碗同埋掃地 English. Cousin really hates washing dishes and sweeping the floor. Literal. Cousin / younger-male / really / is / very / hate / wash / bowl / along / with / sweep / floor
Semantic violation	Cantonese. 掃地好掃真係洗碗同埋表弟 Literal. sweep / floor / very / hate / really / is / very / wash / bowl / along / with / cousin / younger-male
Jabberwocky	Cantonese. 係地掃掃真係碗碗表埋好洗 Literal. is / floor / hate / sweep / really / younger-male / bowl / cousin / along / with / very / wash
Randomized syllables	Cantonese. 掃係同弟埋碗表真洗掃地好 Literal. sweep / is / along / younger-male / with / bowl / cousin / really / wash / hate / floor / very

Table 1. Stimulus design for the functional localizer task

Task

- To covertly repeat the final syllable of each sentence.

Data acquisition

- Structural:** T1-weighted MPRAGE sequence
- Functional:** multi-band EPI sequence (TR = 800 ms, TE = 37 ms, flip angle = 52°, voxel size = 2 × 2 × 2 mm³, 72 axial slices)

Data analysis

- Preprocessing:** Conn toolbox (Whitfield-Gabrieli et al., 2012)
- Functional activation analysis:** custom-made NiLearn scripts
- Functional connectivity analysis:** Generalized psychophysiological interaction (gPPI) analysis in Conn toolbox

Result I: Functional activation

- Widespread functional activation was found between valid sentences and randomized syllables, with valid sentences eliciting stronger activation predominantly the left-hemispheric core language areas.
- In support for a substantial role of the cerebellum in linguistic processing, the **right Crus II** was more **strongly activated** by **semantically valid sentences** than **randomized syllables**.
- Interestingly, the opposite pattern was found for left Crus I and II, as well as for a similarly broad activity in the right hemisphere (the lateral and medial superior frontal gyrus, middle frontal gyrus, anterior cingulate cortex, and superior temporal gyrus).

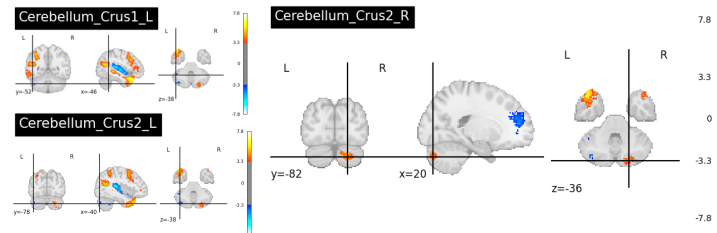


Fig. 1. Crus II in the cerebellum is more strongly activated in the semantically valid condition compared to randomized syllables.

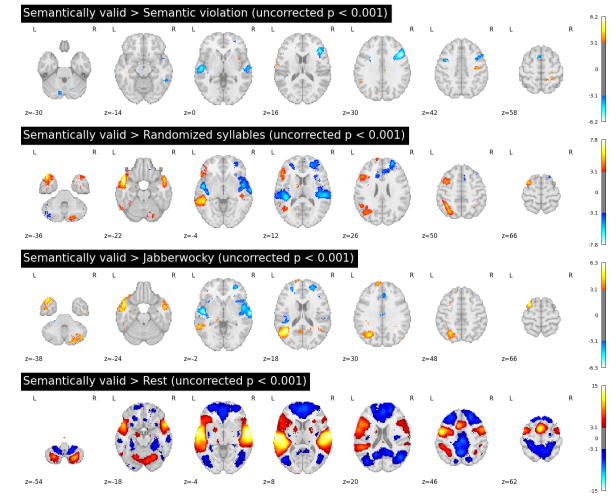


Fig. 2. Differences in functional activation in the semantically valid condition compared to other conditions.

Result II: Functional connectivity analysis with gPPI

- During the processing of randomized syllables:** **increased functional connectivity between right Crus II and left superior and middle frontal gyrus, bilateral precentral gyrus, and left postcentral gyrus (Fig. 3).**
- No such functional connectivity differences were found for left Crus I and II.

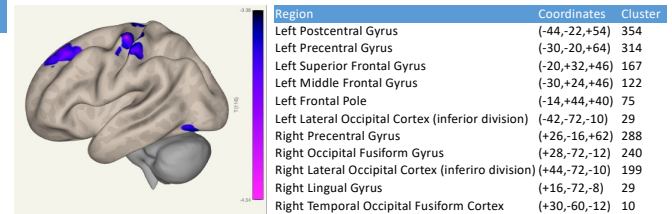


Fig. 3. Functional connectivity of Crus II is smaller in the semantically valid condition, relative to randomized syllables condition.

Discussion

- Although the right Crus II was less activated by randomized syllables, that was accompanied by increased connectivity with the frontoparietal regions.
- Convergent evidence was observed for Jabberwocky conditions.
- Crus II may be a major hub for **linguistic error detection and correction** within the cerebrocerebellar network.

References

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- LeBel, A., & D'Mello, A. M. (2023). A seat at the (language) table: incorporating the cerebellum into frameworks for language processing. *Current Opinion in Behavioral Sciences*, 53, 101310.
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