Neural Tracking of Acoustic Onsets; Towards understanding the brain beyond the lab

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Background

- Tracking auditory perception during complex acoustic scenes with electroencephalography (EEG) requires selection of optimal features
- When tracking auditory perception beyond the lab only limited information about the acoustic scene is available due to hardware limitations and privacy concerns.
- Acoustic transients (onsets) can be readily extracted beyond the lab without violating privacy concerns (AFEx app)

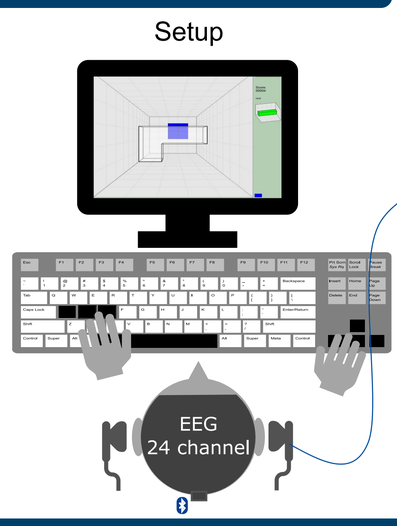
Goal

We aim to understand…

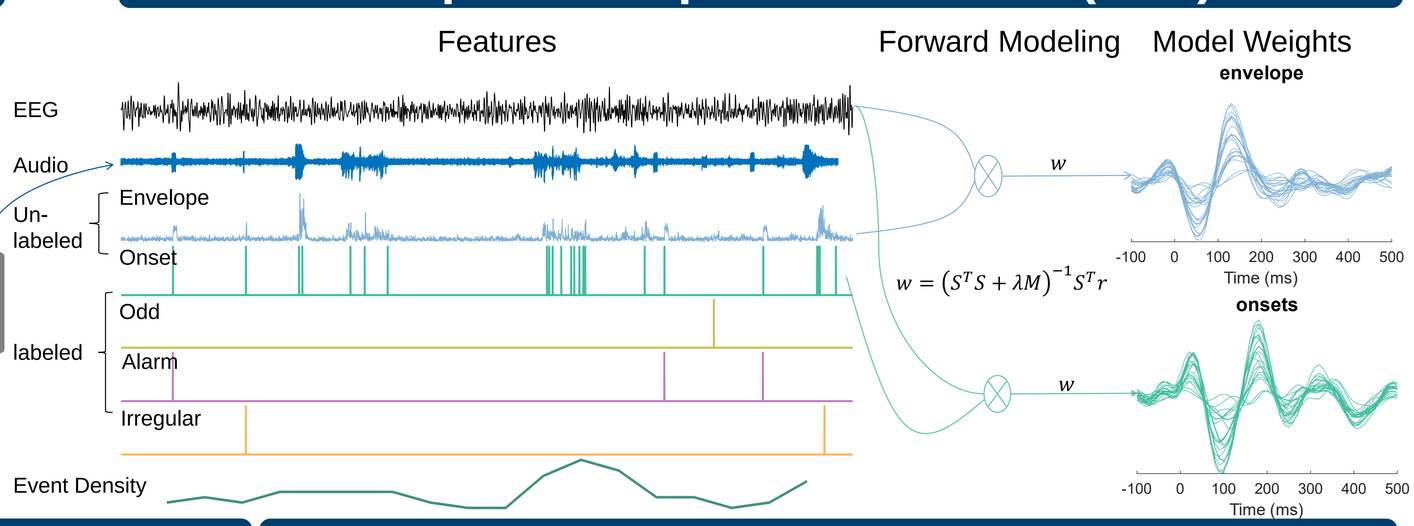
1. … how model performance based on unlabeled onsets compares to other models (labeled and unlabeled)
2. … model sensitivity to trainings data availability
3. … whether information about the environment can be derived from unlabeled onsets
4. … if models that share explained variance, reflect similar neural processes

Paradigm

- Complex soundscape with experimentally placed tones: target (alarm, odd) and irrelevant (irregular)
- Respond to target tones via spacebar press, while performing an audio-visual-motor task
- Extraction of labeled (experimental markers) and unlabeled (onsets, envelope) features



Temporal Response Function (TRF)

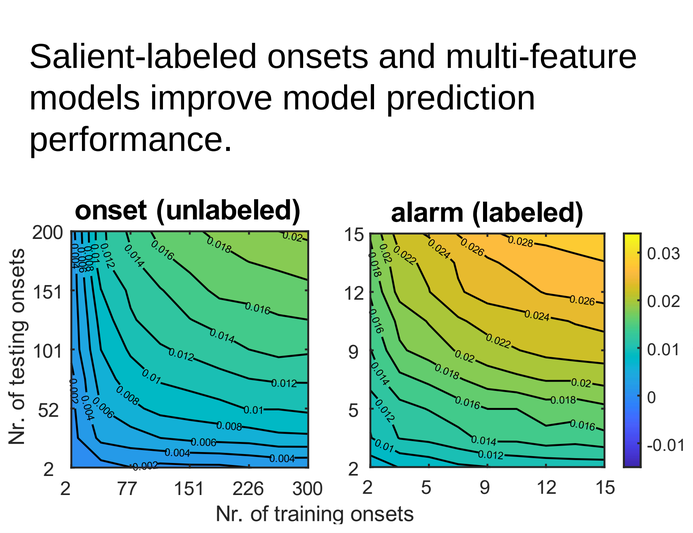


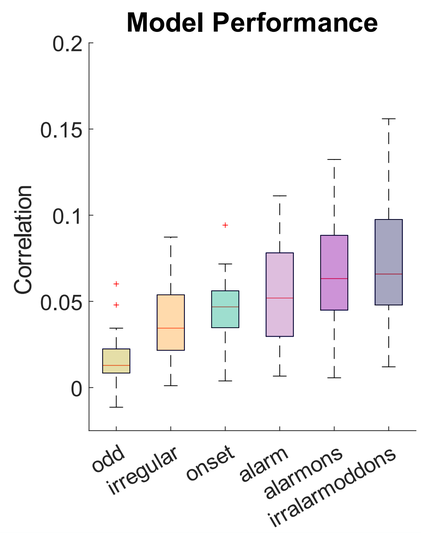
Labeled

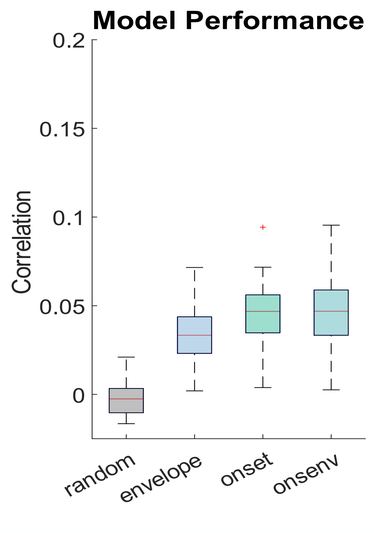
Unlabeled

Model Performance

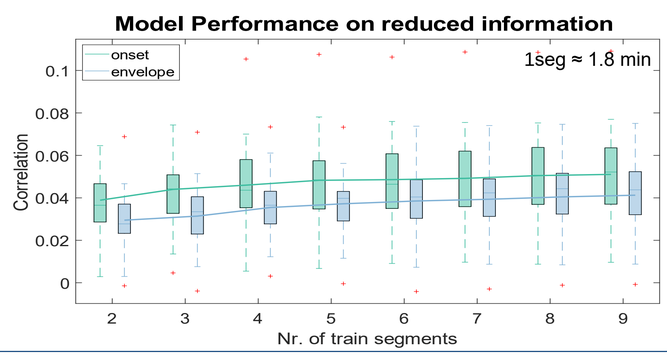
Salient-labeled onsets and multi-feature models improve model prediction performance.





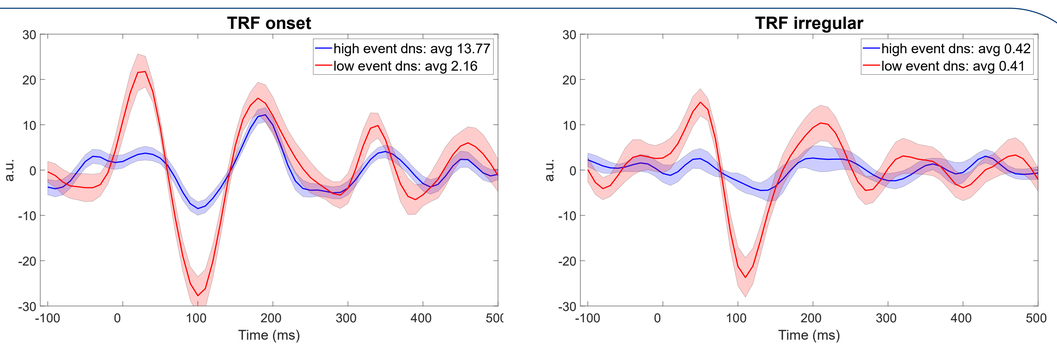


Models based on unlabeled features perform similar.
Multivariate feature models benefit from more trainings information.



Event Density

Event density utilizes unlabeled onsets to depict the average occurrence of sound events over a distinct window of time.



EEG segments can be grouped based on auditory event density. Estimating the corresponding model for high and low event density segments yields different model weights.

Discussion

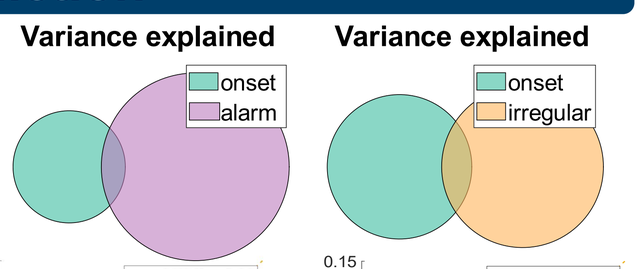
Unlabeled Onsets can be used to study neural tracking of complex acoustic scenes and are sufficient to compute plausible TRFs.

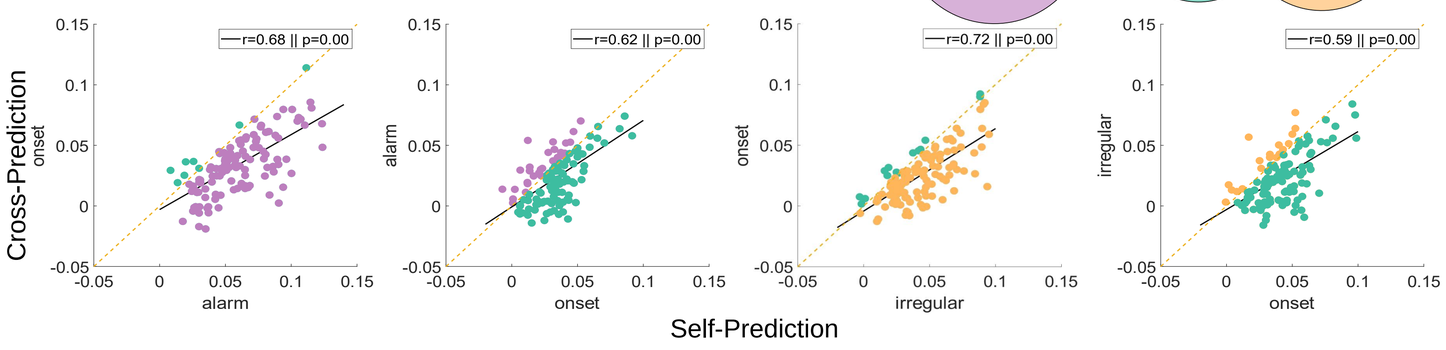
1. Models based on unlabeled onsets compare well to other unlabeled models, but benefit from labeled information
2. Model performance of both un- and labeled features improves with increasing training and testing data availability
3. Event-density provides meaningful information about the acoustic environment
4. Results are not conclusive to argue that models that share explained variance describe similar neural processes

- Results have to be validated on a beyond the lab dataset

Cross-Prediction

Models based on labeled and unlabeled features share little variance.
Yet, model prediction analysis indicates a positive relationship in terms of self- and cross-prediction across different onset features.





Conclusion

- Unlabeled sparse acoustic onsets provide the most fundamental level of informative features that can be derived from sound sources
- Labeled information can improve the interpretation of neural tracking of acoustic events beyond the lab
- The event density can help to understand the neural responses in long EEG recordings

References

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