In-presence vs Remote teaching at driving schools: a neuroscientific study

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INTRODUCTION

The field of driving training is living a "boom" of fully online driving schools providing courses for theory exams, both on the European dimension and worldwide. However, the effectiveness of online education in a broader extent is largely debated[1], especially during some critical historical periods when distance and remoteness are imposed by the current scenario, such as during CoViD-19 pandemic situation[2]. In the context of driving education, there is the perception that some specific topics, such as for example those ones related to road safety, are particularly relevant, therefore "in-presence" education should be encouraged in any case.

To this regard, the present study aimed at comparing "in-presence" vs "remote" modalities of teaching, in the context of driving education, in order to point out the difference of the former in terms of students' cognitive experience and performance. To accomplish such objective, an innovative neuroscientific approach based on the computation of neurophysiological indexes of mental attention and engagement has been employed. The use of neuroscientific methodologies should guarantee a deeper and more objective evaluation of students' experience, being based on the direct analysis of mental and physiological reactions[3].

METHODS

40 driving school students, recruited on voluntary basis, have been recruited for this study. After collecting their informed consent, they were asked to attend a common driving school lesson on the topic of "Crossroads and related signage". In particular, the lesson lasted 1 hour, and the student had to attend half a lesson in presence, and the other half by remote, in a separated room by using a Personal Computer and the Google Meet platform. Interaction through webcam and microphone was enabled. Therefore, all the participants experienced both the modalities ("in presence" and "remote"), but they were divided into two subgroups to avoid any order effect, so the first subgroup started by remote and then continued in presence, while vice-versa for the second subgroup.

During the whole experience, the students' ocular activity, heart activity and skin sweating were recorded by means of biomedical devices in order to collect their neurophysiological reactions and thus to infer psychophysiological insights about the students' experience during the two teaching modalities (i.e. , "in presence" and "remote").

At the end, each student had to fill a questionnaire of 10 questions, where 5 of them were related to the first half and the remaining 5 on the second half of the lesson, thus being balanced between the two modalities.

RESULTS

The first analysis took into consideration the neurophysiological measures.

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[1] Palvia, Shailendra, et al. "Online education: Worldwide status, challenges, trends, and implications." (2018): 233-241.

[2] Paudel, Pitambar. "Online education: Benefits, challenges and strategies during and after COVID-19 in higher education." International Journal on Studies in Education 3.2 (2021): 70-85.

[3] Aricò, P., et al. "Passive BCI beyond the lab: current trends and future directions." Physiological measurement 39.8 (2018): 08TR02.

Di Flumeri, Gianluca, et al. "EEG-based mental workload neurometric to evaluate the impact of different traffic and road conditions in real driving settings." Frontiers in human neuroscience 12 (2018): 509.

In particular, analysis of ocular activity showed a higher Eye Blink Rate (EBR) during the *remote* lesson. If taking into account that EBR has been demonstrated to be inversely correlated to attention and vigilance, i.e. increasing EBR is a biomarker of attention decreasing, loss of situation awareness and even drowsiness[4], these results suggest that students' attention was higher during the lesson in presence.
Analysis of heart activity showed a higher Heart Rate (HR) and related variability (HRV) during the *in-presence* lesson. These two parameters have been demonstrated to be linked to attention and mental effort, i.e. they increase when the user is cognitively involved in the task[5]. Thus, the results confirmed the fact that students were more cognitively involved during the *in-presence* lesson.
Finally, results of skin sweating pointed out a very higher "sweating level" (Skin Conductance Level), especially at the beginning, during the *remote* lesson. In scientific literature, the Skin Conductance Level is considered a biomarker of physiological arousal and even stress[6]. This large difference, in particular at the beginning, could have been linked to a certain discomfort, and eventually stress, experienced because of the less immediate interaction with the teacher by remote. Interestingly, this effect tended to disappear at the end, when the other indicators suggested a decreasing of attention. On the other hand, "in-presence" lessons seemed to induce more calm among students.
All the previous results have been validated by statistical analysis.
In conclusion, analysis of questionnaires pointed out that the students provided about 4 % more wrong answers when the questions were related to their remote lesson. In addition, not few students but almost one third of them (the 31 %) did more errors by remote, i.e. the increased number of wrong answers on topics taught by remote was a frequent recurrence across students.

CONCLUSION

Analysis of neurophysiological indicators highlights a higher «cognitive activity», in terms of attention and mental effort, during the *in-presence* lesson with respect to *remote* modality. On the other hand, analysis of skin sweating seems to suggest a higher stress, in particular during the first part of the lesson, in students by remote. This could be due to the less smoothness in interacting with the teacher. Analysis of questionnaires demonstrated worst performance on the questions related to the matters taught by remote. Therefore, there is evidence of a common "disengaging" behaviour when attending remote courses, that could undermine the teaching effectiveness.
In general, the use of physiological indicators helps to obtain insights about possible mental causes, that are often «blind» to an external supervisor, such as attentional decreasing and stress increasing, as well as their dynamics during the lesson itself.

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[4] McIntire, Lindsey K., et al. "Detection of vigilance performance using eye blinks." Applied ergonomics 45.2 (2014): 354-362..
Borghini, Gianluca, et al. "Measuring neurophysiological signals in aircraft pilots and car drivers for the assessment of mental workload, fatigue and drowsiness." Neuroscience & Biobehavioral Reviews 44 (2014): 58-75.

[5] Borghini, Gianluca, et al. "Measuring neurophysiological signals in aircraft pilots and car drivers for the assessment of mental workload, fatigue and drowsiness." Neuroscience & Biobehavioral Reviews 44 (2014): 58-75.
Mukherjee, Shalini, et al. "Sensitivity to mental effort and test–retest reliability of heart rate variability measures in healthy seniors." Clinical Neurophysiology 122.10 (2011): 2059-2066.

[6] Rosebrock, Laina E., et al. "Skin conductance and subjective arousal in anxiety, depression, and comorbidity." Journal of Psychophysiology (2016).
Borghini, Gianluca, et al. "Stress assessment by combining neurophysiological signals and radio communications of air traffic controllers." 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC). IEEE, 2020.