Physiological signals in daily life among tobacco, alcohol and cannabis users: Discriminating craving from no-craving episodes

E. Baillet[1,2,3]; C. Vacher[1,2,3]; C. Romao[1,2,3]; T. Monseigne[1,2,3];C. Jeunet-Kelway[1,4]; H. Si-Mohammed[5,6]; F. Serre[1,2,3]; M. Auriacombe[1,2,3]

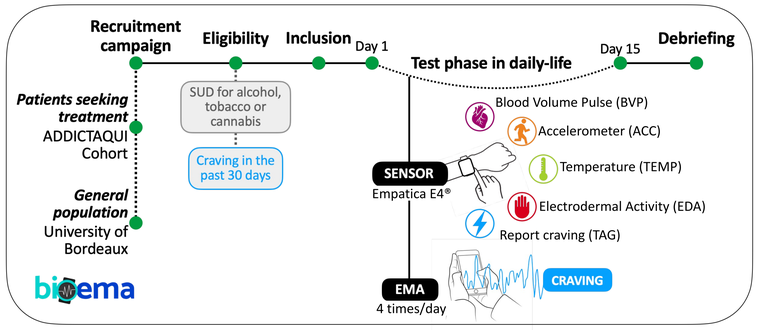
[1]University of Bordeaux, F-33076 Bordeaux, France
[2]CNRS, SANPSY, UMR 6033, F-33076 Bordeaux, France
[3]Pôle Interétablissement d'Addictologie, CH Ch. Perrens and CHU de Bordeaux, F-33076 Bordeaux, France
[4]CNRS, EPHE, INCIA, UMR 5287, F-33000 Bordeaux, France
[5]University of Lille, F-59000 Lille, France
[6]CNRS, Centrale Lille, UMR 9189 CRIStAL

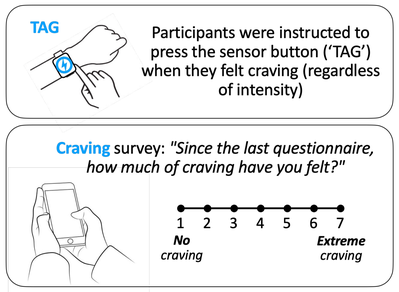
INTRODUCTION

Addiction is characterized by a loss of control over use of reinforcers such as substances (alcohol, tobacco, cannabis…). **Craving** is a clinical phenomenon defined as a strong urge to use (Auriacombe et al., 2018) and plays a central role in addiction (Gauld, Baillet et al., 2023). Craving is a dynamic phenomenon that fluctuates in intensity and frequency and the daily variations of which are prospectively associated with use by Ecological Momentary Assessments method (Cleveland et al., 2021; Serre et al., 2015). It is the cause of repeated relapses and yet, identifying/reporting craving episodes can be difficult for some patients (Raftery et al., 2020). The identification of biomarkers of craving could compensate for this. Craving is associated with **changes in autonomic arousal** and **unique neurobiological changes** (Sinha et al., 2009), that would be identified in daily-life (Carreiro et al., 2020, 2021).

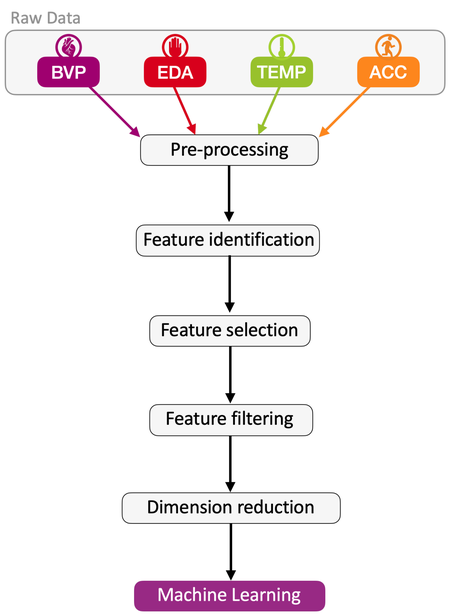
OBJECTIVE To discriminate craving from no-craving episode through the analysis of physiological signals captured in daily-life with Ecological Momentary Assessment and biosensors among participants with addiction.

METHODS





Analysis strategy:



Feature identification Based on features found in literature (Lutin et al., 2021)

- BVP: Time-domain features; Frequency-domain features; Non-linear domain features
- ACC: Time-domain features; Frequency-domain features; Spectral-domain features
- EDA: Time-domain features; Frequency-domain features; Trough-to-peak features

Feature selection

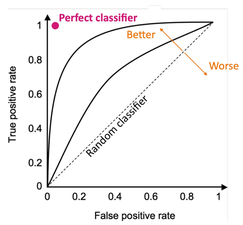
Epochs of **5' before and after** the craving event or randomly in the no-craving period.

Feature filtering

Features were rejected in case of following criteria:
- missing values (not enough physiological data)
- Lack of statistical significance in Student's t test (p-value > 0.05)
- Low variance (Min-Max normalization) (≤0.00025)
- High correlation (≥0.98)

Dimension Reduction

Principal component analysis produces a **linear combination of features** (called principal components (PCs)) ordered according to their ability to explain the total variance of all features, regardless of class.



Machine Learning

Linear Discriminant Analysis & evaluation of classification algorithm with standard metrics: **sensitivity, specificity, accuracy and area under the curve (AUC) of the receiver operating characteristic (ROC) Curve.**

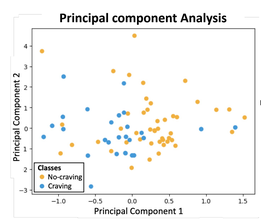
Analyses performed with Python (3.11.2) and R (4.1.0)

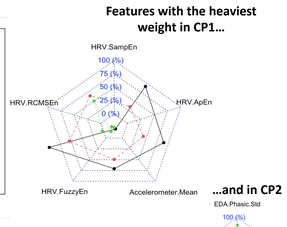
RESULTS

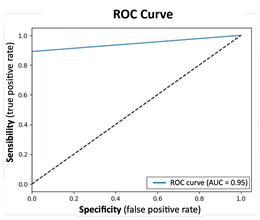
Focus on *one* participant

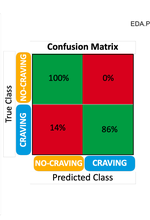
53 y.o.

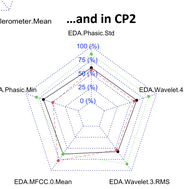
- Feature identification: **187** features extracted
- Feature selection: **46 samples** per class
- Feature filtering: **36** features deleted
- Dimension Reduction: **10 PCs** (66% of variance)









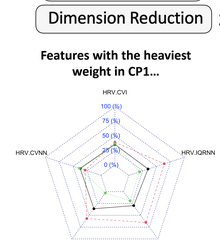


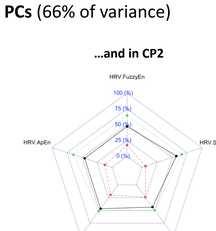
Sensibility: 100%
Specificity: 86%
Accuracy: 93%

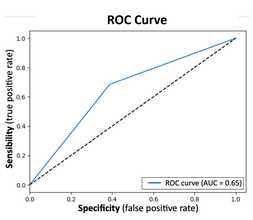
Preliminary results on *all* participants

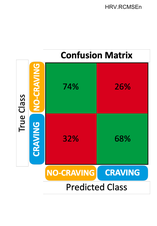
N=29 | 55% n=16 | 32 y.o. (7.7) | 14.5 y. (1.9) | Main inclusion 48% (n=14) | Completion 85% | Sensor port 9.4H/d

- Feature identification: **187** features extracted
- Feature selection: **833 samples** per class
- Feature filtering: **34** features deleted
- Dimension Reduction: **23 PCs** (66% of variance)









Sensibility: 74%
Specificity: 68%
Accuracy: 70%

DISCUSSION

Focusing on one participant: the **accuracy** of model was **93%,** suggesting that this method could be *reliable* to discriminate craving from no-craving episodes.
Preliminary results on all participants: the **low accuracy (70%)** indicating moderate performance. The lack of samples and the lack to minimize inter-individual variability could explain this, and it is necessary to include more participants and standardize each feature to refine the algorithms and the accuracy of model predictions.

CONCLUSION

A better performance of the classification model with good sensibility and specificity, could enable to distinguish craving vs. no-craving episodes from physiologic signals, may enable the development of relapse prevention interventions in daily life.

Contacts: emmanuelle.baillet.1@u-bordeaux.fr ; marc.auriacombe@u-bordeaux.fr

PARTNERS

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