Attempting dream decoding with generalizable visual EEG encoding models

Qiaorong Yu[1], Remington Mallett[2,3], Michelle Carr[2,3]

[1]University of Oxford, [2]University of Montreal, [3]Center for Advanced Research in Sleep Medicine

OVERVIEW

The realm of dreams remains relatively uncharted due to **the reliance of subjective reports to access dream content**.
Building a dream decoding model is difficult due to **the difficulty in collecting large sample sizes of dream experience**.

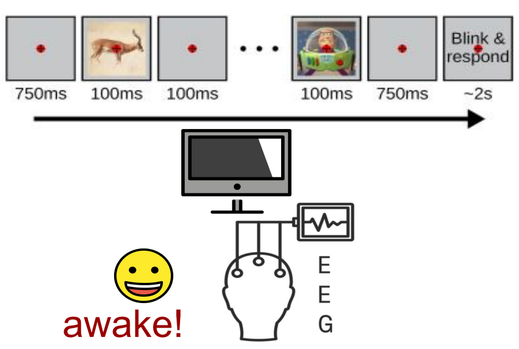
We trained an encoding model to generate EEG signals from deep neural network feature maps of visual images viewed during waking, and used the model to try and predict EEG signals collected during dreaming.

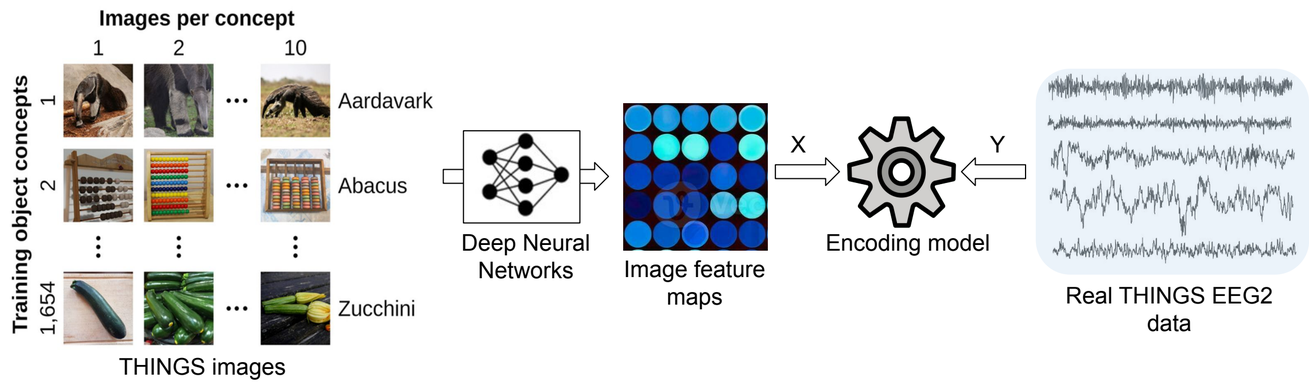
1. Training the Encoding Model on Waking Perception

Dataset: THINGS EEG2

Gifford et al., 2022, *NeuroImage*

Waking EEG responses from 10 participants to 16,740 naturalistic images.



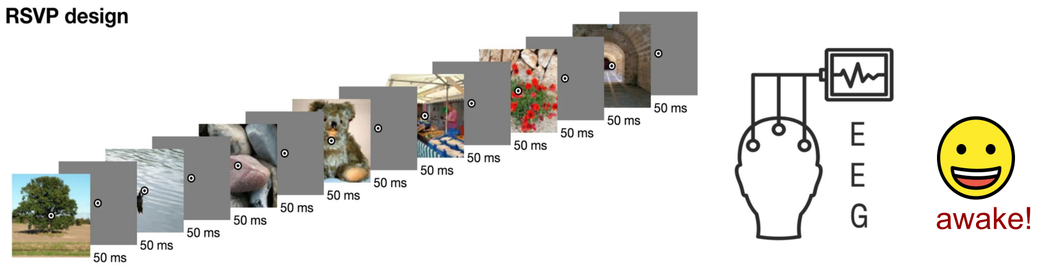


2. Generalization of the Encoding Model across Waking EEG Datasets

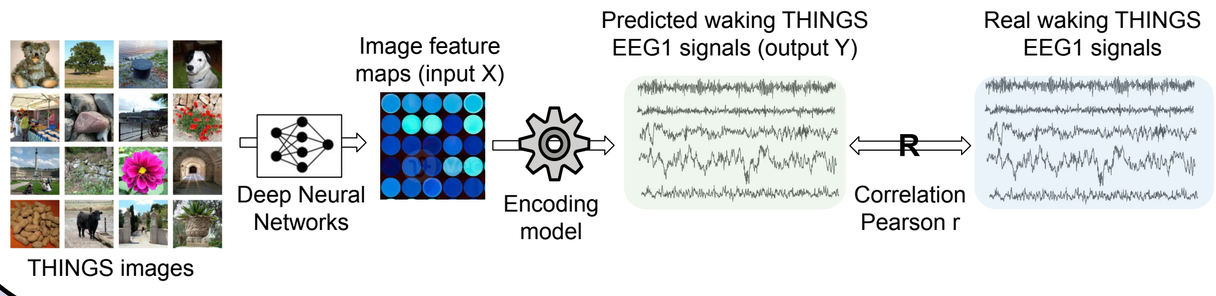
Dataset: THINGS EEG1

Grootswagers et al., 2022, *Sci Data*

Waking EEG responses from 50 subjects to 22,248 naturalistic images using an RSVP paradigm similar to THINGS EEG2.

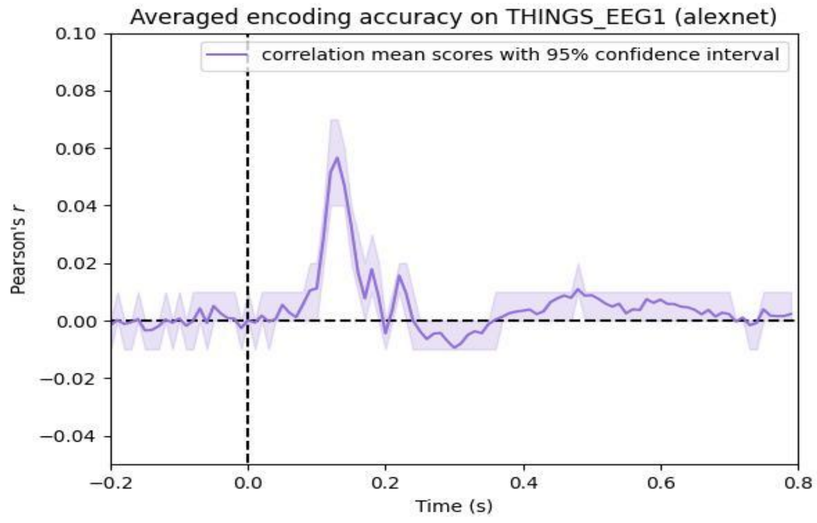


Model trained on THINGS EEG2 is tested on THINGS EEG1



RESULT

The THINGS EEG2 encoding model successfully generalizes to the THINGS EEG1 data, suggesting the model is robust to diverse data collection conditions.

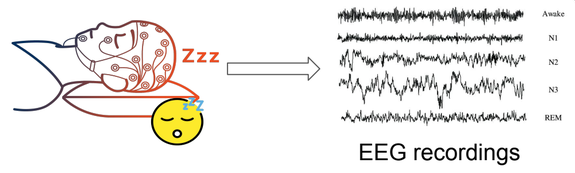


The plot shows the temporal accuracy of testing the encoding model on THINGS EEG1 dataset which is averaged across stimuli across selected (occipital and parietal) EEG electrodes.

3. Using the Encoding Model to Decode Dream Visual Content

Dataset: Zhang & Wamsley, 2019, *Psychophysiology*

A comprehensive dataset of **sleep EEG data and dream reports** of different sleep stages.



The trained encoding model is used to decoding visual content of dream EEG data

ChatGPT and Stable diffusion generate dream images based on dream reports and the model predicts the dream EEG signals based on the feature maps of dream images. The generalizability of the model can be tested via correlating predicted and real dream EEG signals.

RESULT

We conducted the representational similarity analysis (RSA) to test the generalizability of the model. Fig (a), for all dreams, there are no significant encoding outcomes. Fig (b), 11 REM dreams have qualitative encoding traces along the diagonal, but still insignificant. Fig (c), all 11 REM dreams are projected to 2-dim vectors and clustered (purple/green: dreams with/without significant signs of people).

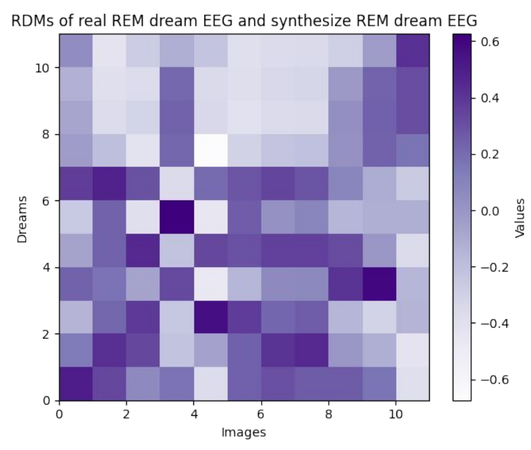


Fig (a)

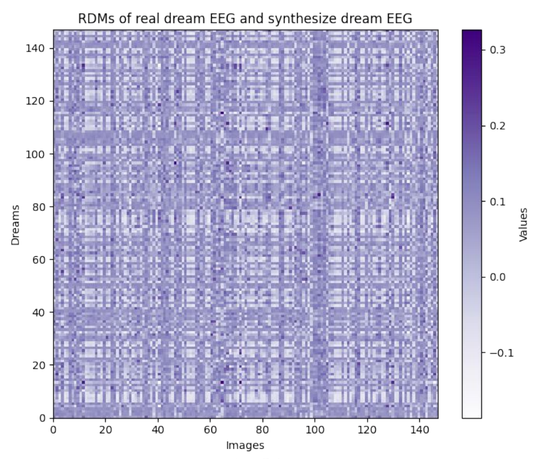


Fig (b)

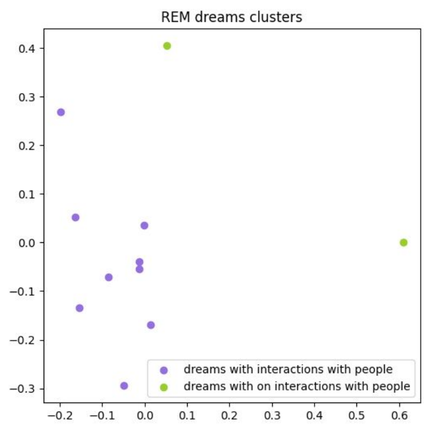


Fig (c)