

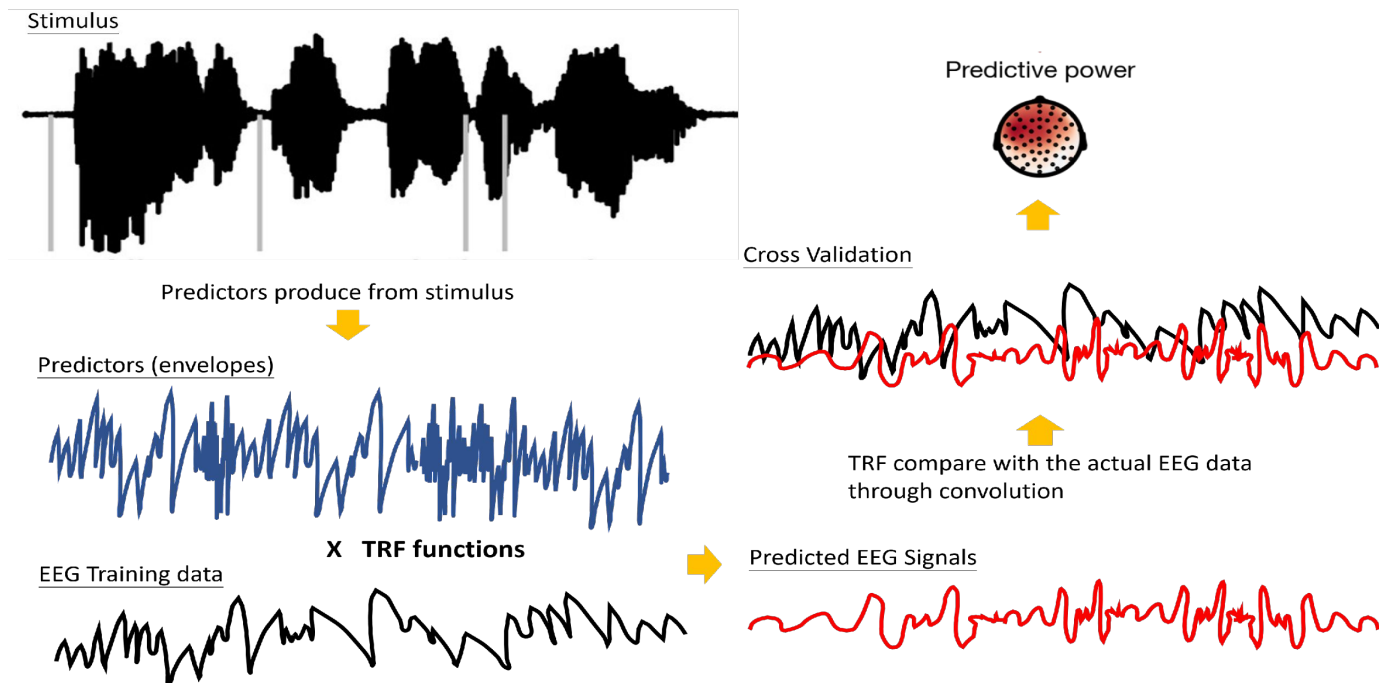
Decoding speech comprehension in ESL learners using Temporal Response Function (TRF)

Aim & Introduction

- Several linguistic features affecting speech comprehension (e.g., phonemes, semantics, word order, sentence structure)
- Neural activities induced from discrete stimuli were commonly used in the experiments (Di Liberto et al., 2015).
- Word onset, speech envelope, and those linguistic features had an effective influence when using Temporal response function (TRF) to decode EEG data (Brodbeck et al., 2022)

Aim: To use TRF to decode speech comprehension in Mandarin native speakers who are ESL learners

Temporal Response Function (TRF)

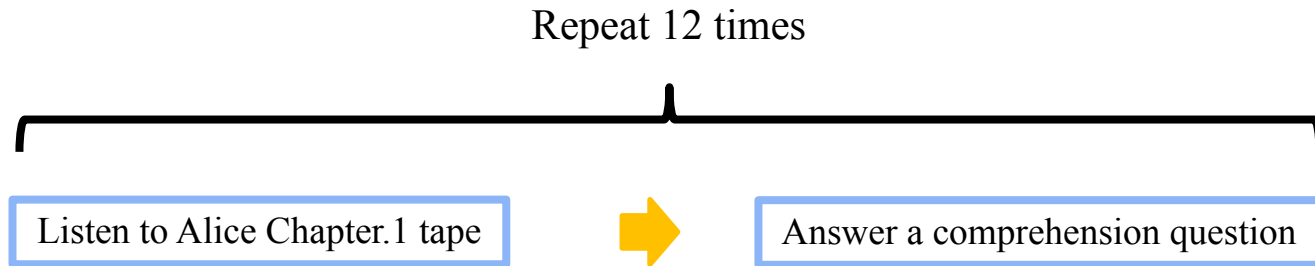


Stimuli & Procedure

Stimuli:

- Audiobook: *Alice's Adventures in Wonderland* Chapter one
- 2,129 words, 12 tapes, lasted 12.4 minutes

Procedure (for Natives & ESLs)



Participants (EEG)

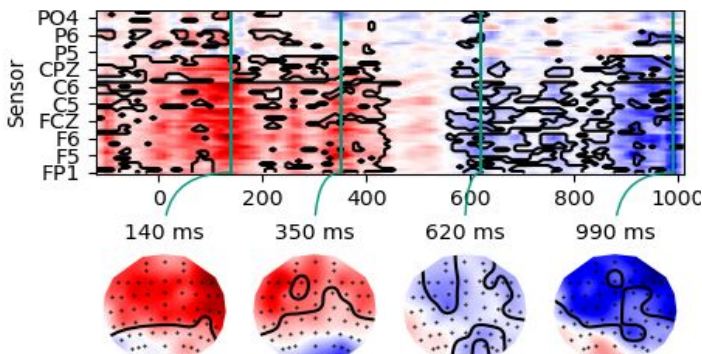
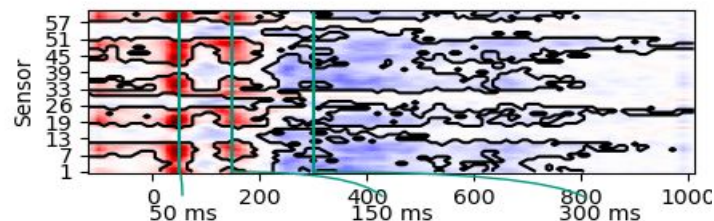
Natives

- EEG recordings: Open Alice EEG dataset (Bhattachali et al., 2020)
- N = 33 native English speaker ($M_{\text{age}} = 20.30$ yrs)
- Sampling rate: 100 Hz (down sample from 500Hz)
- EEG Cap: 61 channels
- Filter: 5 ~ 20 Hz

ESLs

- EEG was recorded from NCU, Taiwan
- N = 26 native Mandarin speaker adults ($M_{\text{age}} = 22.25$ yrs)
- Sampling rate: 100 Hz (down sample from 1000Hz)
- EEG Cap: 64 channels
- Filter: 5 ~ 20 Hz

Envelope (one sample t-test)



Natives:

$\alpha = 0.05$, 33 clusters, $p < .001$

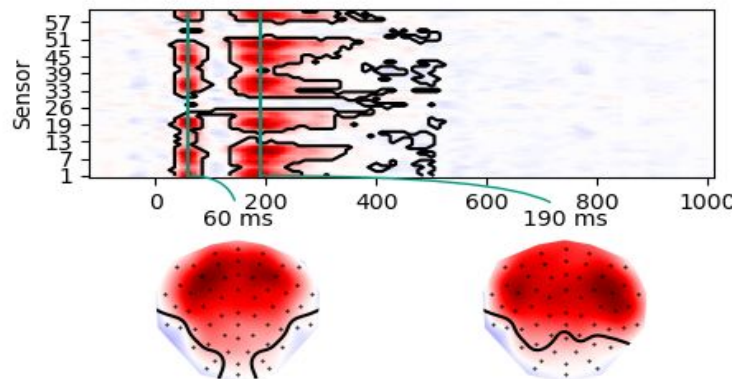
<u>n-sensors</u>	<u>tstart</u>	<u>tstop</u>	<u>duration</u>	<u>v</u>	<u>p</u>	<u>sig</u>
44	-0.12	0.28	0.4	2475.7	0.0001	***
55	0.19	1.02	0.83	-5495.3	0	***

ESLs:

$\alpha = 0.05$, 32 clusters, $p < .001$

<u>n-sensors</u>	<u>tstart</u>	<u>tstop</u>	<u>duration</u>	<u>v</u>	<u>p</u>	<u>sig</u>
51	-0.12	0.45	0.57	3995.8	0	***
36	0.56	0.82	0.26	-612.63	0.0176	*
40	0.81	1.02	0.21	-968.33	0.0063	**

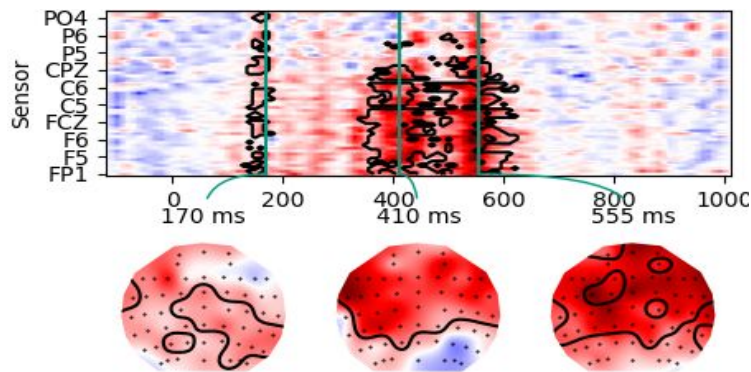
Word onset (one sample t-test)



Natives:

$\alpha = 0.05$, 74 clusters, $p < .001$

<u>n-sensors</u>	<u>tstart</u>	<u>tstop</u>	<u>duration</u>	<u>v</u>	<u>p</u>	<u>sig</u>
54	0.03	0.42	0.39	3156.8	0	***
36	0.37	0.53	0.16	-374.92	0.042	*

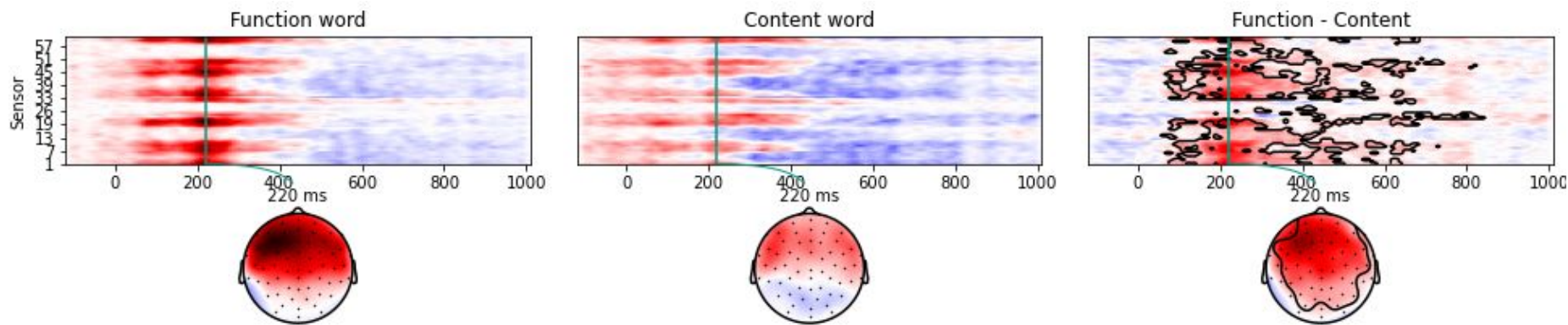


ESLs:

$\alpha = 0.05$, 49 clusters, $p < .001$

<u>n-sensors</u>	<u>tstart</u>	<u>tstop</u>	<u>duration</u>	<u>v</u>	<u>p</u>	<u>sig</u>
41	0.13	0.19	0.06	227.91	0.0185	*
46	0.34	0.63	0.29	1810.7	0	***

Lexicality (Natives, paired t-test)

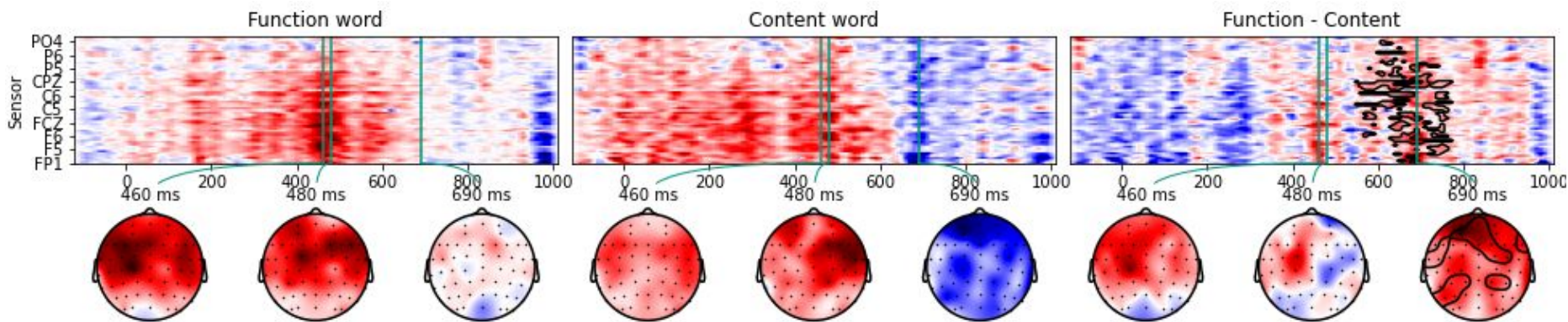


Natives:

$n = 33$, $\alpha = 0.05$, 55 clusters, $p < .001$

n-sensors	tstart	tstop	duration	v	p	sig
57	0.06	0.56	0.5	3443.3	0	***
37	0.55	0.85	0.3	506.42	0.0124	*

Lexicality (ESLs, paired t-test)



ESLs:

$n = 26$, $\alpha = 0.1^*$, 93 clusters, $p = .009$

<u>n-sensors</u>	<u>tstart</u>	<u>tstop</u>	<u>duration</u>	<u>v</u>	<u>p</u>	<u>sig</u>
49	0.55	0.78	0.23	606.72	0.0089	**

Conclusion

The TRF results of the ESLs showed a different pattern with the natives

1. Envelope: ESLs showed a longer and slower response (frontal area)
2. Onset: ESLs presented a more significant longer response
3. Lexicality (non-lexical - lexical): ESLs presented a delayed and shorter response

Summary:

TRFs shown by ESLs indicated that comprehending speeches in the second language might require more effort to parse linguistic information.