

Beta coherence as objective measure of immersion in film

All slides black text on white, left aligned.





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Introduction

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- Film is dynamic and polysemiotic.
 - It makes various demands on cognitive capacity.
 - Viewers process verbal and non-verbal information presented in auditory and visual channels.
 - And then we add subtitles and AD...
 - Investigating the cognitive processing of subtitles is complicated:
 - text, moving images and sound are processed simultaneously.
 - in AD, the original soundtrack and dialogue have to be processed together with the AD.
 - it is challenging to disentangle the processing of different channels.

Introduction continued

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- We know by now that subtitles affect viewing behaviour.
 - Some viewing behaviour is automatic (bottom-up processing), and not under conscious control:
 - Looking at movement or contrast;
 - Looking at the centre of the screen;
 - Looking at faces, mouths, eyes;
 - Looking at on-screen text.
 - Reading is a conscious activity (top-down processing).
 - In this research, we will look at the tension between top-down and bottom-up processing of text on video.
 - We will also consider the complexity of measuring competing sound sources.

What impact does text have on the viewer?

- Various studies have indicated that text is processed automatically (see d'Ydewalle and colleagues).
- There is ample evidence that subtitles are processed effectively by viewers (see, e.g. Perego et al. 2010).
- It has also been established that subtitled film does not impact the viewer experience negatively.
- Adding English same-language subtitles actually improves the immersion of viewers in terms of transportation, especially for viewers watching the program in their second language (Kruger *et al.* forthcoming).

But:

- Viewer immersion and visual attention in the film varies considerably depending on the nature of the scene (Kruger et al., 2016).

Iconicity

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- Film is iconic.
 - It presents "a heterocosm which resembles real life" (Mainar).
 - We use similar cognitive tools to process film and reality, drawing on schemas and "recognitional prompts" (Carroll & Seeley) established over time.
 - A lot of what we do when we engage with real and fictional realities, is filling in gaps, predicting, assuming continuities even when absent.
 - For the blind audience this is no different, as they have to rely on the interpretation of contextual sounds supplemented by dialogue and AD.

Narrativisation

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- When watching a fiction film, we make sense of the narrative through what could be termed narrativisation.
 - Project ourselves into the fictional reality, interpreting, experiencing and co-creating the narrative (as AVT practitioner or audience member)
 - We experience fictional events as though we are living them, using the same cognitive tools; fictional characters as though we are in their shoes, "impostulating" them – imposing, posturing, postulating.

Embodied simulation

- There is a continuity between film and viewer known as embodied simulation (cf. Gallese; Gallese & Guerra).
- We take allocentric perspectives when we witness populated scenes – resulting in disembodied cognition (Tversky & Hard).
- Deictically, we assume hypothetical positions outside ourselves.
- Embodied simulation concerns actions, emotions and sensations of others being mapped onto the observer's sensory-motor and viscera-motor neural representations (Gallese & Guerra).
- How, then, does subtitling and AD impact on this? It is extradiegetic, graphic or auditory interference, causing split attention.

Immersion

- Immersion is the sensation of viewers being transported into the story world, being swept up in this world to such an extent that it takes priority over their experience of their immediate surroundings.
- Fictional immersion is a delicate cognitive state.
- The audience is drawn into a virtual reality in which they experience the fiction created by the film as though they had a position much closer to the action than they actually have.
- This willing suspension of disbelief is central to the enjoyment of film.
- Do subtitling and AD affect the audience's ability to immerse?

Measuring immersion

- Engagement/immersion has been around for some time in Psychology – as subjective measurement:
 - Transportation (loss of awareness of immediate surroundings);
 - Character identification (directly related to ES, our identification and affinity with characters – also impostulation);
 - Presence (sense of 'being there');
 - Perceived realism.

Aims of the study

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- To determine whether beta (frequencies between 14-30Hz) coherence between the prefrontal and parietal cortex acquired from EEG recordings can be used as a measure of immersion in film (subtitled, but with the aim to apply this to AD later).
 - To determine whether aspects of film presentation such as subtitling or AD can effect immersion.
 - To develop further understanding on how to measure immersion objectively.

Experimental Design

Stimulus:

Sherlock Holmes : Game of Shadows – only the first 30 minutes were presented

Participants:

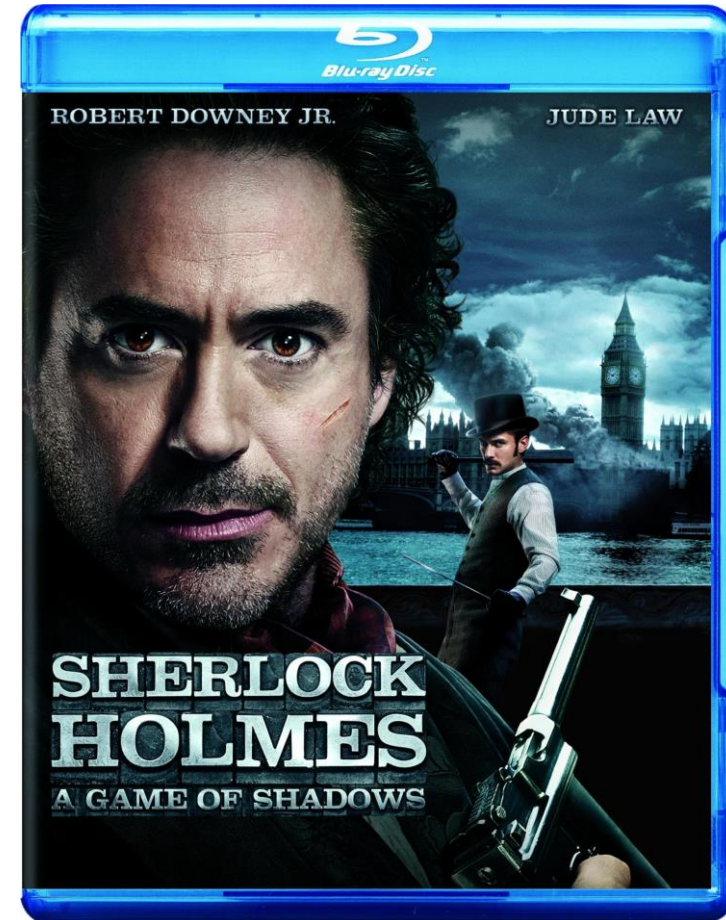
41 Mandarin dominant bilingual speakers

Conditions:

- with subtitles
- without subtitles

Measurement :

- Electroencephalography (EEG).
- Immersion scale questionnaire.

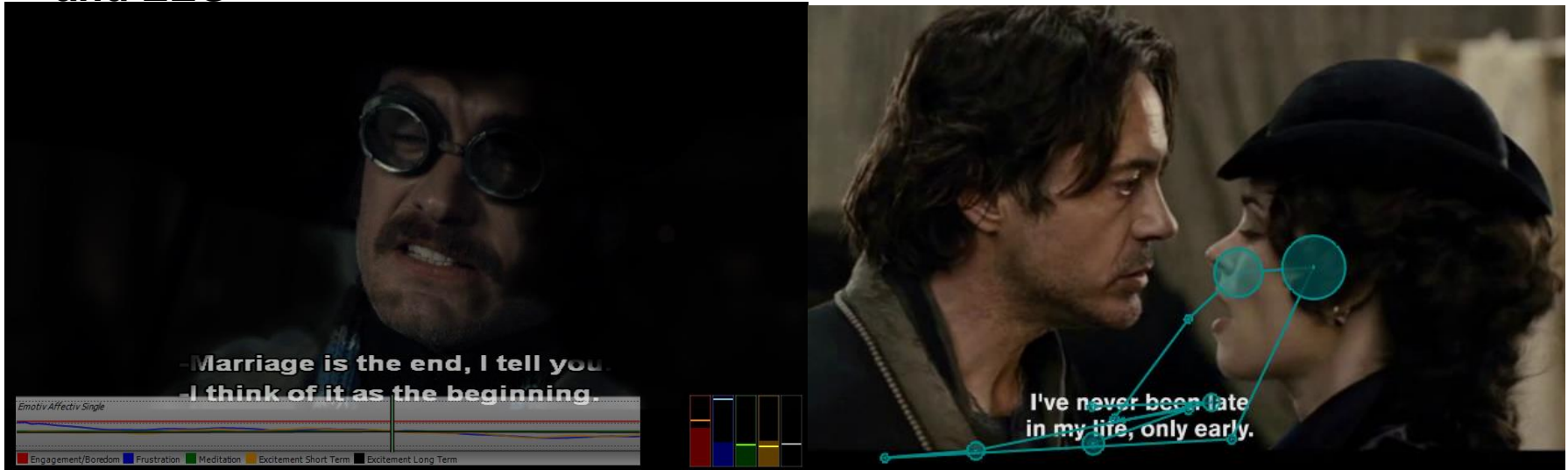


Participants

- Students with Mandarin Chinese as L1, English as L2 recruited.
- All participants had intermediate to high English L2 proficiency with IELTS scores of above 6.5 on all bands.
- Spent an average of 27 months in an English-speaking country.
- Availability sample of 41 participants (mean age 26 ranging from 19 to 49).
- Participants were assigned randomly to two groups:
 - First group ($n = 21$) were exposed to unsubtitled clip (NS) (15 used in EEG).
 - Second group ($n = 20$) were exposed to conventional subtitles (CS) (17 used in EEG) .

Online measurement:

Illustrated with images of focus map with EEG; scan path, and experimental setup with remote eye tracking and EEG



Subjective measurements

A subjective immersion questionnaire with a set of sub-items was used consisting of 44 items on 7-point Likert scales:

- 10 on transportation
- 4 on character identification
- 8 on presence
- 21 on perceived realism
- 1 on enjoyment

Cronbach's Alpha: .899

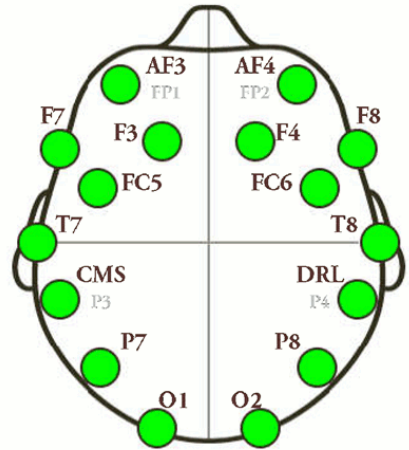
EEG: Immersion - beta coherence



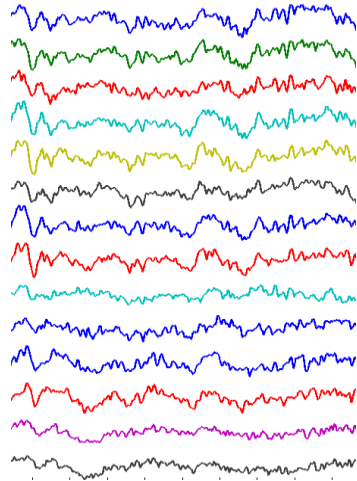
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- We looked at coherence in the beta band (frequency range between 14-30Hz) between the Prefrontal cortex and the Posterior parietal cortex.
 - Prefrontal cortex (PFC): location of cortical (executive) processing.
 - Posterior parietal cortex (PPC): linked to imagination - particularly when imagining ourselves as someone else/somewhere else/at another time.
 - We calculated spectral coherence from left and right hemispheres and prefrontal and posterior regions.
 - An increased EEG beta coherence is linked to less emotional involvement (cf. Reiser et al.)



Simplified Beta Coherence feature extraction

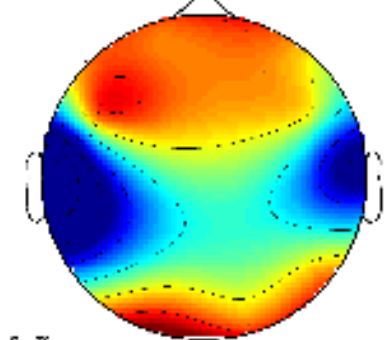


EEG signal

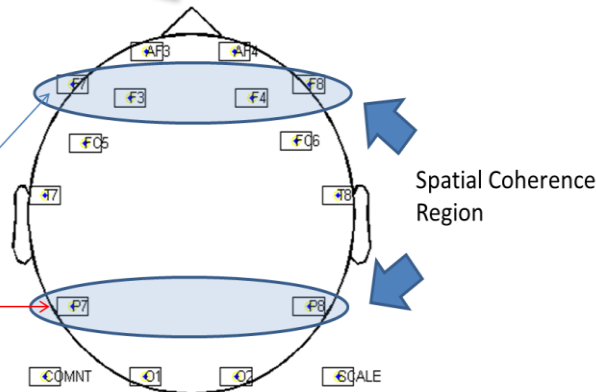
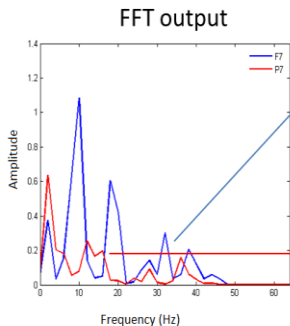


Artifact
Removal
(eyeblink,
heartbeat)

Coherence Calculations



Frequency domain
Fourier Transform



Beta band spectrum
power distribution

Description of feature extraction



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1. Raw EEG signals are obtained using the EMOTIV Epoc+ headset.
 2. Artifacts such as blinks and heartbeats are removed.
 3. Data is then filtered and transformed to obtain the beta frequency.
 4. The beta band spectrum power distribution is then analysed
 5. Finally, coherence is calculated.

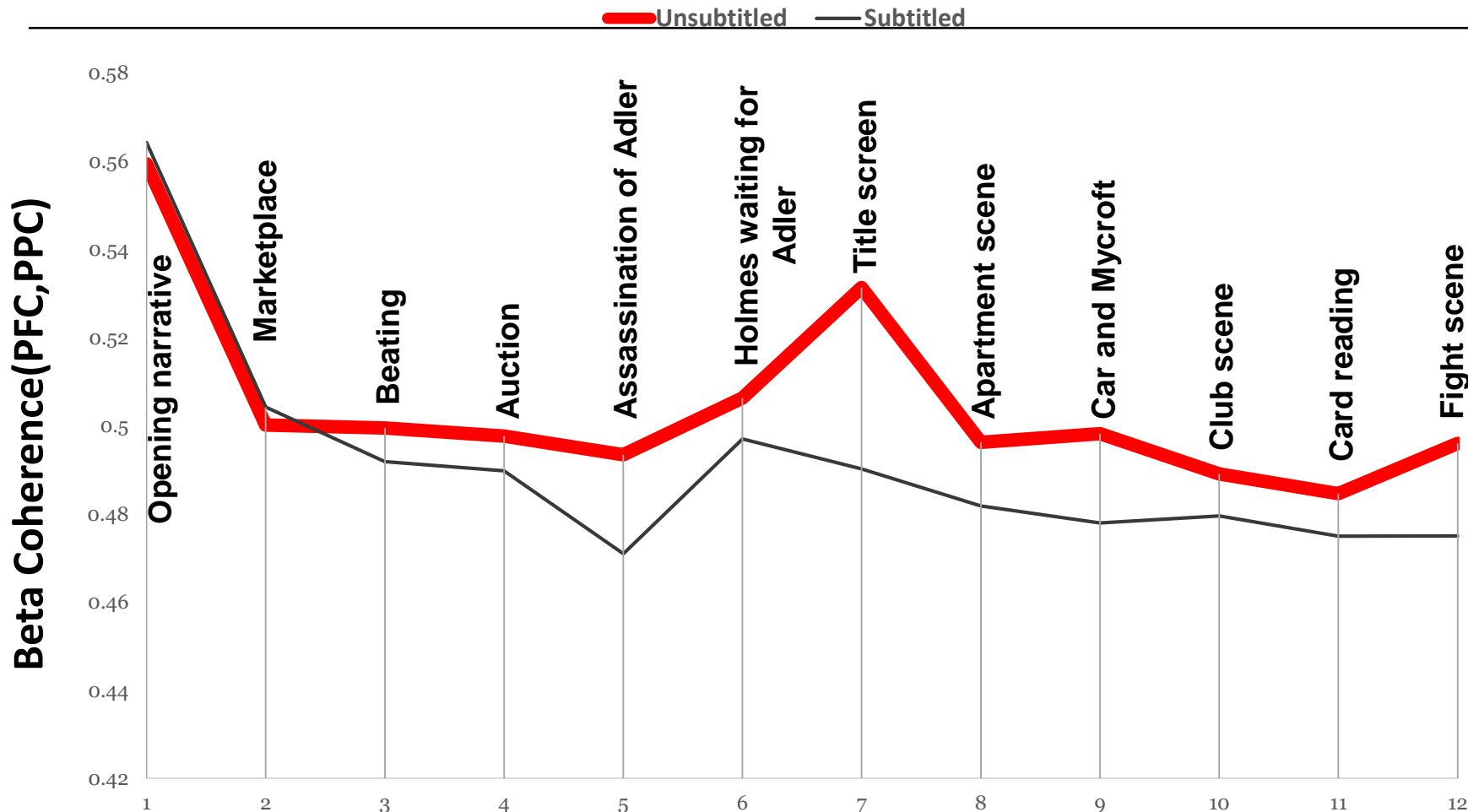
Scene details

Scene	Scene	Duration (s)	
1	Watson opening narrative	47.64	Exposition by Watson
2	Marketplace	113.96	Holmes in disguise meets up with Adler
3	Beating	122.4	Holmes is beaten up by Moriarty's goons
4	Auction	119.96	Holmes prevents bomb from exploding
5	Assassination of Adler	152.32	Moriarty poison's Adler after telling her he has no use for her
6	Holmes being stood up, to title	22.92	Holmes waits for the now deceased Adler
7	Title screen	6.52	Freeze frame, title
8	Apartment	394.36	Watson enters Holmes's apartment, Holmes in disguise, they discuss the conspiracy
9	Car and Mycroft	182.8	Comic relief as Holmes in disguise banter with Watson on way to the club
10	First club scene until Holmes joins gypsy	139.12	Holmes looks for assassins during Watson's stag party
11	Fortune teller scene	201.16	Holmes meets fortune teller whose brother was corrupted by Moriarty
12	Fight scene	259.04	Holmes fights Cossacks

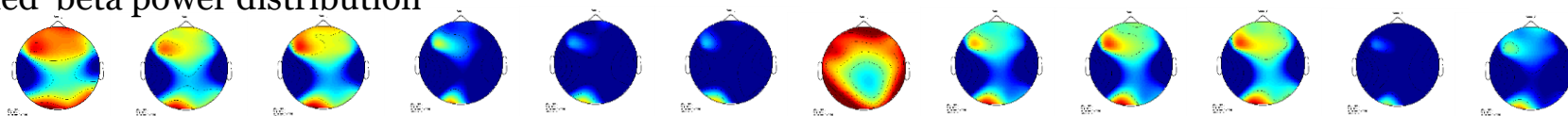
Results - Self-reports

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- No statistically significant difference was found on any of the subsets of immersion.
 - This could be ascribed to the following:
 - This was not a full text, only the extended exposition, so the overall immersion may not have had sufficient time to diverge between conditions.
 - There is a limitation in using post-hoc questionnaires namely that they do not allow for the analysis of variation in immersion in the course of the film.

Results - Beta coherence across scenes



Unsubtitled beta power distribution



Description of beta coherence graph



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- For both conditions the beta coherence decreases from the opening narrative to the marketplace and beating scenes as well as the auction and the assassination scene, before increasing in the two short scenes where Holmes waits for Adler and the title screen.
 - The coherence then decreases again for the remaining scenes.
 - With the exception of the first two scenes, the coherence is lower for subtitled than unsubtitled (i.e. the immersion is higher).

Findings EEG

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- Subtitled movie presentation elicited lower beta coherence (between PFC and PPC).
 - There was a significant difference between conditions ($F(2,1080) = 51.475, p < 0.001$):
 - Unsubtitled significantly higher than subtitled ($d = 0.5$).
 - **Interpretation: Subtitles resulted in higher levels of immersion.**

Discussion

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- Subtitles (SLS) have a positive impact on immersion in terms of objective measures, and no negative impact in terms of subjective offline post-task measurements.
 - This is a step in the direction of establishing a scientific methodology for investigating cognitive processing of AVT products.
 - The next step is to use the same methodology to investigate the processing of different versions of AD on immersion.

Conclusions

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- **Self-report** – is rich in subjective meaning but arguably limited and biased.
 - **EEG**
Beta coherence shows promise to be used as an objective tracking measure of audio-visual text on immersion.

Further details

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- Kruger, J. L., Sanfiel, M. T. S., Doherty, S., & Ibrahim, R. (2016). Towards a cognitive audiovisual translatology. In R. Muñoz Martín (Ed.), *Reembedding Translation Process Research* (pp. 171–194). Amsterdam, the Netherlands: John Benjamins.
 - Kruger J. L., Doherty, S., Fox, W., & de Lissa, P. (in press). Multimodal measurement of cognitive load during subtitle processing. In I. Lacruz & R. Jääskeläinen (Eds.), *New directions in cognitive and empirical translation process research*. Amsterdam, the Netherlands: John Benjamins.
 - Kruger J. L., Doherty, S., & Sato-Sanfiel, M. (2016). Original language subtitles: Their effects on the native and foreign viewer. *Comunicar*, 50.

Thank you!

A rousing round of applause, whistling and cheers can now commence...



Additional information on data processing

- Artifact rejection is performed to remove any noisy EEG recordings by rejecting trials with variance greater than $400 \mu\text{V}^2$ within any of its channel's recordings.
- Each of the accepted trials is transformed into the frequency domain using the Fast Fourier Transform (FFT).
- The cross-spectrum coherence is calculated from the FFT spectrum for each electrode pairing from each scene.
- Coherence from electrode pairing of P8-F8, P8-F4, P8-F3, P8-F7, P7-F8, P7-F4, P7-F3, P7-F7 is averaged to form the fronto-parietal coupling.
- Beta coherence is then calculated by averaging frequencies from 14-30Hz.
- To get a sense of time-course data, beta coherence is calculated in segments of 10 x 0.5sec intervals (every 5 seconds)