Intracerebral electrical stimulation of the left word-selective temporal cortex induces pure alexia

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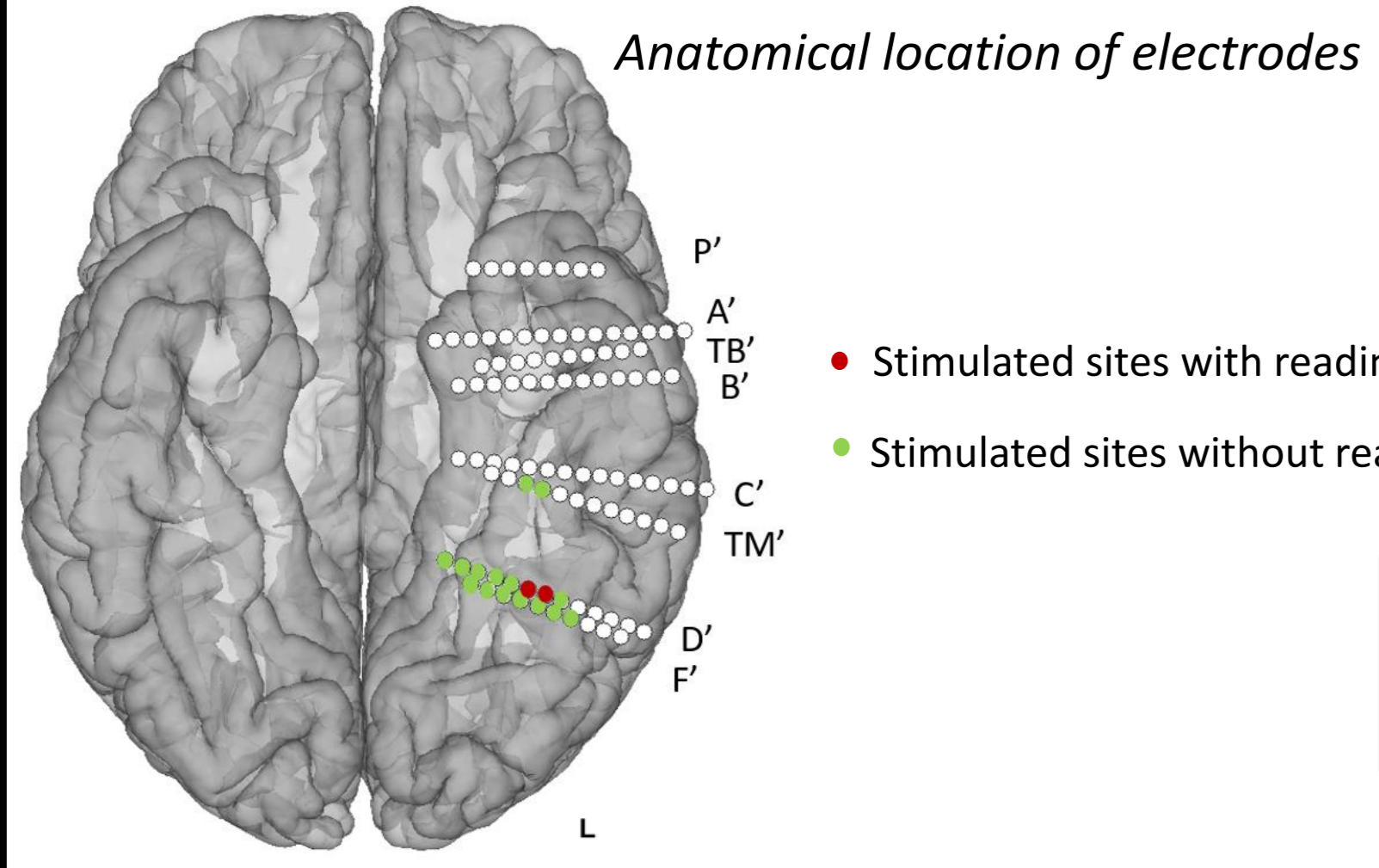[5]Université de Lorraine, CHRU-Nancy, Service de Neurochirurgie, F-54000 Nancy, France
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INTRODUCTION

❖ The central role of the left ventral occipito-temporal cortex (VOTC) in processing letter strings was initially suggested by pure alexia in lesion studies.

❖ Direct Electrical Stimulation (DES) is a powerful tool to assess causality between regions and functions. But until now DES case studies did not provide stringent evaluation of the stimulation effect on reading performance.

❖ Here : functional mapping with FPVS (Fast Periodic Visual Stimulation Lochy et al., 2015;2018), numerous behavioural tasks with accuracy and RT measurements during DES, effective connectivity of the stimulation site using an original approach (concomitant FPVS-DES).
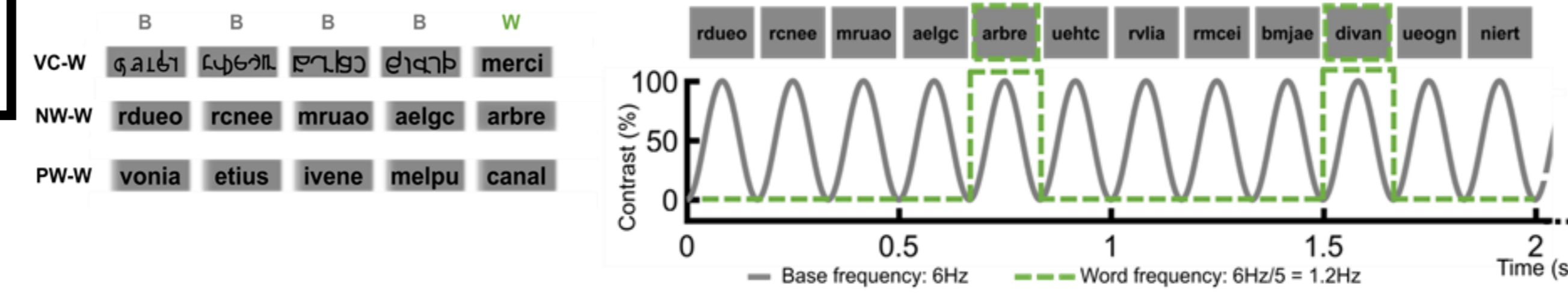
MATERIAL & METHODS

Case study
- LV is a right-handed 39 year-old woman
- Refractory focal epilepsy
- Implanted with 15 electrodes (8 in the left VOTC)

Anatomical location of electrodes

- ● Stimulated sites with reading impairment
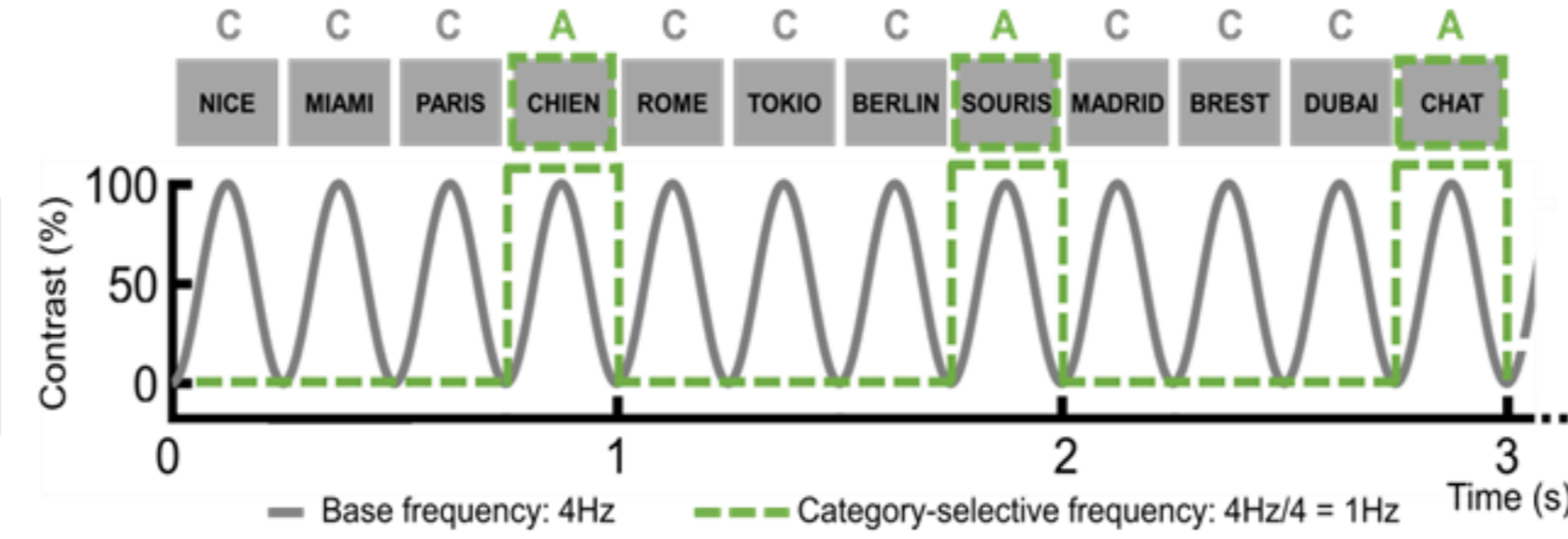- ● Stimulated sites without reading impairment

Functional mapping with FPVS paradigms

- Word-selective response (Lochy et al., 2015; 2018)

- Semantic categorization (Volfart et al., 2021)

Animal names embedded in cities every 4th images

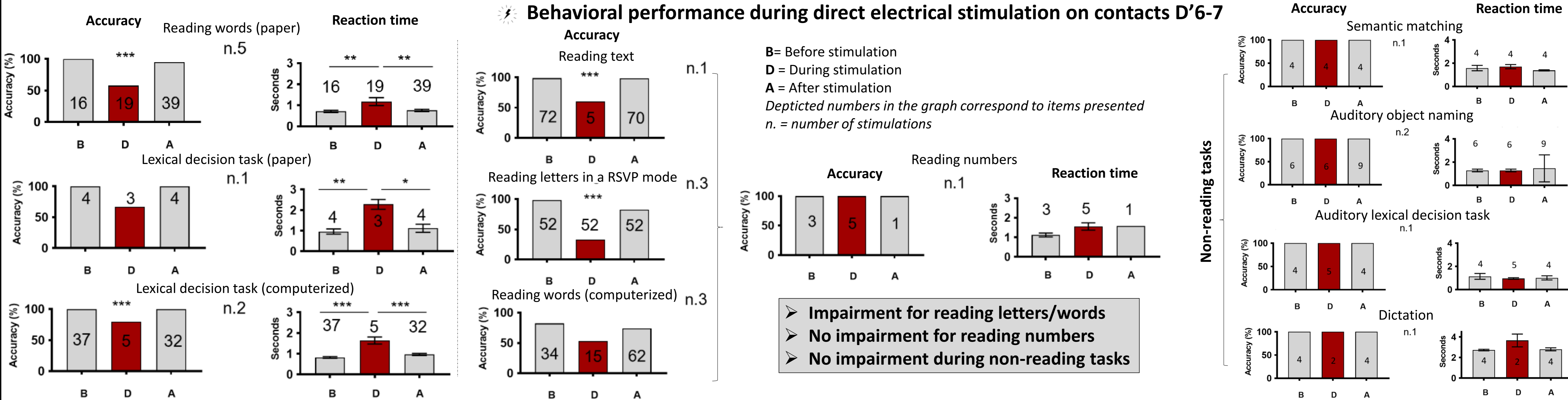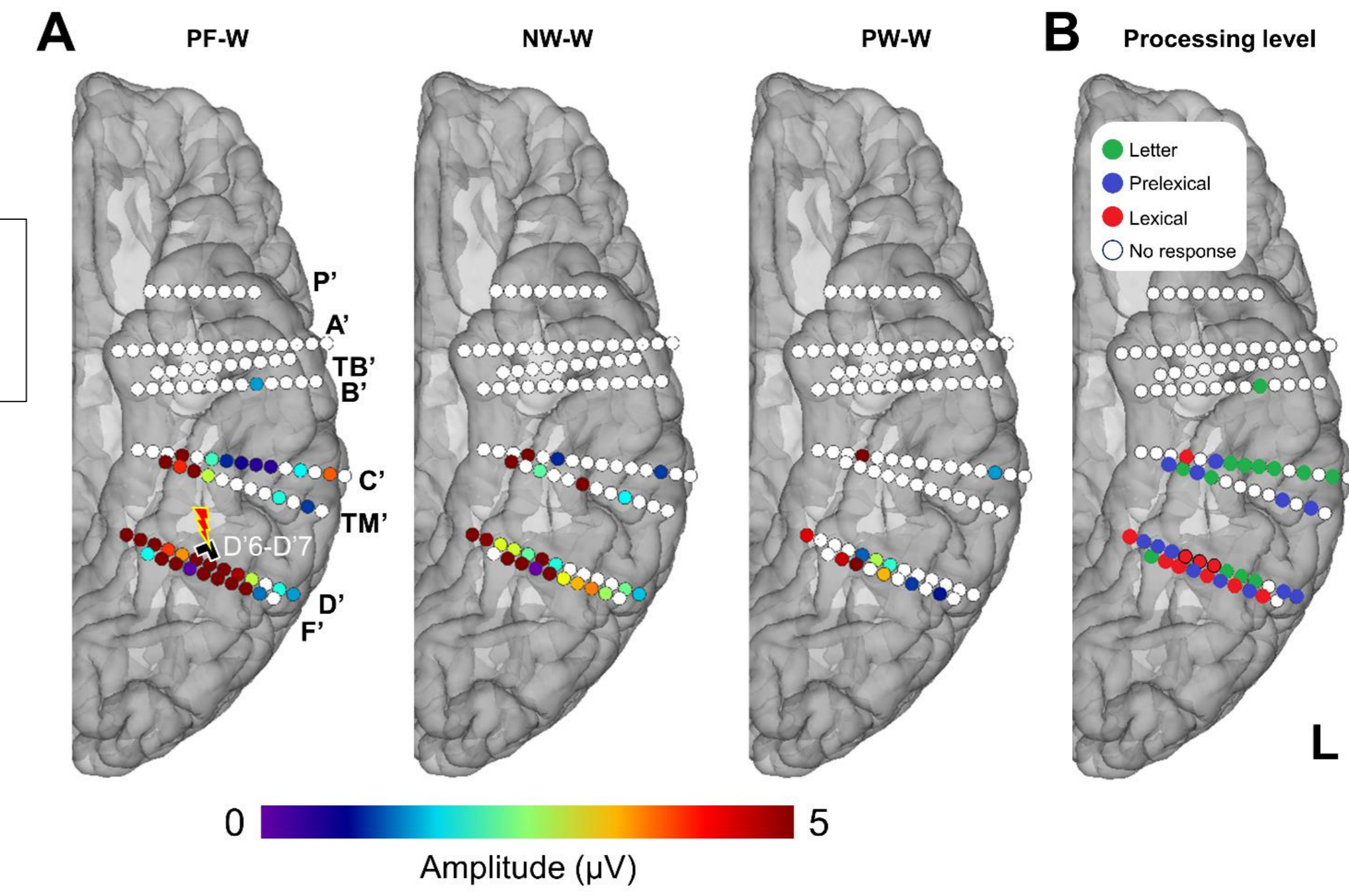**Direct electrical stimulation on left VOTC electrodes**

- Reading tasks / Non-reading tasks

Reading aloud letter strings (isolated words, text) — Auditory object naming

Reading aloud numbers — Auditory lexical decision task "Stylo ?" Yes / "Gompe?" No

Reading aloud isolated letters in a RSVP mode — Dictation

Lexical decision task (computerized and paper) — Semantic matching

SEEG RESULTS

**SEEG recordings during a FPVS paradigm on word-selective response without DES**
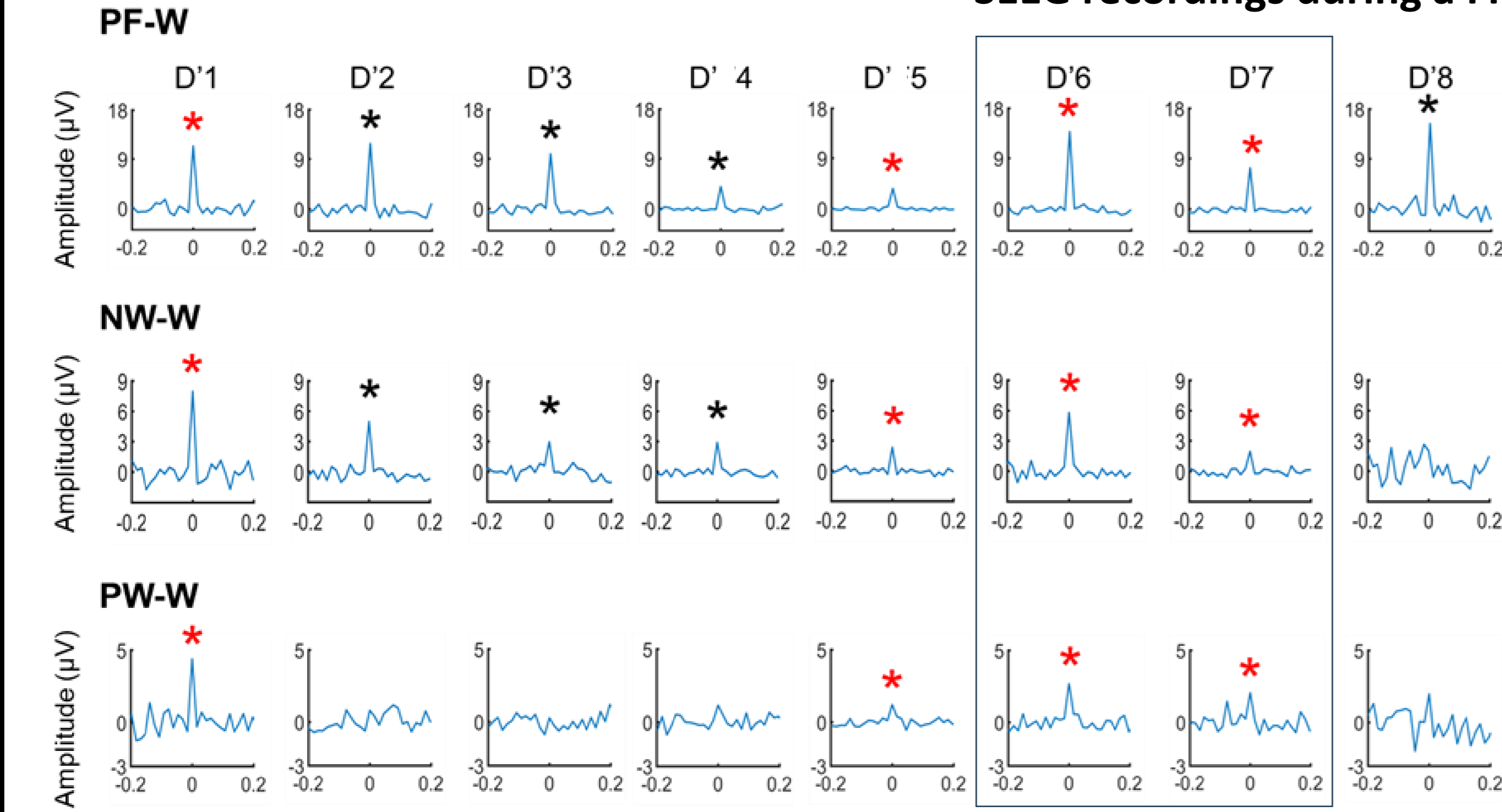
D'6-7 : Highly word-selective with large response amplitudes for all 3 conditions
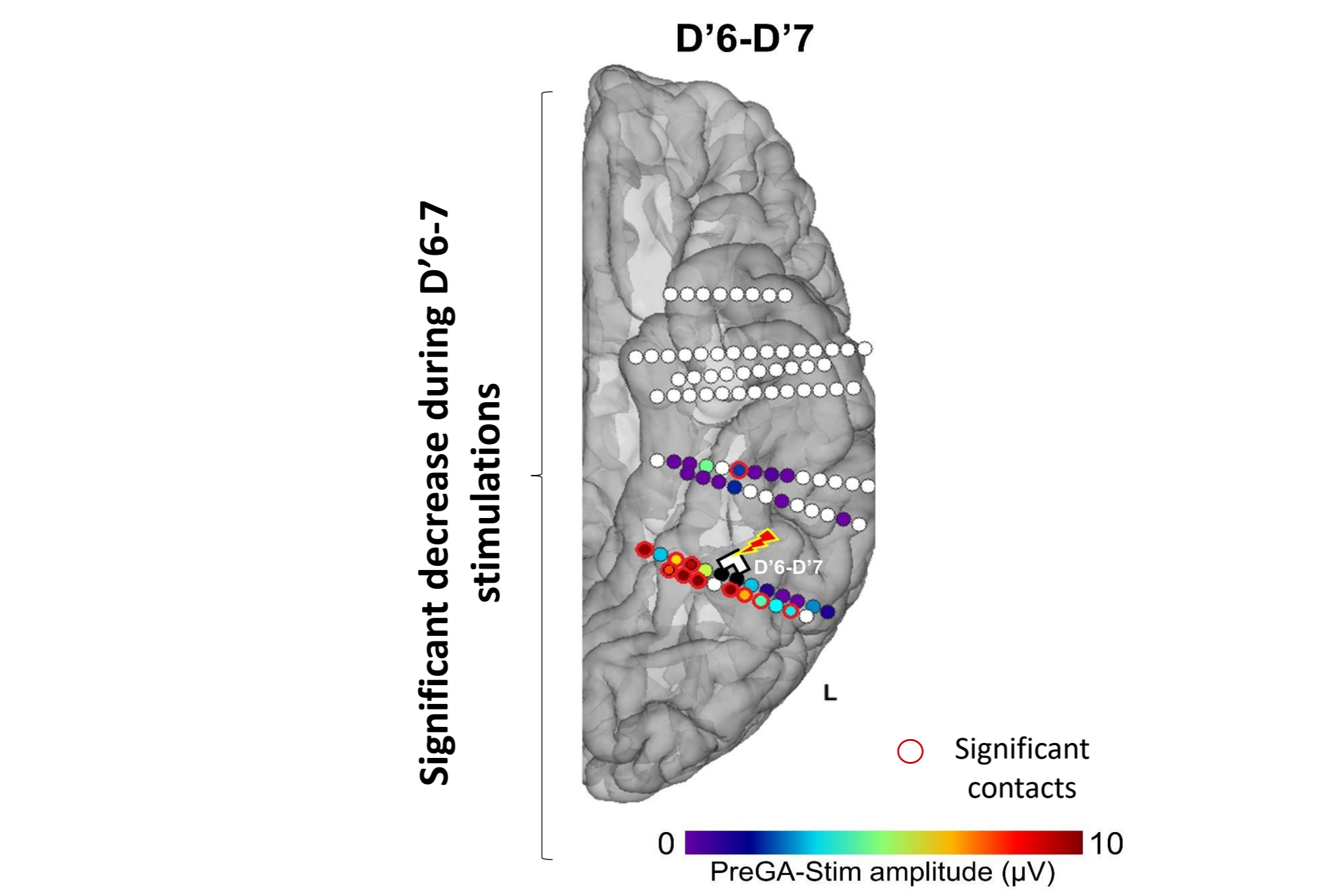
D'6-7 : Pure lexical contacts

B Processing level
- ● Letter
- ● Prelexical
- ● Lexical
- ○ No response

Amplitude (µV) 0 — 5

BEHAVIORAL RESULTS

Behavioral performance during direct electrical stimulation on contacts D'6-7

B = Before stimulation
D = During stimulation
A = After stimulation
Depicted numbers in the graph correspond to items presented
n. = number of stimulations

➤ Impairment for reading letters/words
➤ No impairment for reading numbers
➤ No impairment during non-reading tasks

EFFECTIVE CONNECTIVITY

Effective connectivity of the critical region observed through concurrent intracerebral electrical stimulation and FPVS (Semantic paradigm)
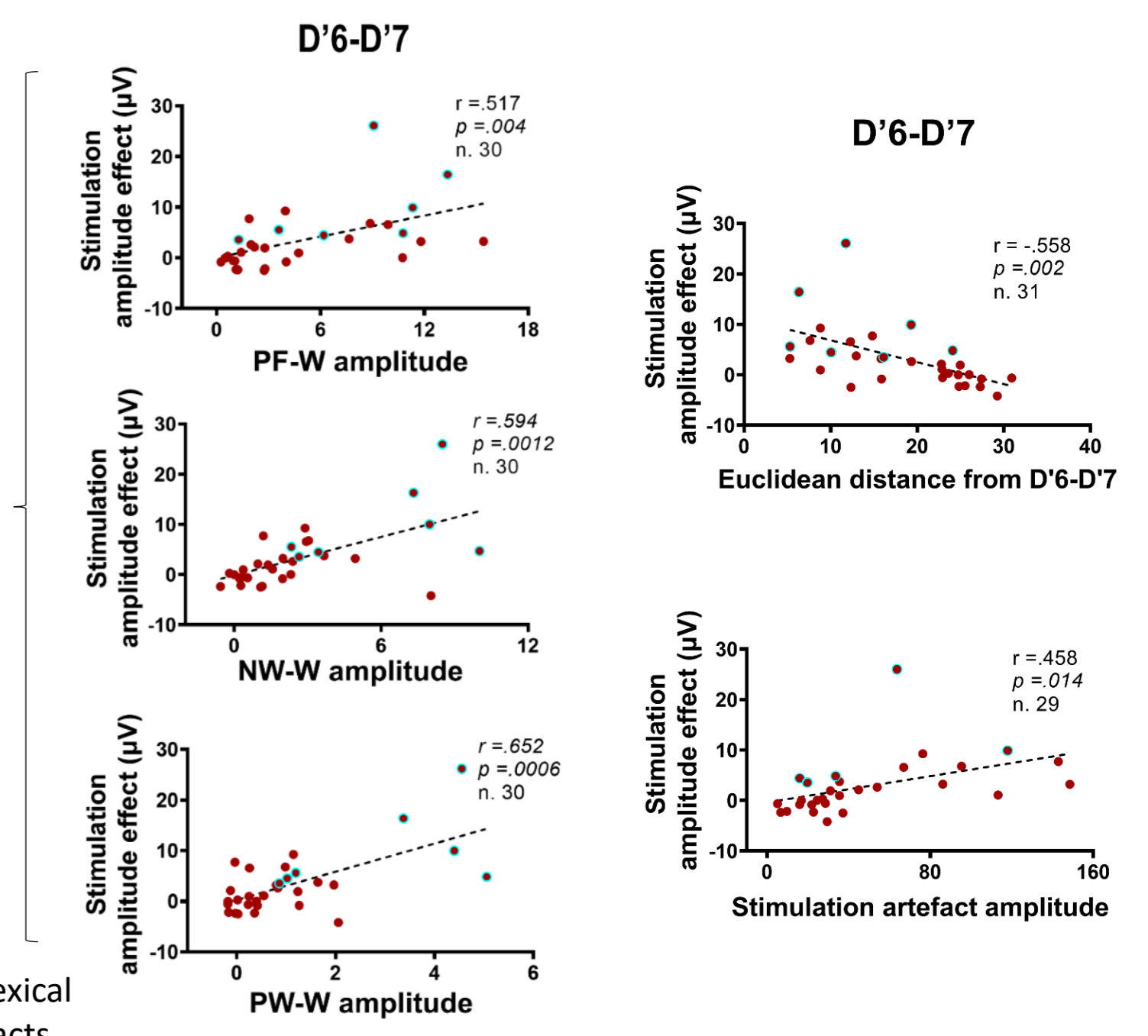
Examples of amplitude variation across time of the word response at 2Hz (semantic paradigm) linked to electrical stimulation of D'6-D7
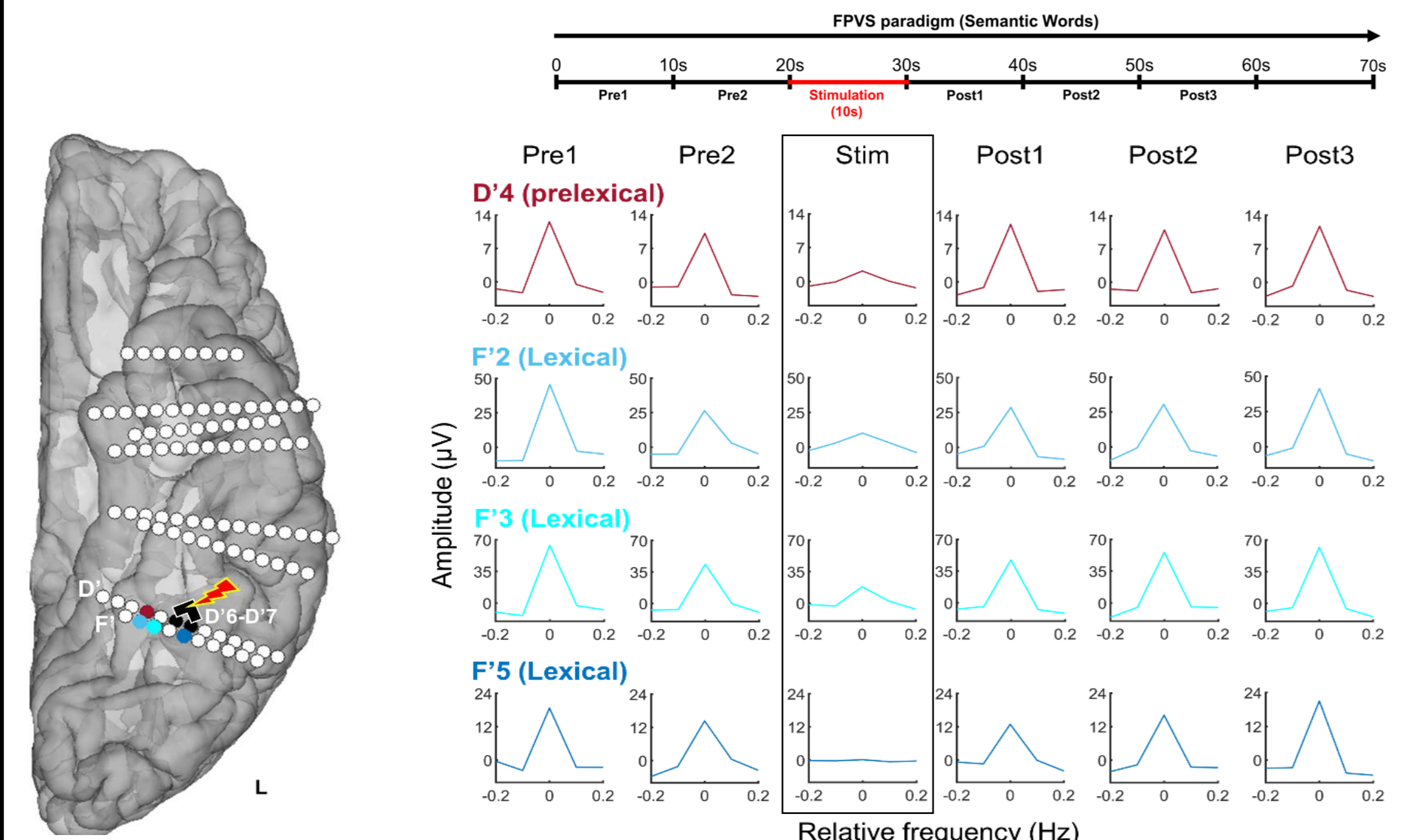
Spatial distribution of the stimulation effect (word response amplitude at 2Hz: averaged amplitude pre1/pre2 – amplitude during stim) relative to the critical site

D'6-D'7

Significant decrease during D'6-7 stimulations

PreGA-Stim amplitude (µV) 0 — 10
○ Significant contacts
○ Pure lexical contacts

Correlations between the stimulation effect and independent word responses outside stimulation

D'6-D'7

r = .517 p = .004 n. 30
r = .594 p = .0012 n. 30
r = .652 p = .0006 n. 30
r = -.558 p = .002 n. 31
r = .458 p = .014 n. 29

DISCUSSION

- Frequency-tagging approach in SEEG showed that the stimulated site was located in a highly word-selective region.
- DES of the word-selective left VOTC induced pure alexia remarkably selective to words reading.
- Diagnostic value of behavioral task with fast presentation during DES (letter reading).
- Effective connectivity of the critical site showed that the behavioural effect is related to the impairment of a word-selective network in the left VOTC.

REFERENCES

- Lochy A, Van Belle G, Rossion B (2015). A robust index of lexical representation in the left occipito-temporal cortex as evidenced by EEG responses to fast periodic visual stimulation. Neuropsychologia 66:18–31.
- Lochy, A., Jacques, C., Maillard, L., Colnat-Coulbois, S., Rossion, B., & Jonas, J. (2018). Selective visual representation of letters and words in the left ventral occipito-temporal cortex with intracerebral recordings. Proceedings of the National Academy of Sciences, 115(32).
- Volfart, A., Rice, G., Ralph, M. A. L., & Rossion, B. (2021). Implicit, automatic semantic word categorisation in the left occipito-temporal cortex as revealed by fast periodic visual stimulation. NeuroImage, 238, 118228.