Exploring Prosody Recognition in Glioma Patients:

A reverse-correlation Study

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Glioma

- Glioma is a growth of cells that starts in the brain or spinal cord; The cells in a glioma look similar to healthy brain cells called glial cells. often detected during epileptic seizures (90%) or accidentally (10%). (Mandonnet et al., 2017).Diagnosis involves MRI and biopsy.
- Gliomas are most common in adults between ages 45 and 65 years old. But glioma can happen at any age.
- Classified into low-grade (Grades 1 and 2) for slow progression and high-grade (Grades 3 and 4) for aggressiveness.(Duffau, 2018).
- Treatments include surgery (primary choice), radiotherapy, and chemotherapy.(Mandonnet & Duffau, 2018).
- Post-surgery patients often struggle with emotion recognition, especially through facial cues, while the impact on auditory emotion recognition is less studied. Despite thorough analysis of language deficits in these patients, the exploration into their prosody decoding abilities—significantly impaired in stroke or epilepsy patients—is notably lacking.

Prosody in glioma

- Prosody is a part of social cognition skills, allowing the transmission of emotional and linguistic intents through speech.
- There are two types of prosody: linguistic prosody and emotional prosody. Prosody disorders involve difficulties in understanding(perception) or expressing variations in voice tone and language affective aspects, which affects social engagement and quality of life.
- Post surgery patients despite good recovery due to brain plasticity, the presence of a glioma and brain surgery can affect social cognition abilities, leading to altered social interactions and changes in social behavior(Duffau & Taillandier, 2015).
- This is why it seems interesting to us to investigate **whether**, firstly, the glioma modifies prosody recognition performance and **whether**, secondly, the excision of this glioma has an impact on these skills.

  Sammler et al (2018) demonstrated that after excision of a patient's meningioma, his linguistic prosody recognition skills improved. However, Aura (2012) demonstrated a slight weakening of the recognition abilities of linguistic and emotional prosody in a patient after excision of a low-grade glioma in the immediate post-operative period.

The research question

Q:

Do patients with glioma present problems of the perception of linguistic prosody in pre and post operatively?

O:

- The main objective would be to highlight a possible disorder of prosody recognition, in a sensitive and specific manner (emotional and/or linguistic prosody) in patients with glioma pre- and post-operatively.

-The secondary objective would be to analyze and identify potential correlations between disorders of emotional prosody processing with other emotion recognition tasks, and disorders of linguistic prosody processing with other linguistic tasks on the other hand.

S:

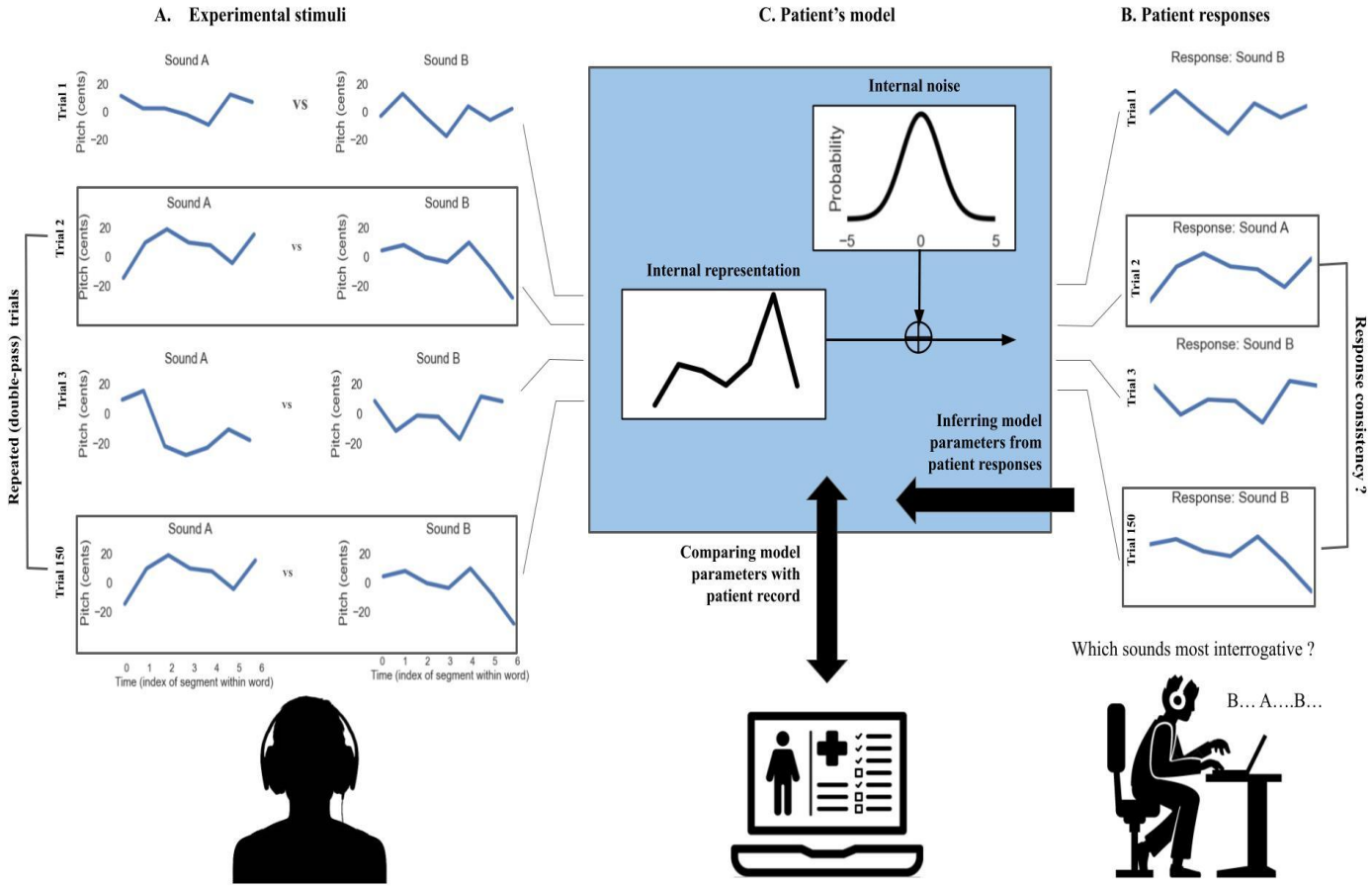
- *As in previous studies we were able to validate that the reverse-correlation framework was sensitive to acquired disorders of prosody perception in participants who recently had a right-hemisphere brain stroke (Adl Zarrabi et al., 2023) and we know that prosody perception is influenced both by kernels and internal noise.*

The experiment

- We employed a psychophysical procedure with reverse-correlation analysis to assess how patients perceive speech prosody (Ponsot et al., 2018).
- Patients with planned glioma surgery (Neurosurgery Dept, Hôpital Pitié Salpêtrière in Paris), are tested 1-3 weeks pre- and post-surgery, with a 15-minute assessment consisting of 150 trials, each consisting of 2 random pronunciations of the word "really?"
- For each pair, participants are tasked to indicate which of the two words sound more interrogative. Participant responses are then analysed to extract both a pitch contour that corresponds to their mental representation of interrogative prosody (a final pitch rise), and a measure of how consistently they use this representation (also called "internal noise").
- Both representation and noise are then compared pre- and post-surgery, as well as correlated with standardized tests for emotional and linguistic prosody and broader cognitive and emotional evaluations conducted as part of the surgery process.

Computational model

- we model the perceptual decisions made by glioma patients regarding classifying words as interrogative/not, based on their pitch contour.
- To do this, we use the experimental paradigm of reverse-correlation to extract parameters of a model composed of
  - an internal "representation", or prosodic template (also called psychophysical kernel, or classification image in the psychophysical literature; Murray, 2011) and
  - a measure of "internal noise" which is inferred from response consistency and response bias across the repeated double-pass trials, using the simulation procedure of Neri (2010).



Adl Zarrabi et al., 2023

Participants

We studied a group of N= 21 patients who had a glioma tumor (has passed the surgery) and 16 of them had neuropsy follow-up (i-Mel and revcor M=30 days after surgery)

and N=21 (male: 13;M=58 yo, SD=13.34)

		Grouped by type				
		Missing	Overall	controls	post	pre
n			58	21	16	21
sex, n (%)	f	0	25 (43.1)	8 (38.1)	8 (50.0)	9 (42.9)
	m		33 (56.9)	13 (61.9)	8 (50.0)	12 (57.1)
age, median [Q1,Q3]		0	47.5 [37.0,53.0]	58.0 [52.0,64.0]	38.5 [34.8,47.5]	37.0 [35.0,47.0]
hemisphere, n (%)	D	21	19 (51.4)		8 (50.0)	11 (52.4)
	G		18 (48.6)		8 (50.0)	10 (47.6)
lateralizaion, n (%)	Controls	0	21 (36.2)	21 (100.0)		
	Frontal		22 (37.9)		9 (56.2)	13 (61.9)
	Insulaire		2 (3.4)		1 (6.2)	1 (4.8)
	Pariétal		3 (5.2)		1 (6.2)	2 (9.5)
	Temporal		10 (17.2)		5 (31.2)	5 (23.8)
Grade, n (%)	2	22	18 (50.0)		8 (50.0)	10 (50.0)
	3		15 (41.7)		7 (43.8)	8 (40.0)
	4		2 (5.6)		1 (6.2)	1 (5.0)
	Glioblastome		1 (2.8)			1 (5.0)
Délai-postop, median [Q1,Q3]		26	30.5 [17.0,44.0]	nan [nan,nan]	30.5 [17.0,44.0]	30.5 [17.0,44.0]
Résultats-bruts-i-MEL , median [Q1,Q3]		21	12.0 [11.0,12.0]	nan [nan,nan]	12.0 [11.0,12.0]	12.0 [11.0,12.0]
Patho-sain, median [Q1,Q3]		21	0.0 [0.0,1.0]	nan [nan,nan]	0.0 [0.0,1.0]	0.0 [0.0,1.0]

* *The i-MEL fr: French-speaking Montreal computerized language assessment protocol*

* *revcor : reverse correlation*

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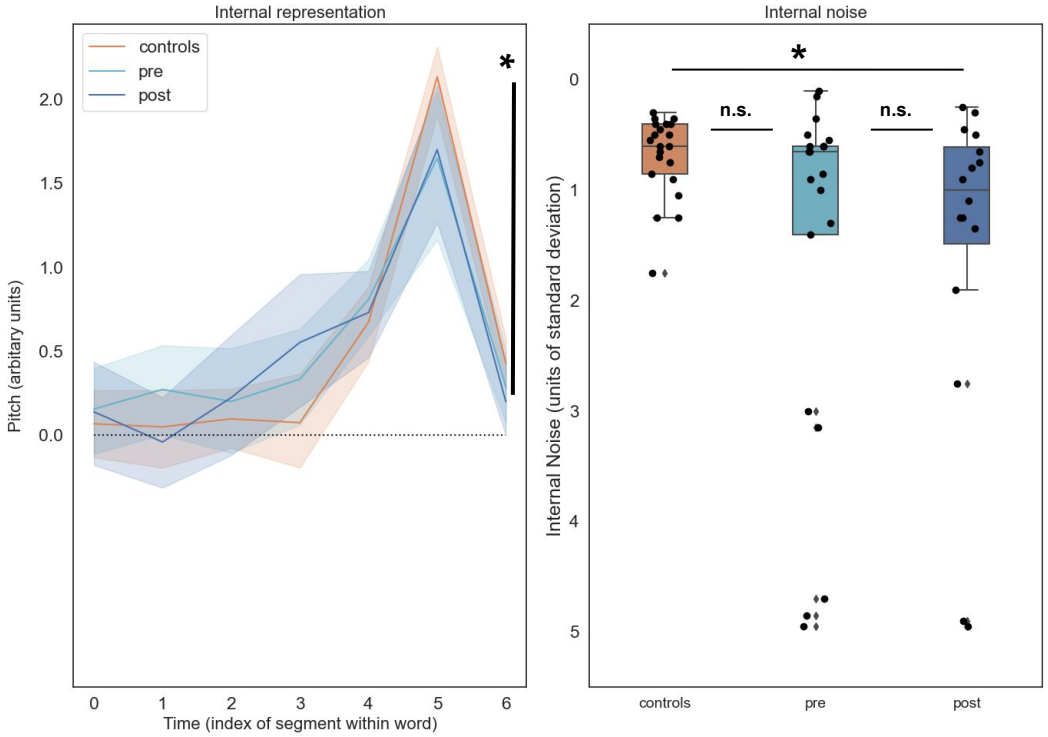
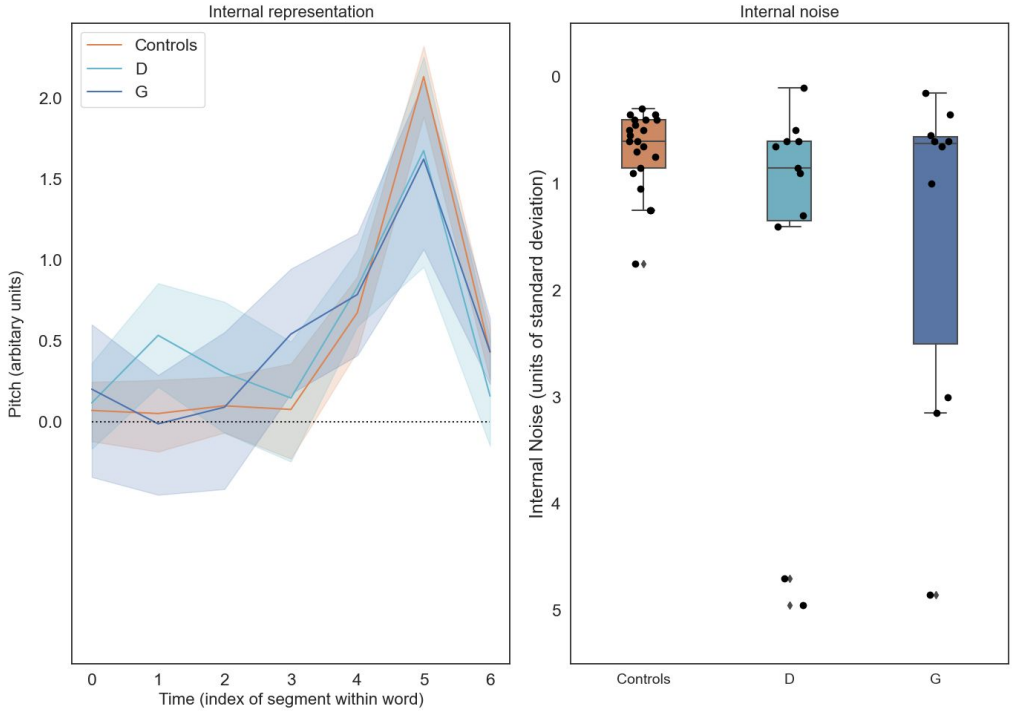
Reverse correlation measures differentiate controls & patients pre-post operatively



Does Reverse correlation measures differentiate controls & hemispheric localization of gliome (pre-operation)?



No significant difference

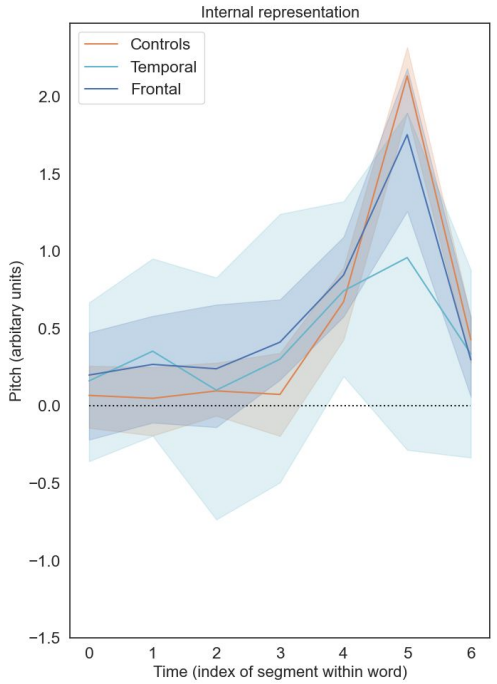
Different measures of Revcor based on Glioma hemispheric location

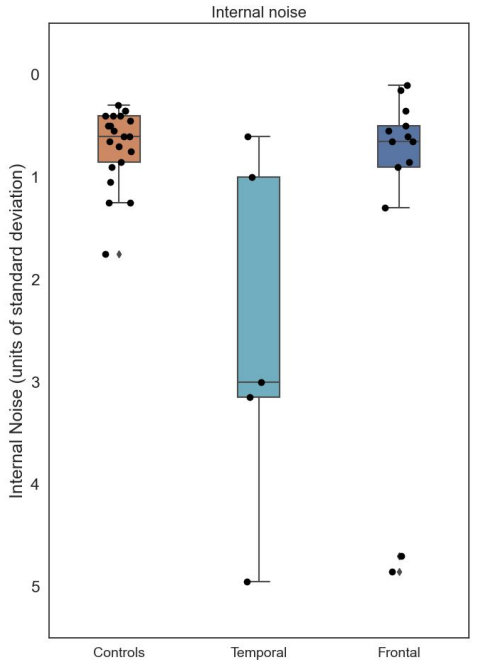
internal noise

Group1	Group2	U-statistic	P-value
Controls	Insulaire	1.0	0.155080
Controls	Temporal	14.0	0.013251
Controls	Frontal	123.5	0.657190
Controls	Pariétal	20.0	0.956310
Insulaire	Temporal	2.0	1.000000
Insulaire	Frontal	11.0	0.320530
Insulaire	Pariétal	2.0	0.479500
Temporal	Frontal	50.5	0.084202
Temporal	Pariétal	9.0	0.159512
Frontal	Pariétal	15.0	0.798022

kernel typicality

Group1	Group2	U-statistic	P-value
Controls	Insulaire	17.0	0.454545
Controls	Temporal	91.0	0.009851
Controls	Frontal	160.0	0.415023
Controls	Pariétal	6.0	0.126482
Insulaire	Temporal	4.0	0.666667
Insulaire	Frontal	6.0	1.000000
Insulaire	Pariétal	0.0	0.666667
Temporal	Frontal	16.0	0.117180
Temporal	Pariétal	0.0	0.095238
Frontal	Pariétal	3.0	0.114286



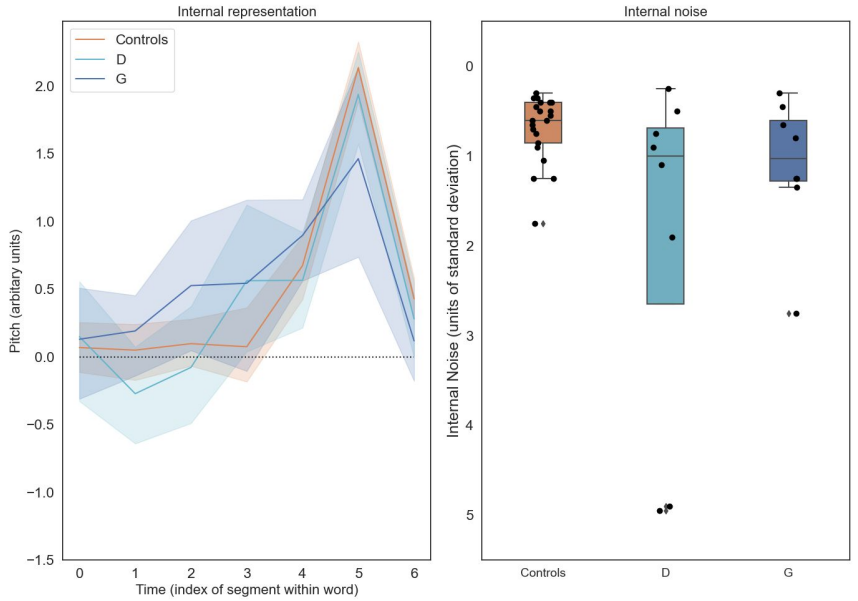


			subject	kernel_typicality		internal_noise_with_criteria		
			count	mean	std	mean	std	max
hemisphere	lateralizaion	type						
D	Frontal	post	5	0.823067	0.169616	0.930000	0.636003	1.90
		pre	7	0.843561	0.144965	1.285714	1.550461	4.70
	Insulaire	post	1	0.903254	NaN	0.750000	NaN	0.75
		pre	1	0.902697	NaN	1.400000	NaN	1.40
	Pariétal	pre	1	1.000000	NaN	0.600000	NaN	0.60
	Temporal	post	2	0.856449	0.016182	4.925000	0.035355	4.95
		pre	2	0.469230	0.663592	2.775000	3.075914	4.95
G	Frontal	post	4	0.891299	0.127519	0.700000	0.422295	1.25
		pre	6	0.802069	0.309536	1.191667	1.801782	4.85
	Pariétal	post	1	0.971368	NaN	0.650000	NaN	0.65
		pre	1	0.969396	NaN	0.600000	NaN	0.60
	Temporal	post	3	0.482834	0.326010	1.783333	0.838650	2.75
		pre	3	0.708107	0.076595	2.383333	1.200347	3.15

- Vilidaite, Marsh & Baker, 2019; which identifies sources of internal noise are in early sensory areas.

Preliminary conclusion

- Patients presented little or no problems in prosody recognition preoperatively but a decline in performance observed postoperatively.
    - Patients who had brain tumor in right hemisphere have different internal representation -post-surgery- from controls.



- Our study highlights a significant distinction in sensory regions where auditory processing takes place and no effects founded in parietal and frontal regions.

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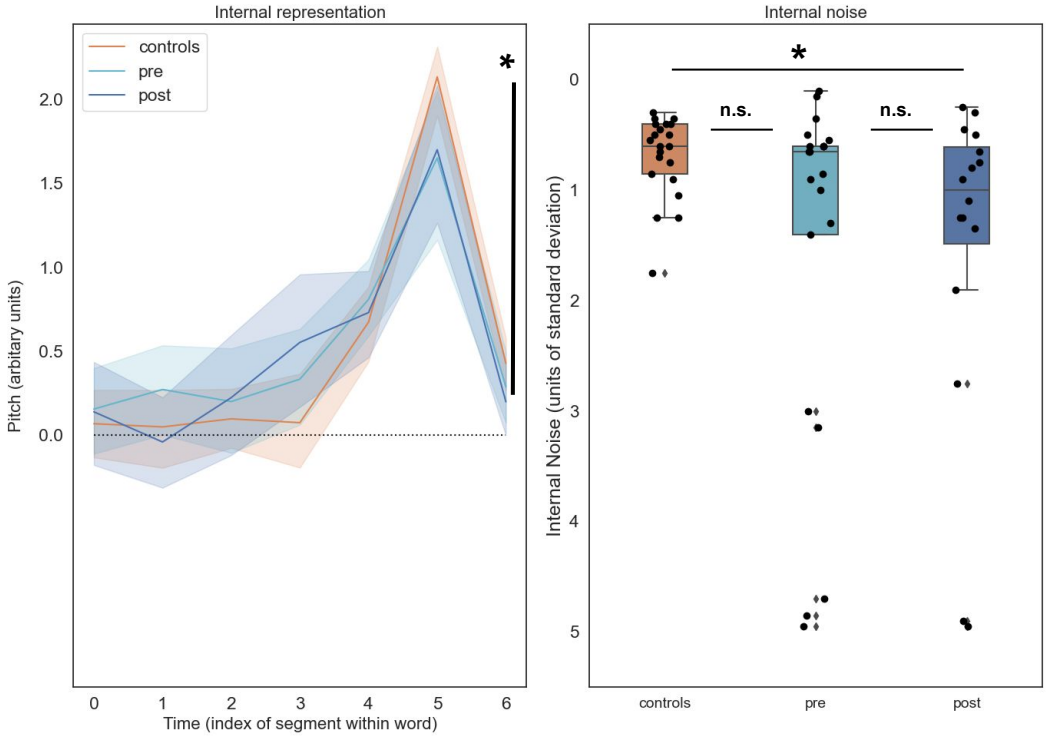

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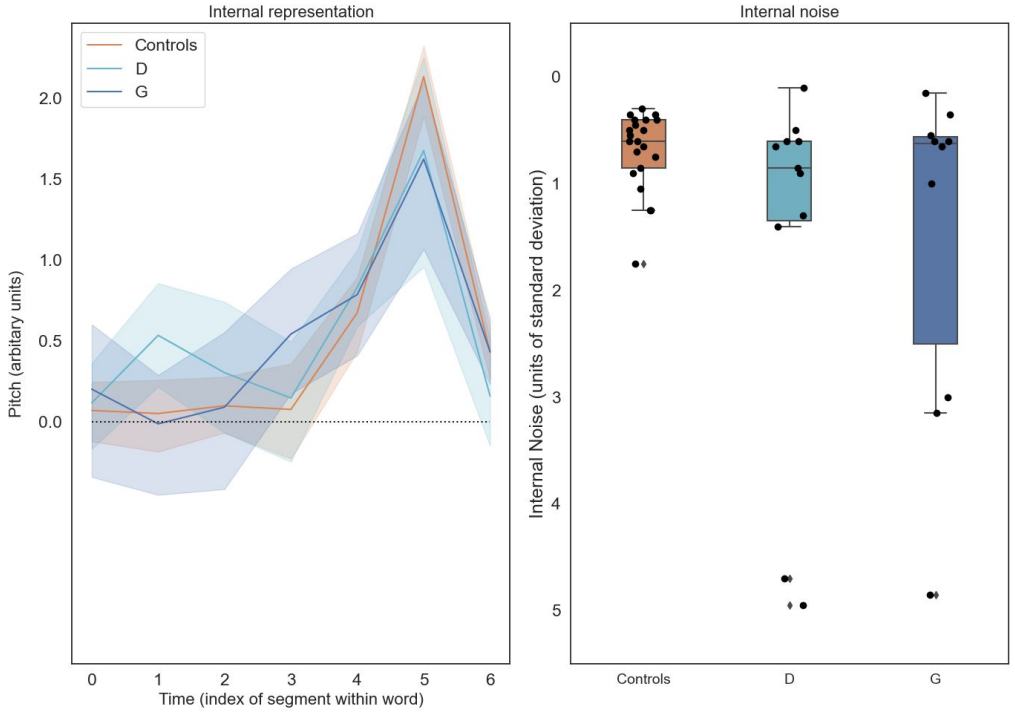

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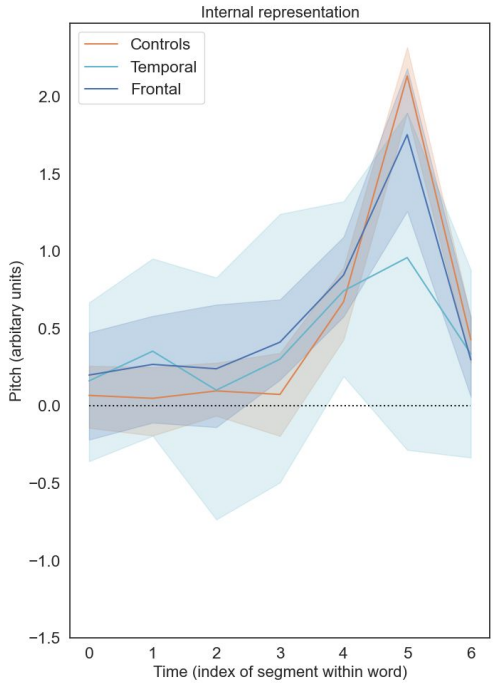

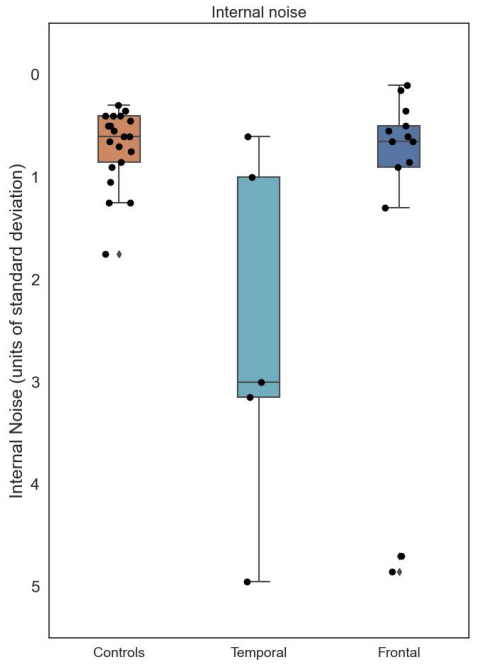

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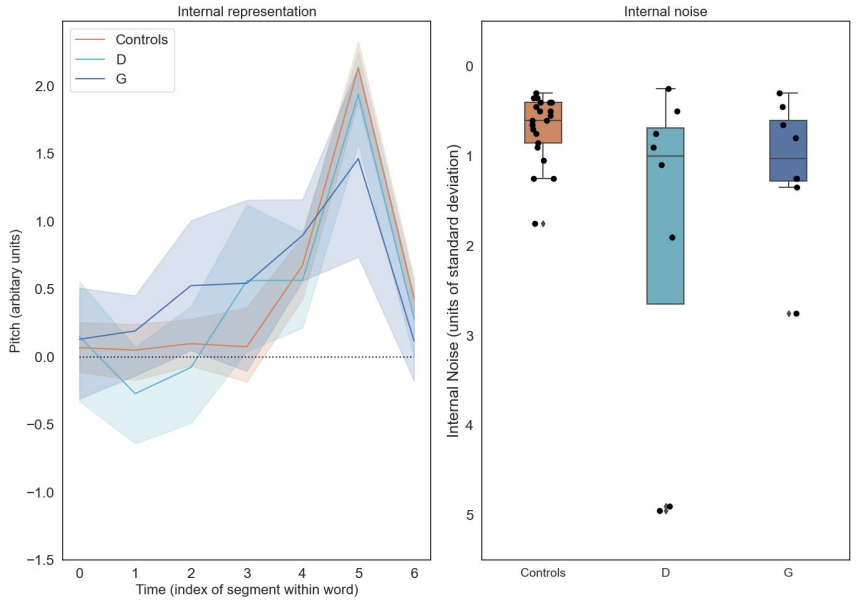

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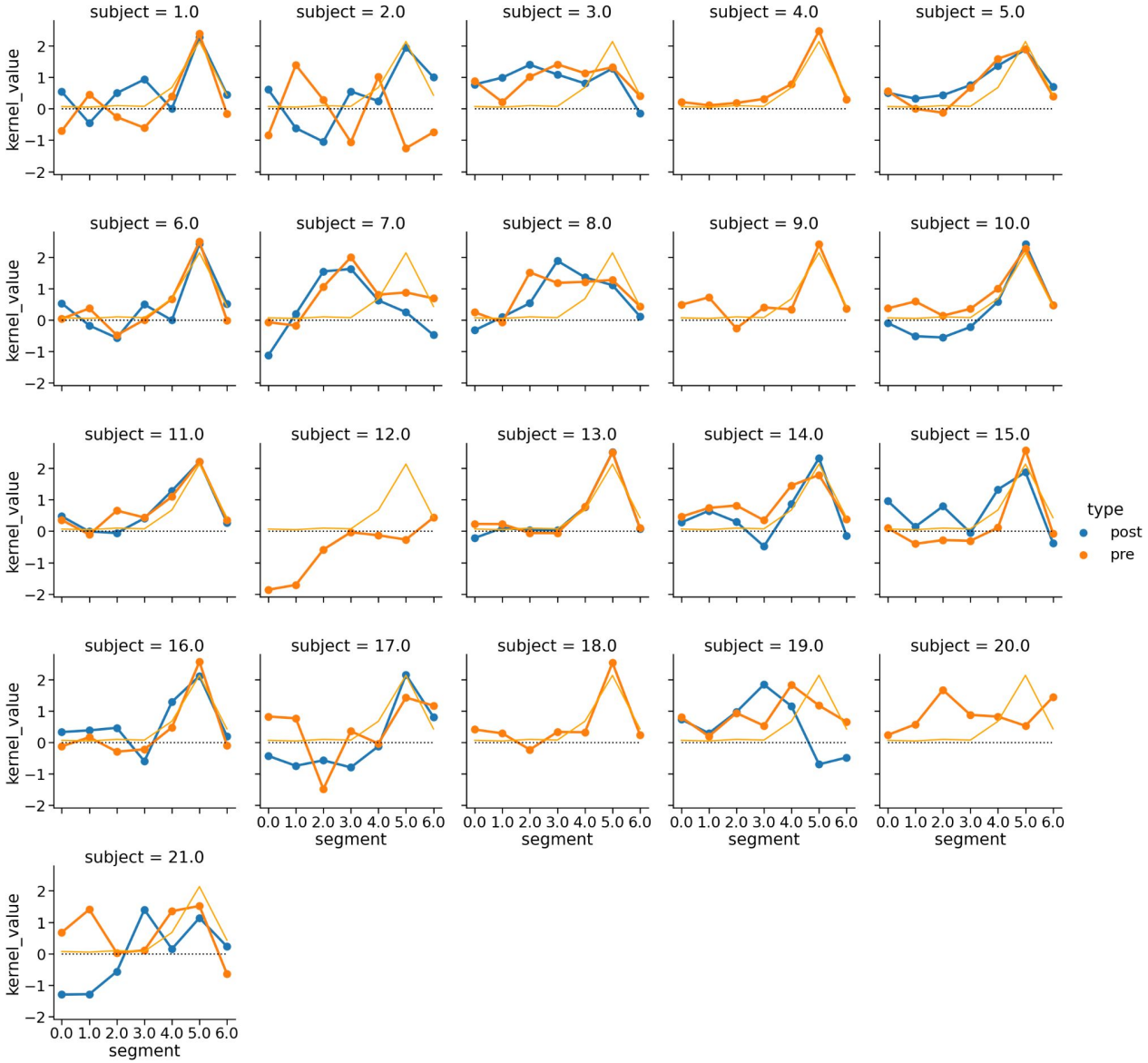
Annexes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Thank you for your attention!