WE-COLLAB

Co-funded by the Erasmus+ Programme of the European Union

Multiplier Event We-Collab Project

University of Rijeka, 09 December 2024

Learning in a Future Digital Environment

Gianluca Di Flumeri, PhD
gianluca.diflumeri@brainsigns.com

Know-how

Industrial Neuroscience Laboratories
@ Dept. of Molecular Medicine, Sapienza University of Rome

FROM 2010

SAPIENZA UNIVERSITÀ DI ROMA

BRAINSigns

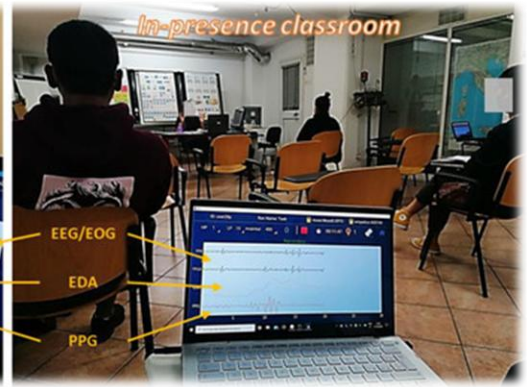
SPIN-OFF COMPANY

First neuroscience labs in Italy since 1989
MISSION: to develop innovation based on scientific knowledge in the recording and analysis of human neurophysiological signals for evaluating human factor in different applied research areas.

European Commission
Horizon 2020
European Union funding
for Research & Innovation

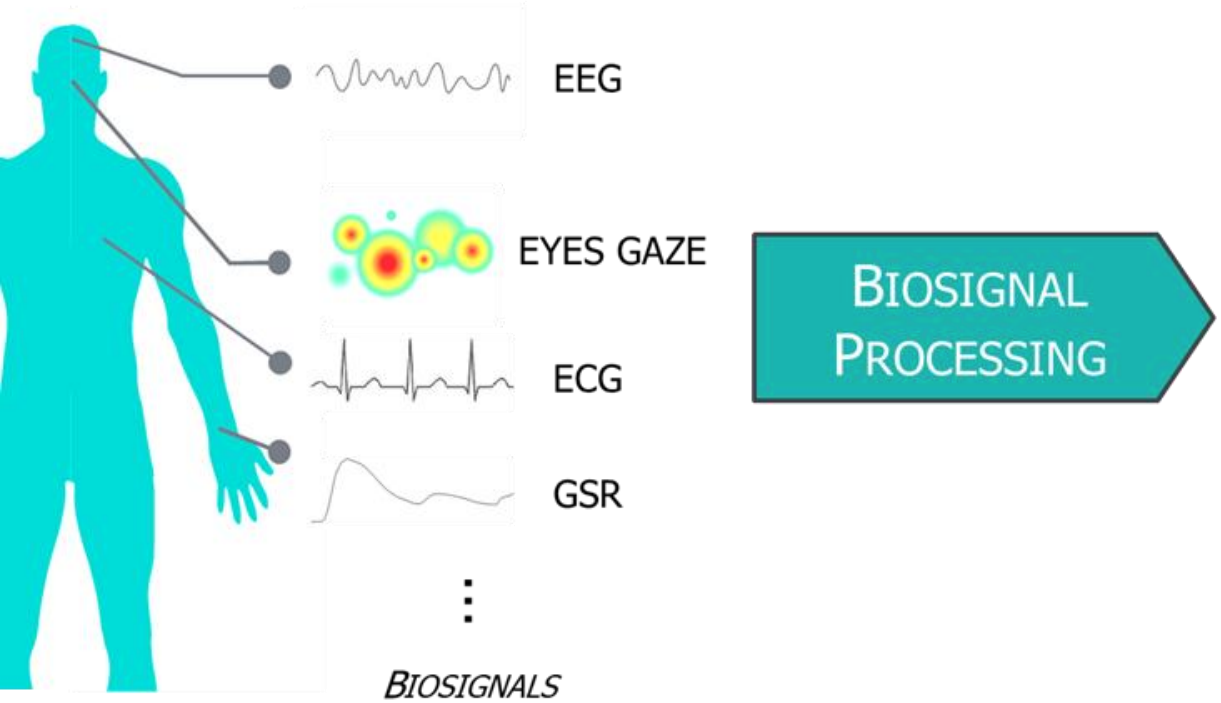
SESAR
JOINT UNDERTAKING

MIUR
Ministero dell'Istruzione, dell'Università e della Ricerca



Measuring the Human Factor

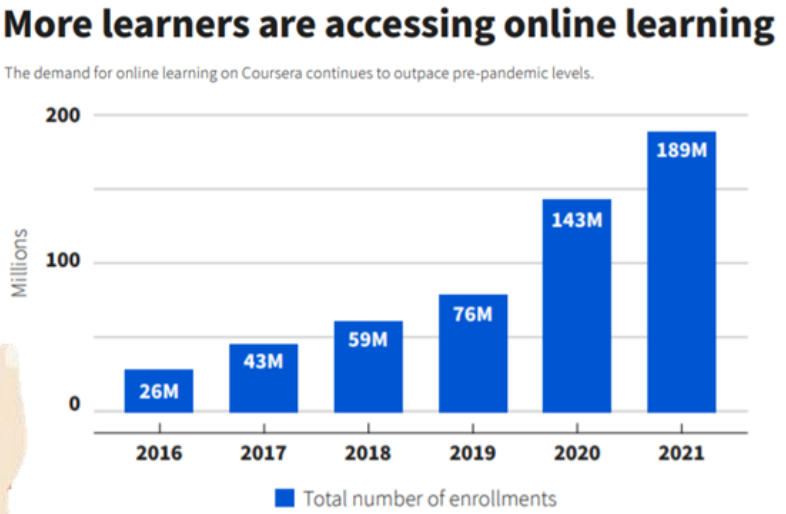
Neuroscientific approach



Cognitive Neuroscience applied to operational environments

The problem

Contextual circumstances, such as economic crisis and pandemic restrictions, are **promoting *remote learning* in different domains**.



Effectiveness of online education in a broader extent is largely debated. There are few, and even disagreeing results, about the comparison between "in-presence" and "remote" modalities.

BrainSigns currently involved in:

Erasmus+
Enriching lives, opening minds.

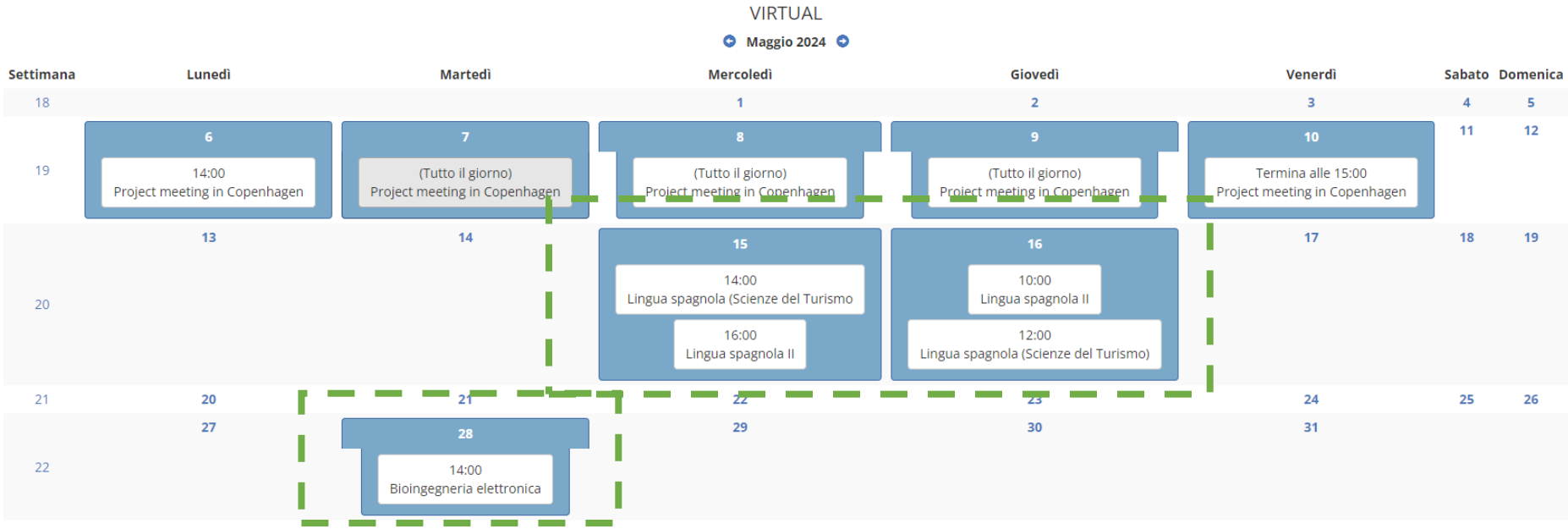
WE-COLLAB

SOULSS
Scaffolding Online University Learning Support Systems

PR5 – Data collection @Sapienza

Comparison of *Presence* vs *Remote* conditions (same teacher)
30-minutes-long lessons. Sample size:

- 6 students attended 4 lessons within *Lingua Spagnola* course (Prof. Fernando Martinez).
- 3 students attended 1 lesson within *Bioingegneria* course (Prof. Gianluca Di Flumeri).



Research tools

Mindtooth Touch

Headset for recording brain electrical activity (EEG)

Shimmer3 GSR+

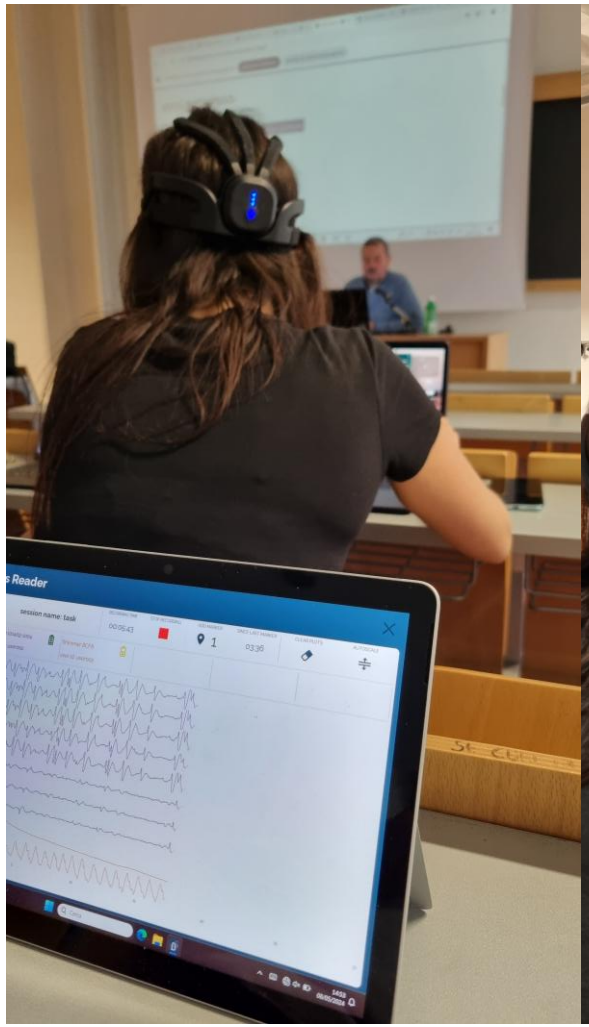
Wristband for recording heart activity (PPG) and skin sweating (EDA)

BrainSignsReader

BrainSigns software for synchronously recording biosignals from different devices.

PR5 – Data collection @Sapienza

IN PRESENCE



REMOTE

PR5 – Data collection @Sapienza

Neurophysiological parameters analysis performed on EEG signals:

- **Mental workload** is linked to the amount of cognitive resources allocated on the task
- **Distraction** is linked to the difference between workload and attention (high difference means that students are *mindwandering*).
- **Stress** is linked to the overall 'comfort perception' of the students.

Autonomic parameters analysis performed on PPG and EDA signals:

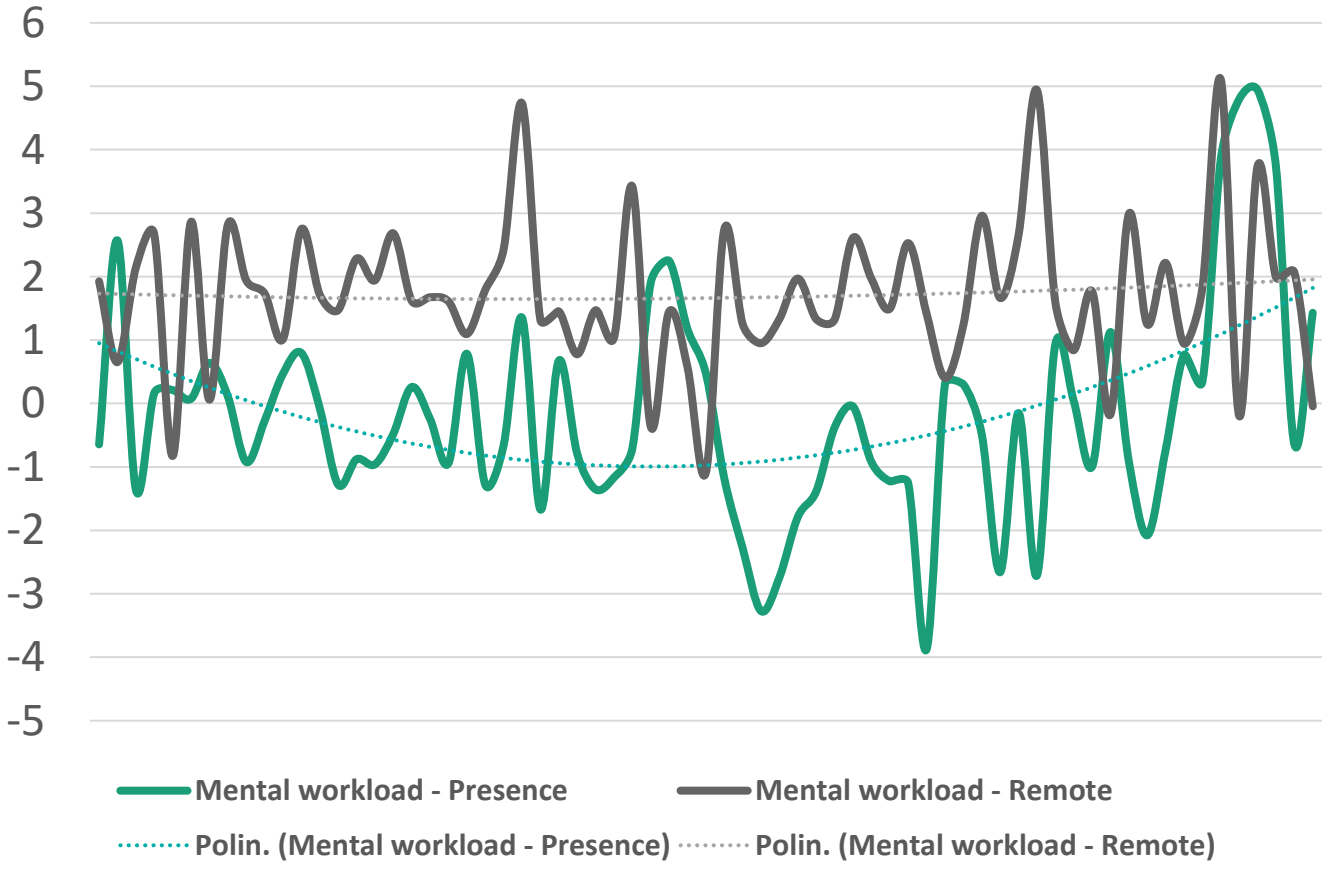
- Skin Conductance Level (**SCL**) is an EDA-derived parameter representing the state of **arousal** along the learning experience
- Emotional Index (**EI**) is a combination of SCL and Heart Rate (HR) parameters representing the **emotional state** of the students experienced along the learning modalities

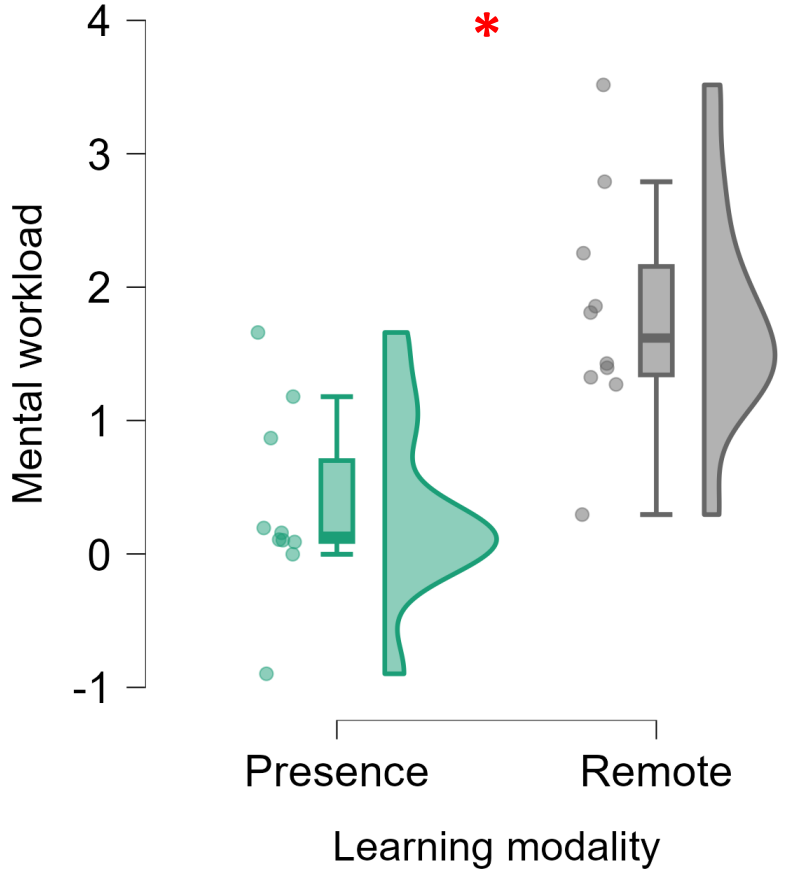
The results will be presented:

- By visualizing the Neuro-Indicators variations **overtime**
- Neuro-Indicators mean values along the ***Presence*** and ***Remote*** learning modalities.

Neurophysiological parameters (EEG analysis)

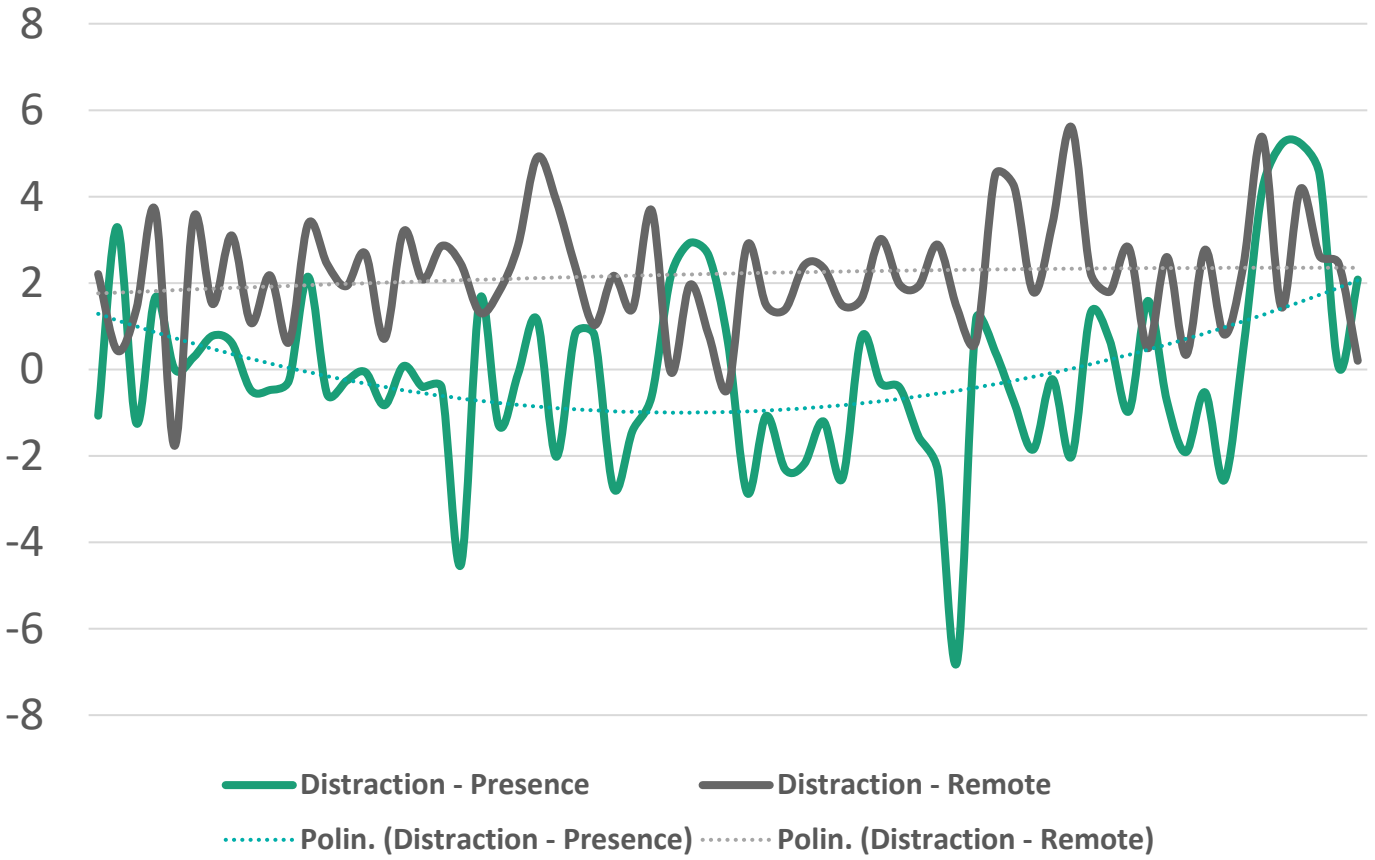
Mental workload

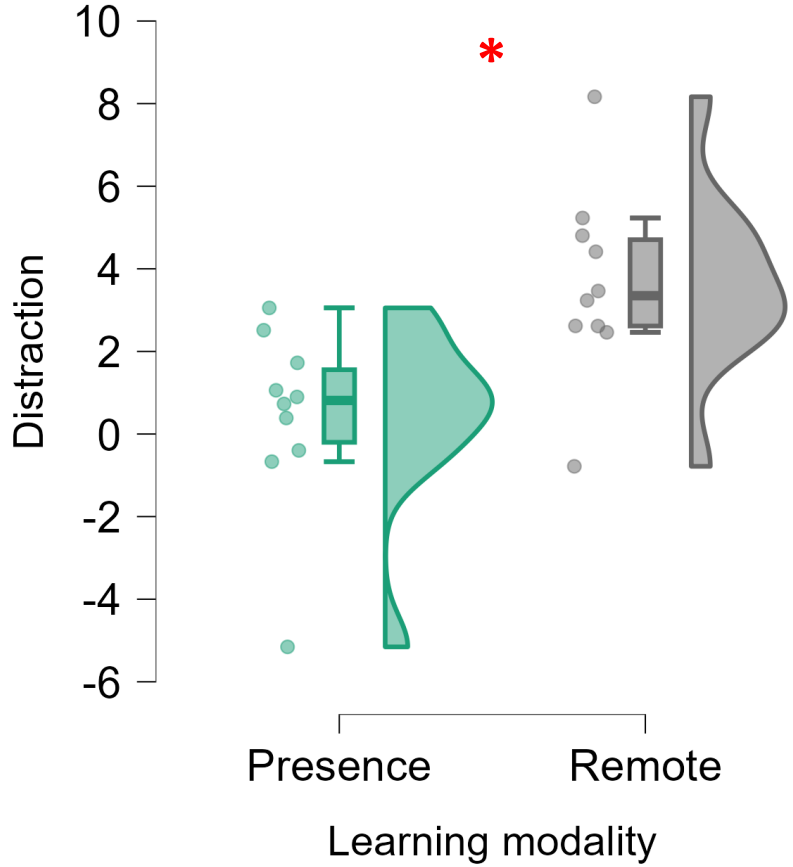




Significantly higher workload by remote → Higher difficulty? More engagement?

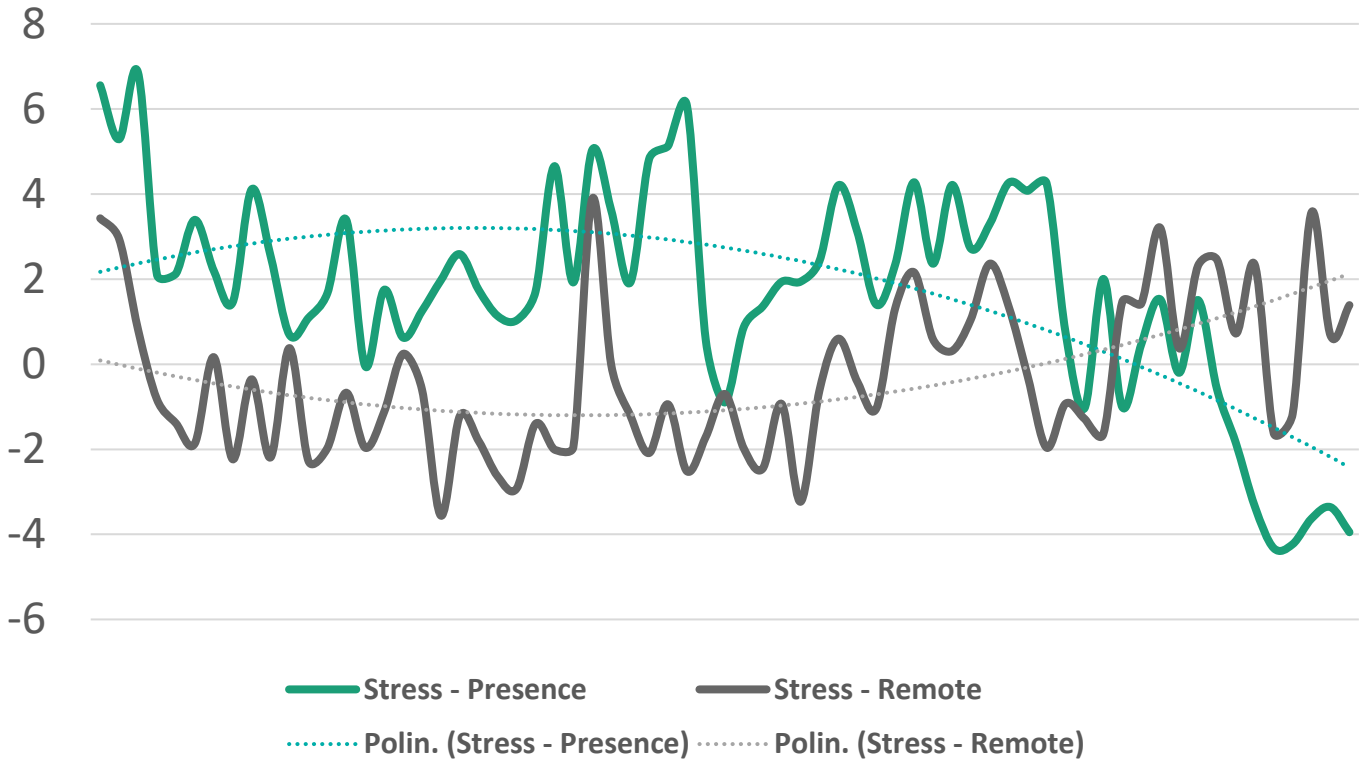
Distraction

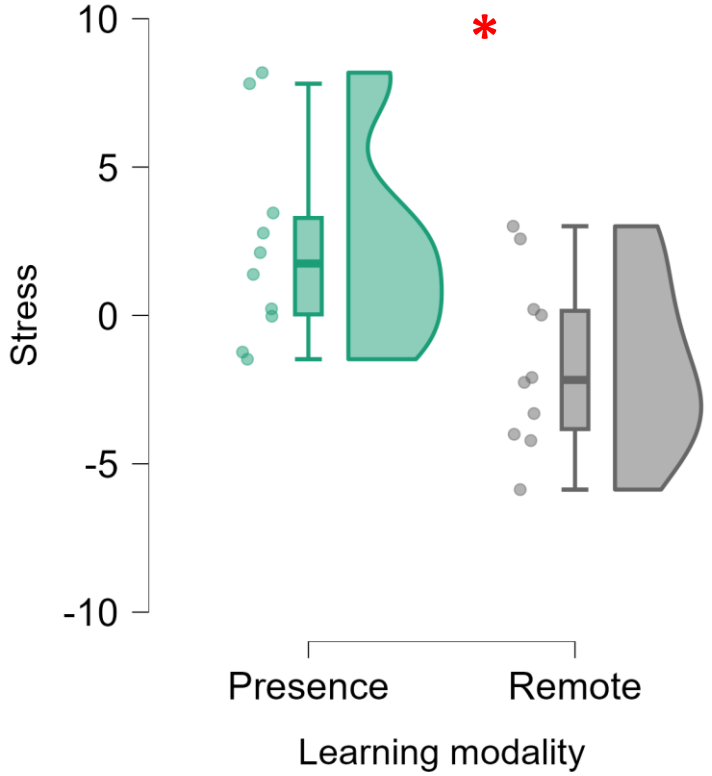




Significantly higher distraction by remote → Less attention, the higher workload was due to the difficulty and not to the engagement.

Stress

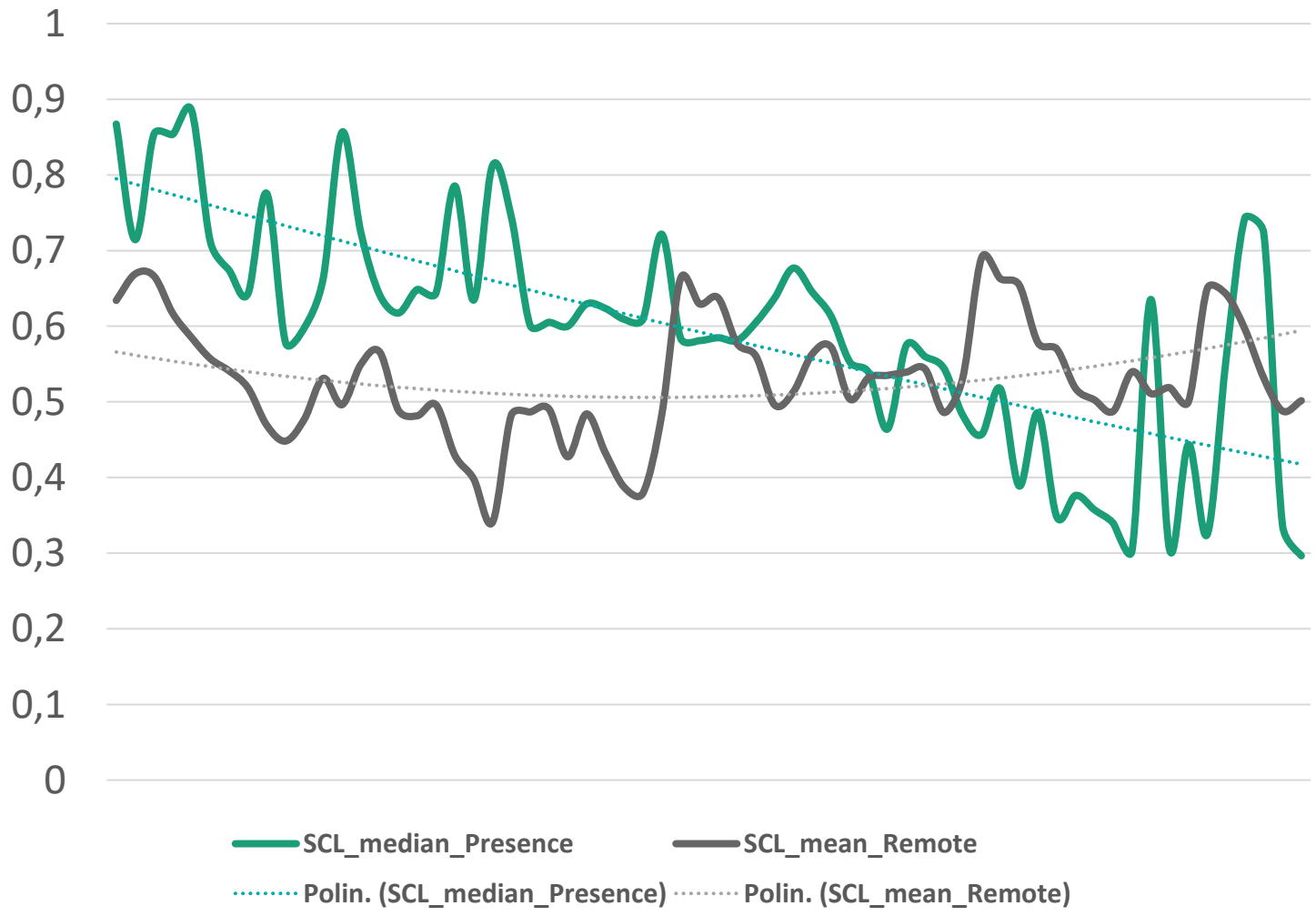


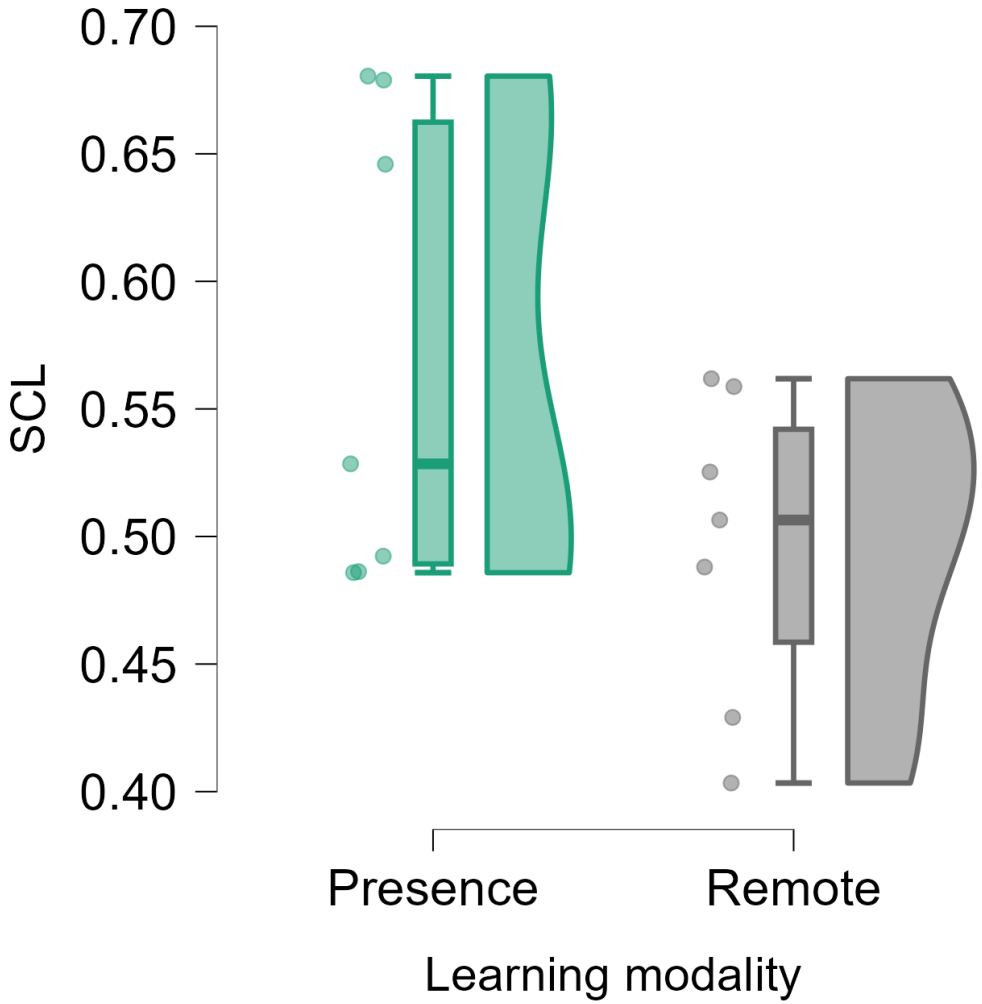


Significantly higher stress in presence, especially at the beginning.

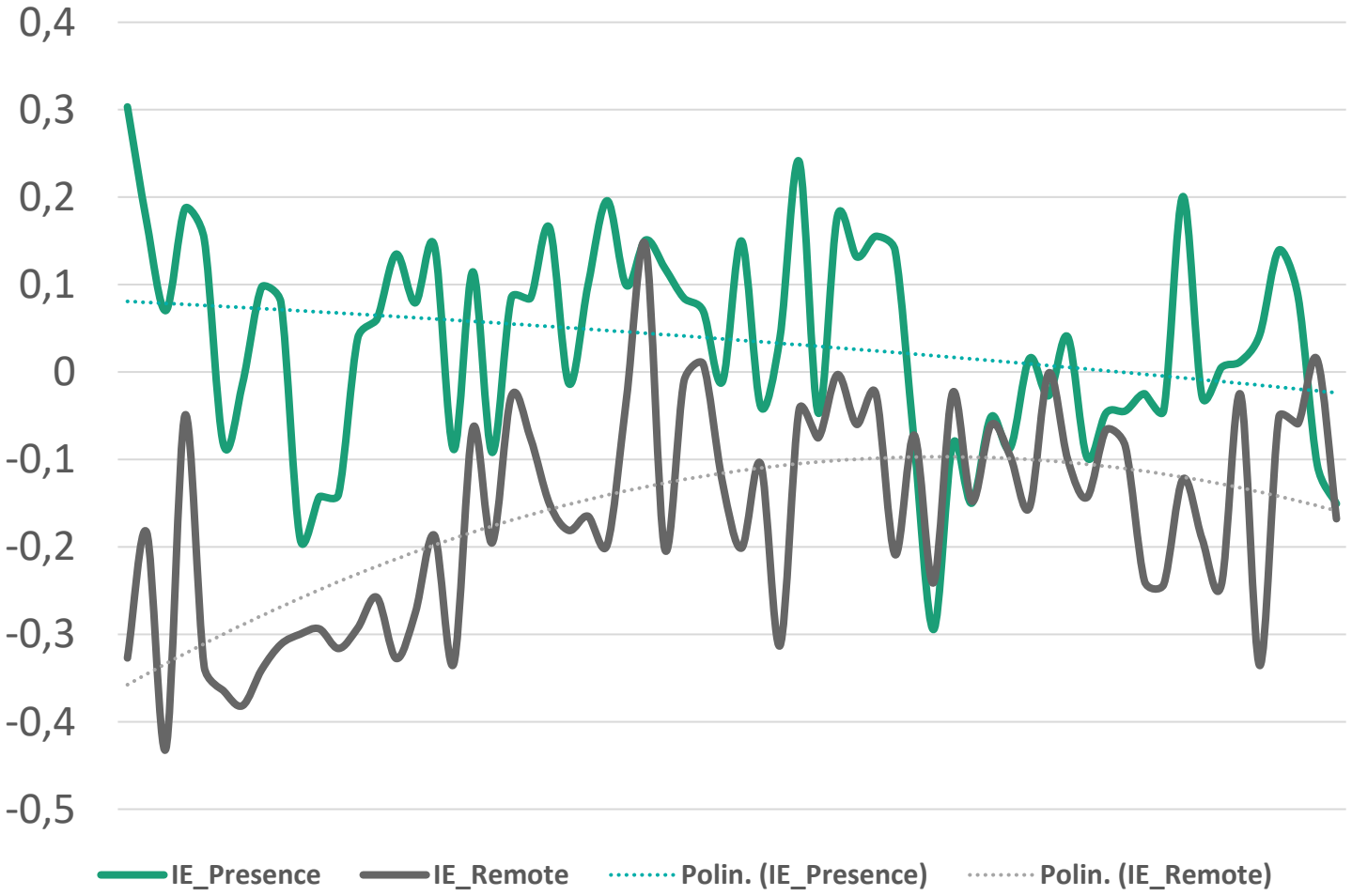
Autonomic parameters (EDA and PPG analysis)

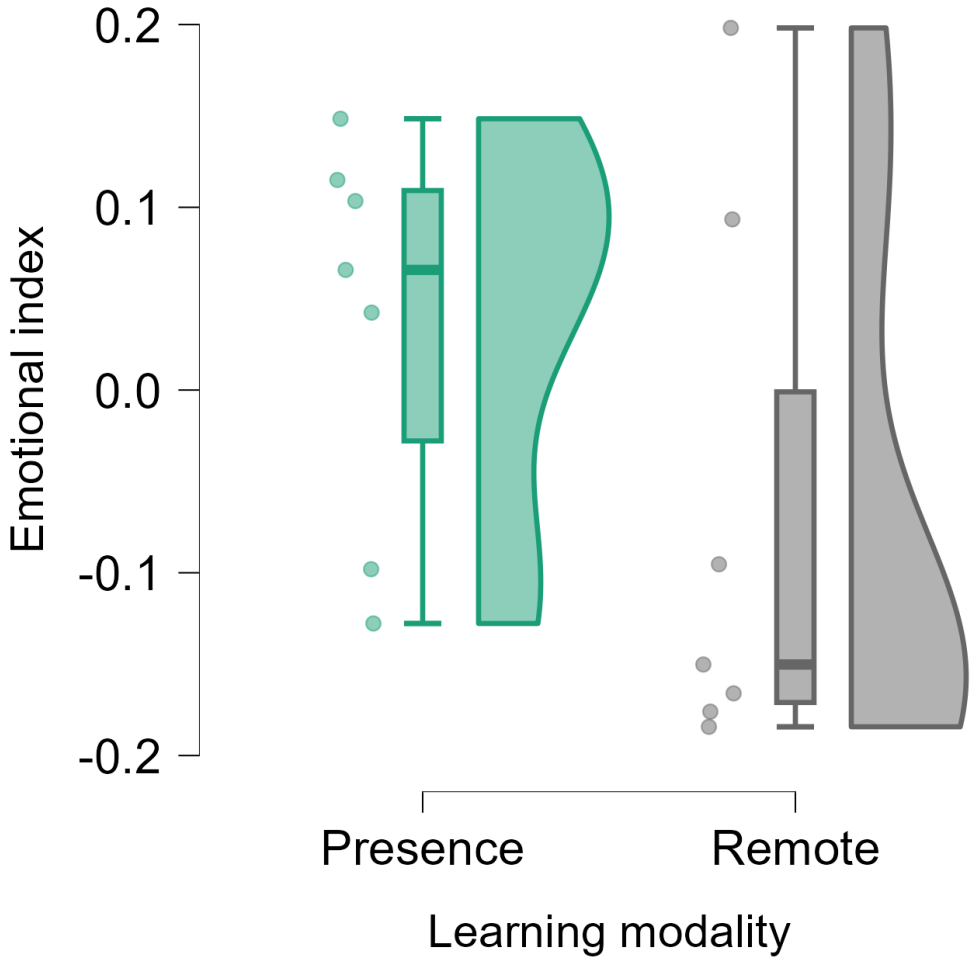
Arousal


1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
SCL_median_Presence
SCL_mean_Remote
Polin. (SCL_median_Presence)
Polin. (SCL_mean_Remote)


SCL
0.70
0.65
0.60
0.55
0.50
0.45
0.40
Presence
Remote
Learning modality

Emotional index overall





What about educational material?

If I had necessarily to provide a lesson by remote, may I optimize my material in order to promote students' engagement and learning?

Research objectives

The experiment was organized during the training week at Copenhagen Business School with the aim of showcasing the potential of deploying a neuroscientific approach to evaluate students' cognitive and emotional experience with respect to different educational contents.

- 2 videos, consisting of a ppt presentation and a voice-over, regarding the same matter but of different length, namely LONG and SHORT, have been tested.

Experimental design

5 participants (students)

- 3 males
- 2 females

Copenhagen Business School

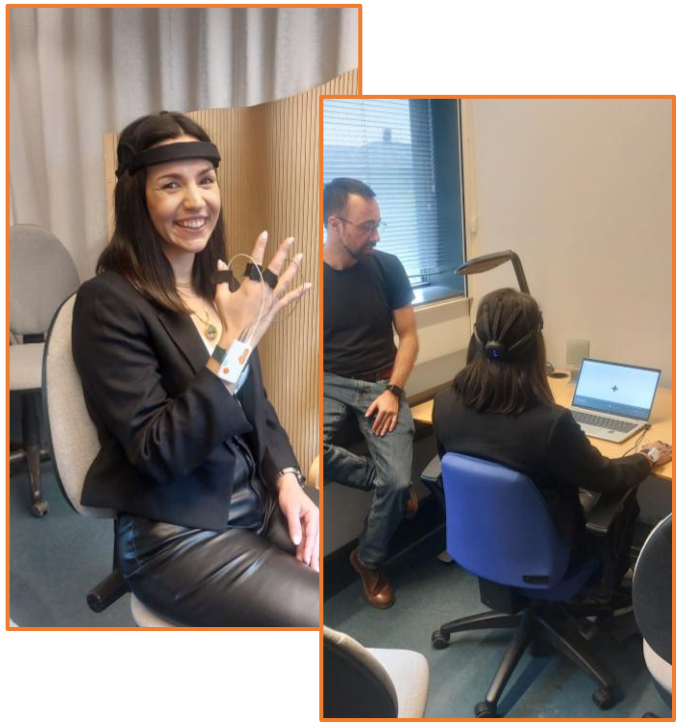
09/05/2024

2 VIDEOS:

- Same topic: Politeness and communication
- Same teacher
- Different length: LONG = 11’ 30’’ & SHORT = 5’ 20’’

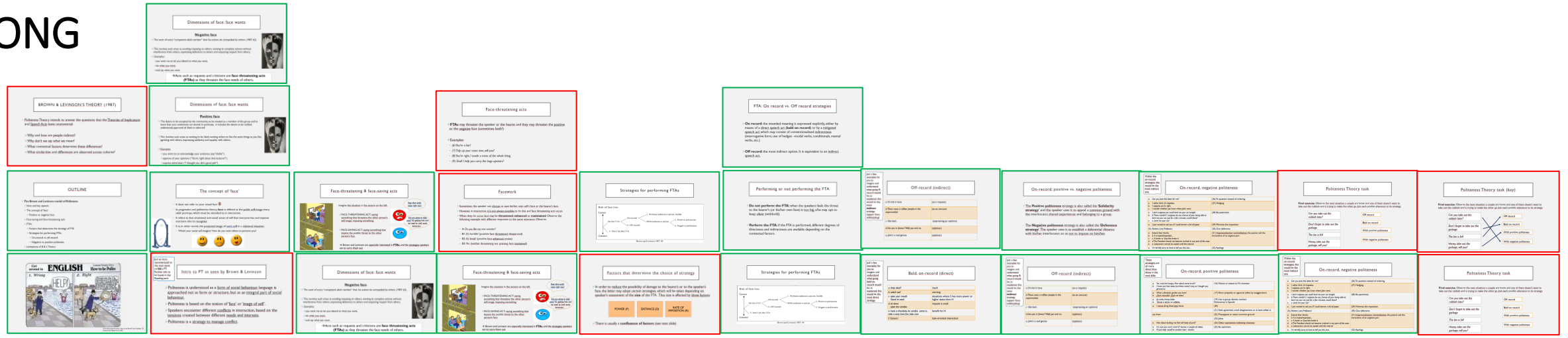
➢ BASELINE: 76” beginning, 86” end

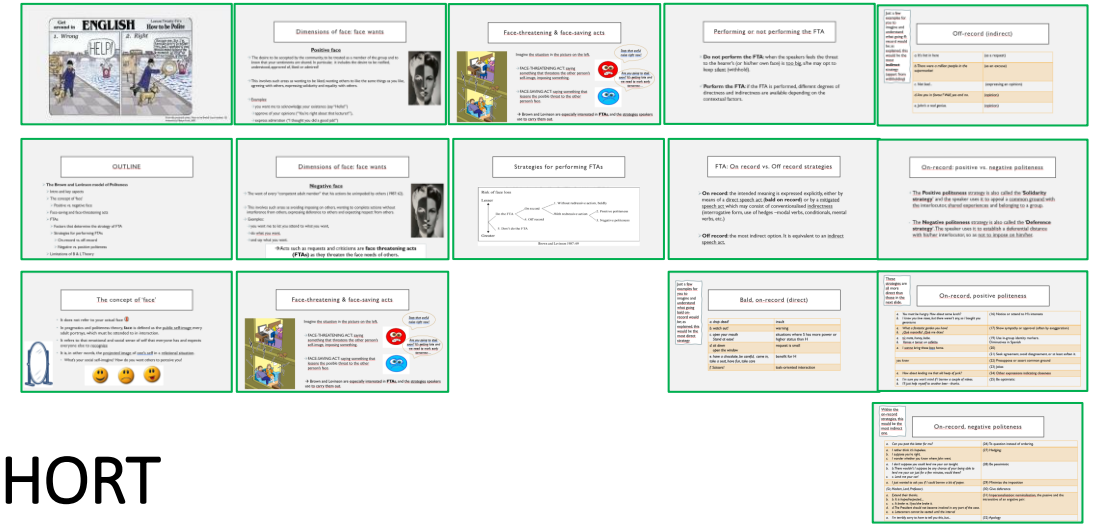
➢ FINAL QUESTIONNAIRE of 10 questions



Experimental design

LONG





SHORT

Neurometrics

Mental Workload is the amount of cognitive resources “allocated” on the main tasks.

Approach-Withdrawal, being the balance between the behavioral inhibition and approach systems, is a measure of the positive or negative user’s motivation.

Visual attention is a measure of the sustained focus.

Emotion combines the information about the valence, i.e., the quality, and the arousal, i.e., the intensity, of the user’s emotional state into a synthetic indicator.

**all the metrics have been individually normalized with respect to the baseline, therefore the ‘0 level’ corresponds to the level of that metric during the baseline itself (fixing cross, no contents)*

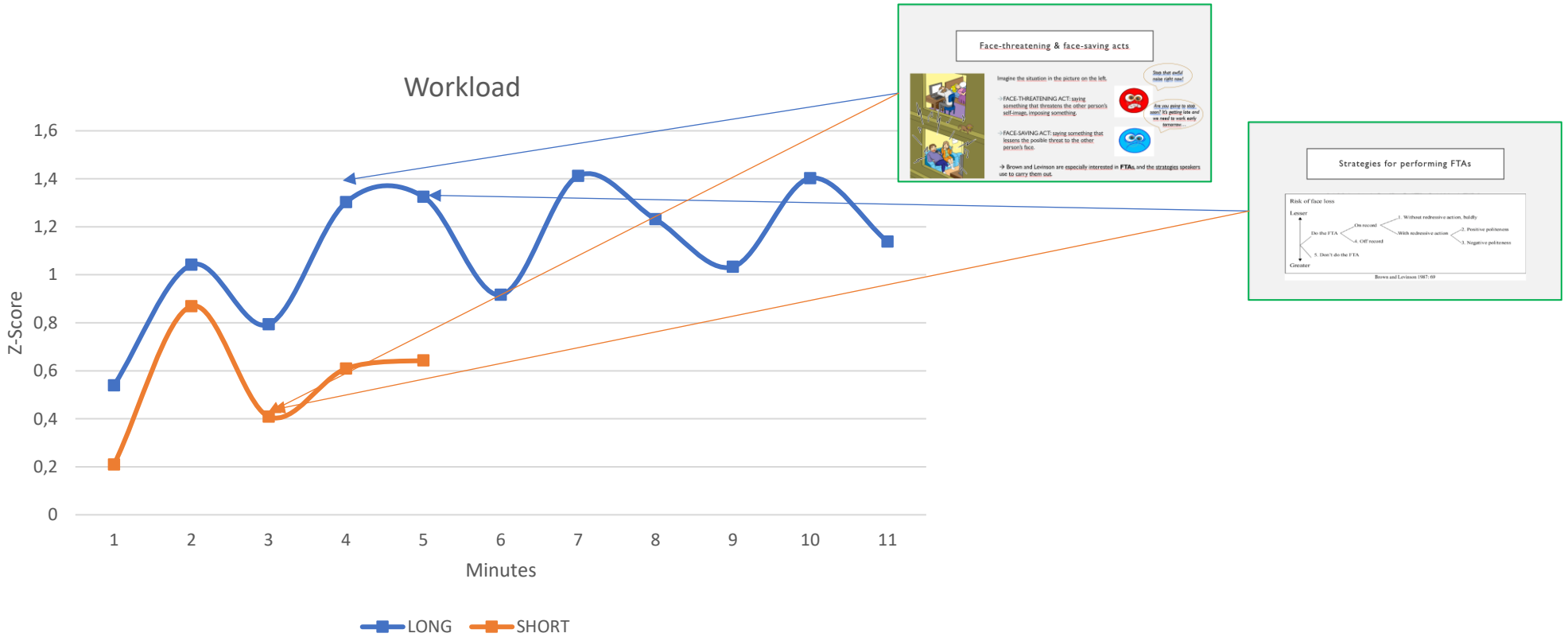
RESULTS

Results – Neurometrics over time

MENTAL WORKLOAD

In both the cases the participants were mentally “active” (positive values → higher than baseline)

Similar trend in the first three minutes, then the LONG video results more mentally demanding.

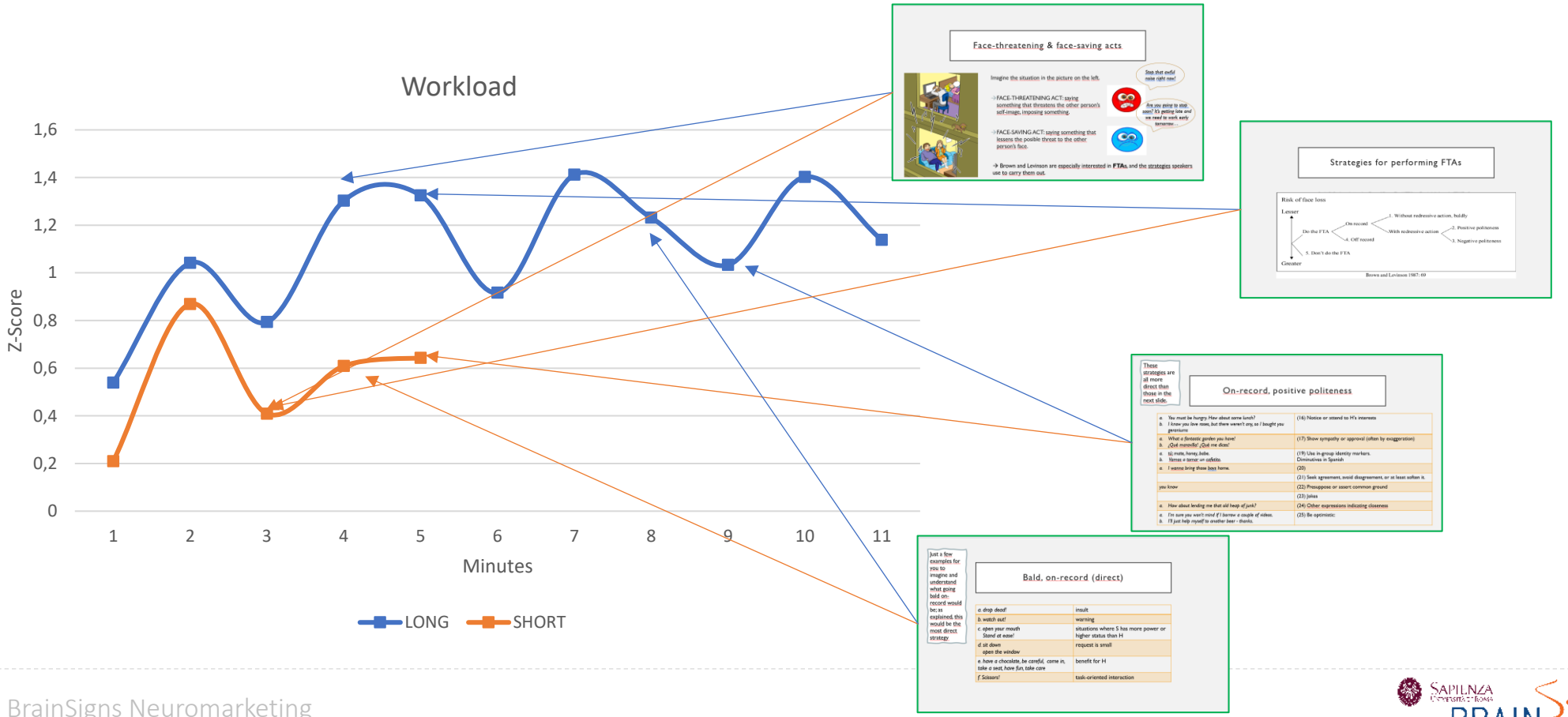


Results – Neurometrics over time

MENTAL WORKLOAD

In both the cases the participants were mentally “active” (positive values → higher than baseline)

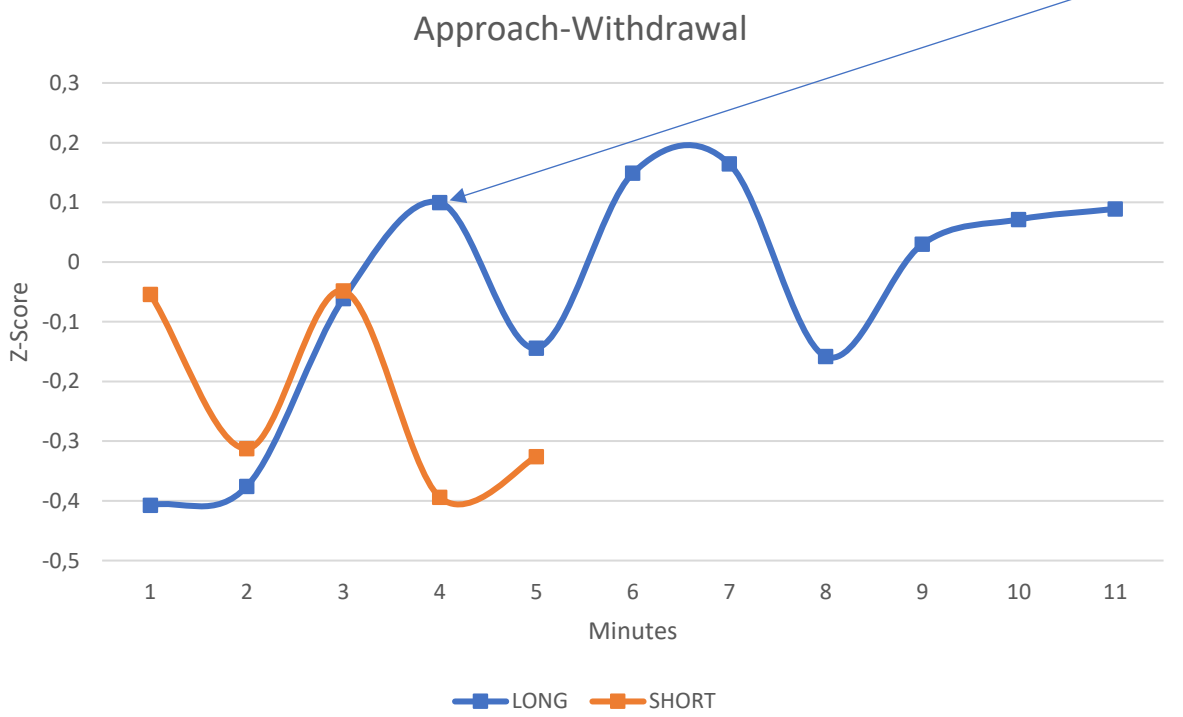
Similar trend in the first three minutes, then the LONG video results more mentally demanding.

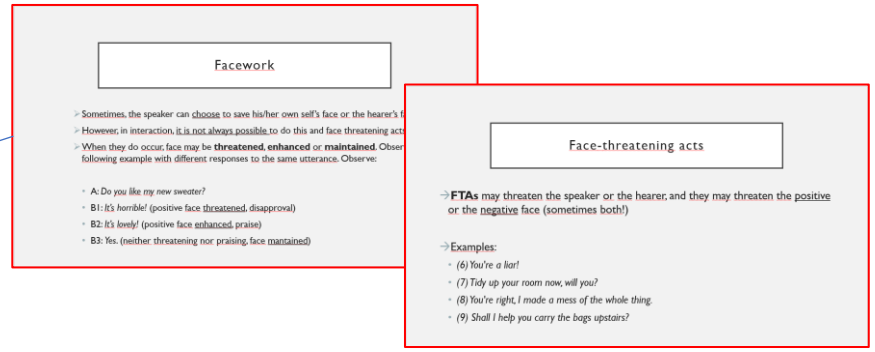


Results – Neurometrics over time

APPROACH-WITHDRAWAL

At the beginning maybe the users were not highly motivated (few negative values), with a similar trend in the first three minutes, then the LONG video was able to induce more interest until its conclusion, maybe also thanks to the new slides.

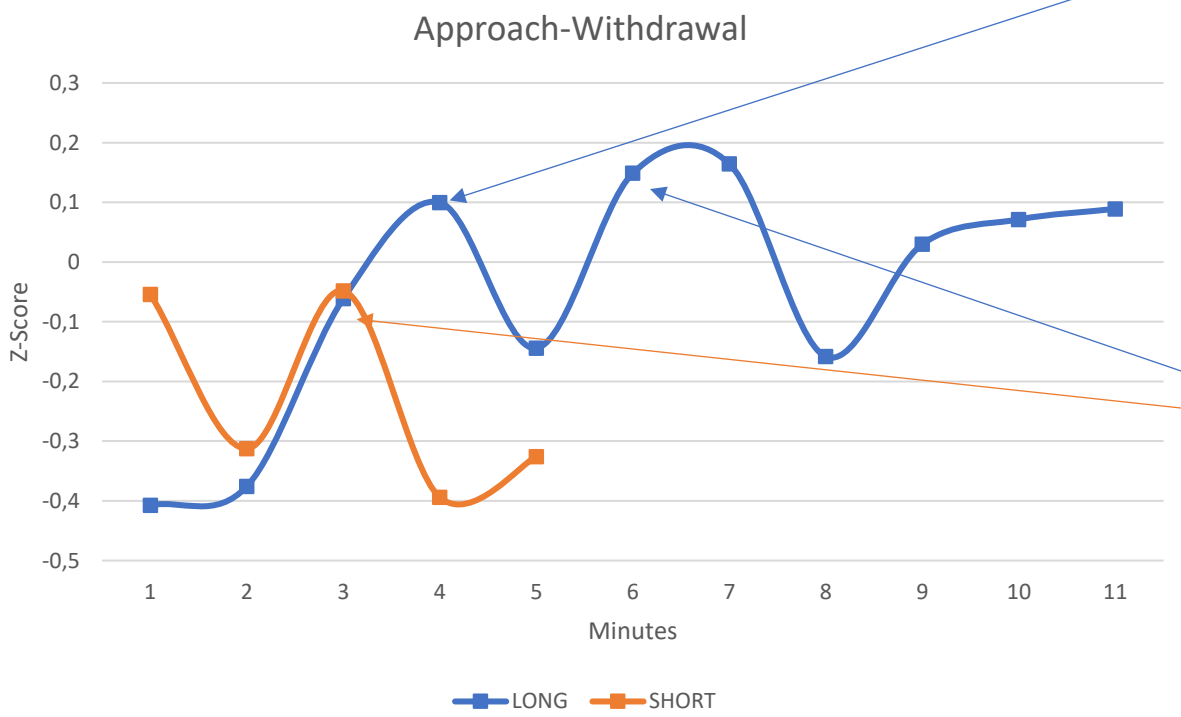


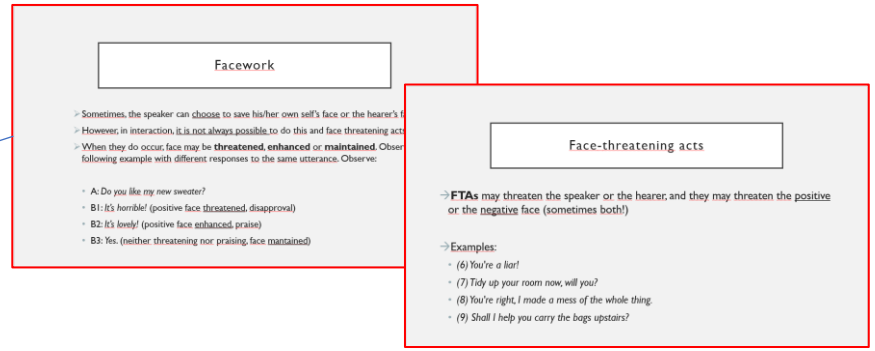


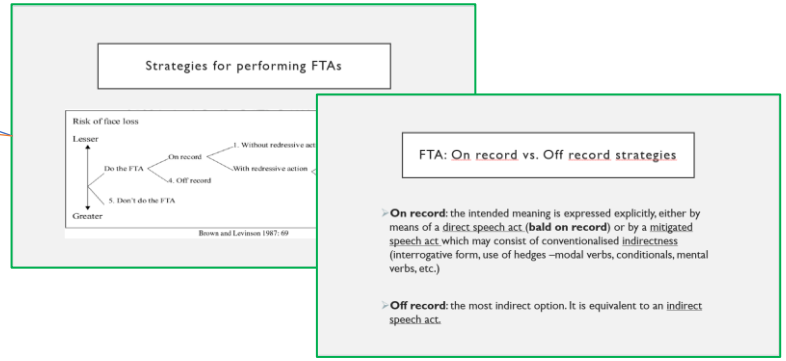
Results – Neurometrics over time

APPROACH-WITHDRAWAL

At the beginning maybe the users were not highly motivated (few negative values), with a similar trend in the first three minutes, then the LONG video was able to induce more interest until its conclusion, maybe also thanks to the new slides.







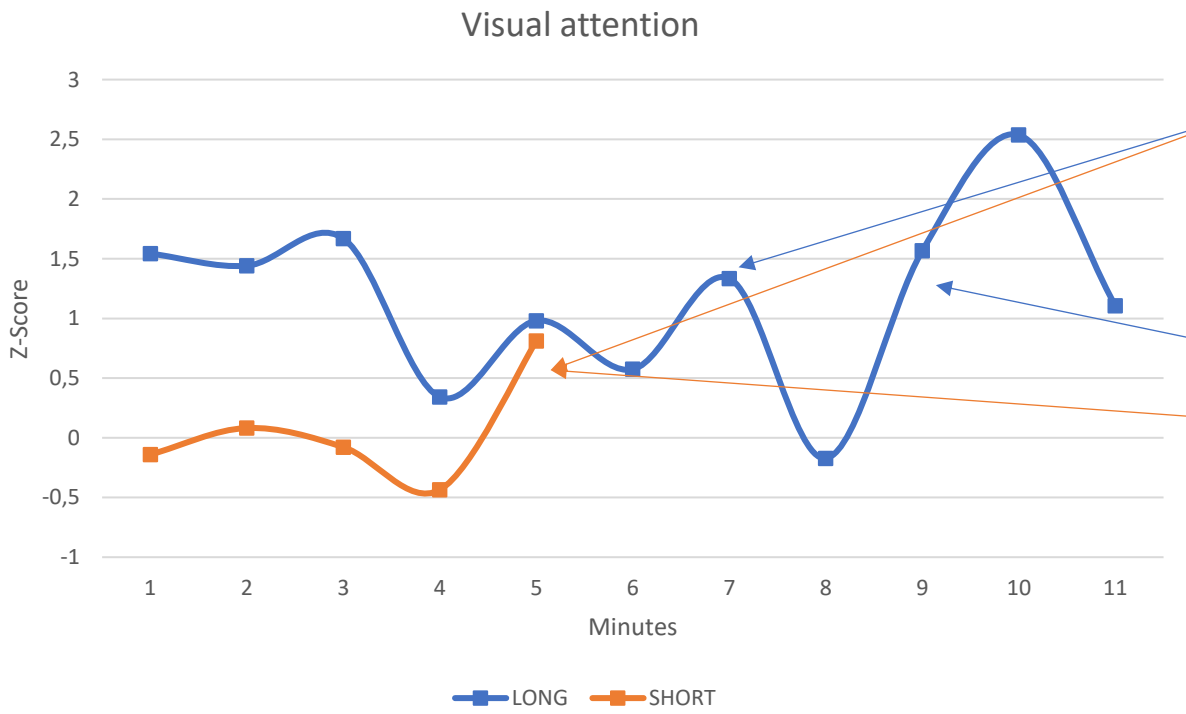
Results – Neurometrics over time

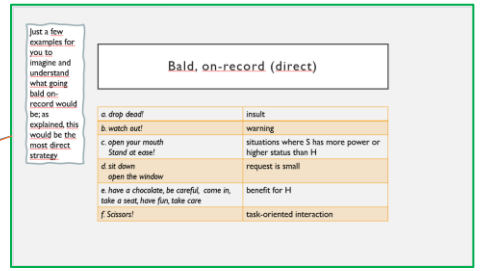
VISUAL ATTENTION

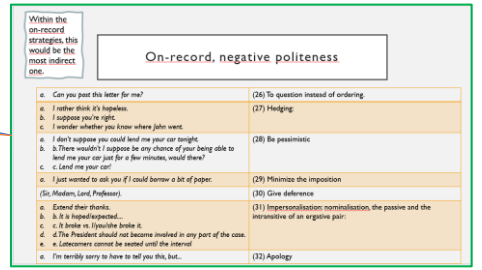
The LONG video seems to induce more attention especially at the beginning…

…but the LONG video contains 9 slides in the first 3 minutes, and with more text, while the SHORT video contains 8 slides, one of which is just a graph.

Tables seem to require more attention, independently from the video.







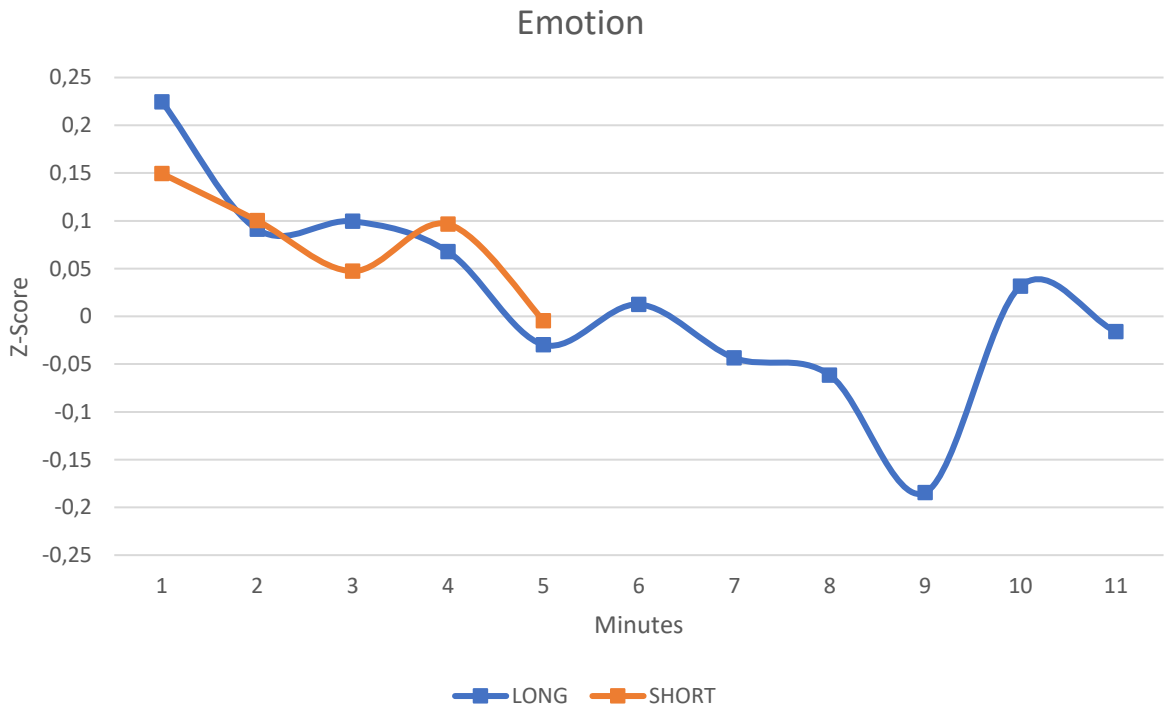
Results – Neurometrics over time

EMOTION

In terms of emotion, it does not appear any particular phenomenon characterising a specific video.

Highest values at the beginning could be linked to initial curiosity and “activation”.

Decreasing trend is linked to the physiological relaxation…



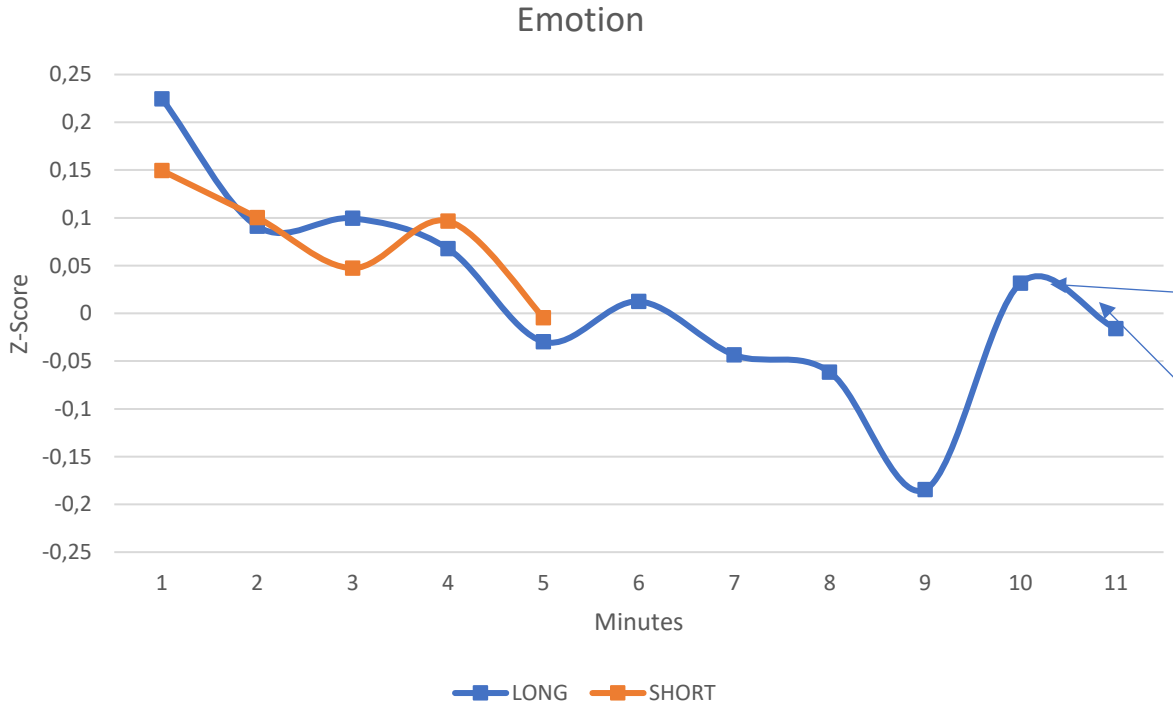
Results – Neurometrics over time

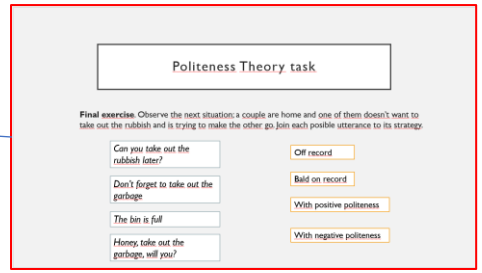
EMOTION

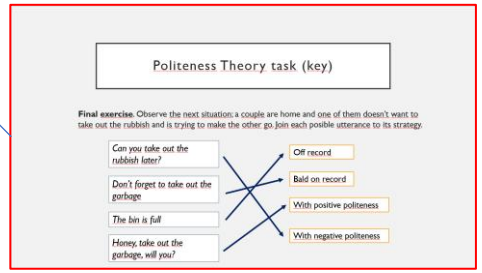
In terms of emotion, it does not appear any particular phenomenon characterising a specific video.

Highest values at the beginning could be linked to initial curiosity and “activation”.

Decreasing trend is linked to the physiological relaxation… but the final exercise present only in the LONG video helped to “stimulate” again the users.







Insights

- ✓ More corrected answers were given after the LONG video.

- For almost all the neurometrics, except the visual attention, the behaviour in the first 3 minutes was similar (similar information), then the narrative impacted on the user's experience.
- In general, the LONG video, even by requiring more workload and attention, produced better performance → more effective narrative and harmony between topics?
- LONG video = more workload and attention, but also more appreciation
- Tables require less workload but more attention on both the videos.
- Duration is not necessarily a problem, even if there is a "boring" effect (emotion) → the key is the compromise between duration and amount of information
- Higher emotion and appreciation at the conclusion of the LONG video → Participatory examples help!

Conclusions

- ✓ Neurotechnologies are a powerful tool to get objective information about the students' experience
- ✓ The advantage of this information is to be available online and eventually synchronous with specific events
- ✓ They can be translated into relevant KPIs, i.e. learning analytics, to be applied at different levels of education: evaluation of materials and contents, of education modalities, of lessons design, etc.
- ✓ It is still difficult to integrate them with other analytics (e.g. Feedback App), to understand how to integrate them in a different way

Conclusions

Neuroscience enable a student-centred educational model

It is possible to evaluate:

- ✓ User's experience
- ✓ Effect to the different contents
- ✓ Reactions to different narrative

Allowing to tailor the lessons and in general the courses to the students' abilities and capabilities

Discovering unconscious **Insights**

BrainSigns

Administrator Office:
Via Tirso n.14, 00198, Rome

info@brainsigns.com
www.BrainSigns.com