

Attempting dream decoding with generalizable visual EEG encoding models

Dream Engineering
Laboratory

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OVERVIEW

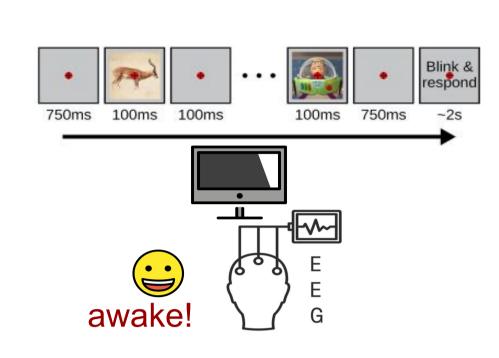
The realm of dreams remains relatively uncharted due to **the reliance of subjective reports to access dream content**. Building a dream decoding model is difficult due to the difficulty in collecting large sample sizes of dream experience.

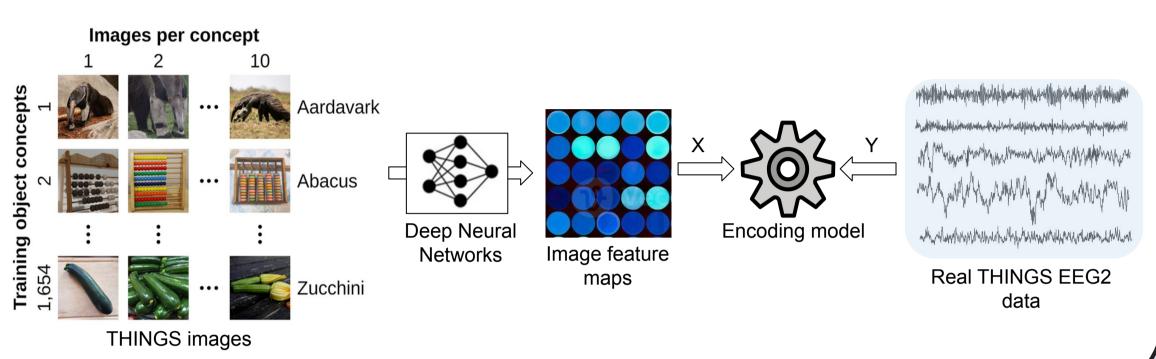
We trained an encoding model to generate EEG signals from deep neural network feature maps of visual images viewed during waking, and used the model to try and predict EEG signals collected during dreaming.

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.



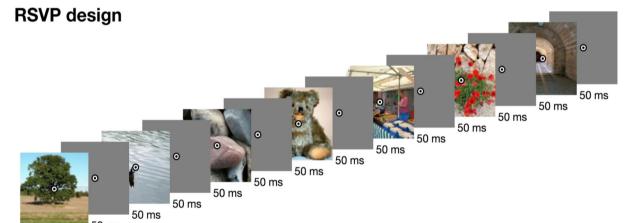


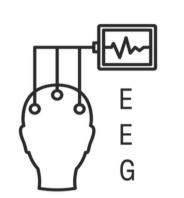
2. Generalization of the Encoding Model across Waking EEG Datasets

Dataset: THINGS EEG1

Grootswagers et al., 2022, Sci Data

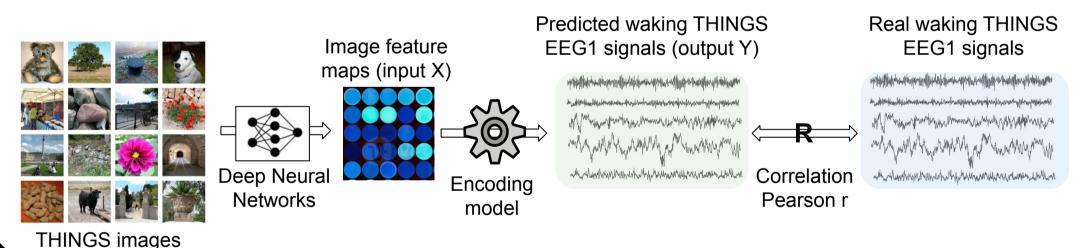
Waking EEG responses from 50 subjects to 22,248 naturalistic images using an RSVP paradigm similar to THINGS EEG2.





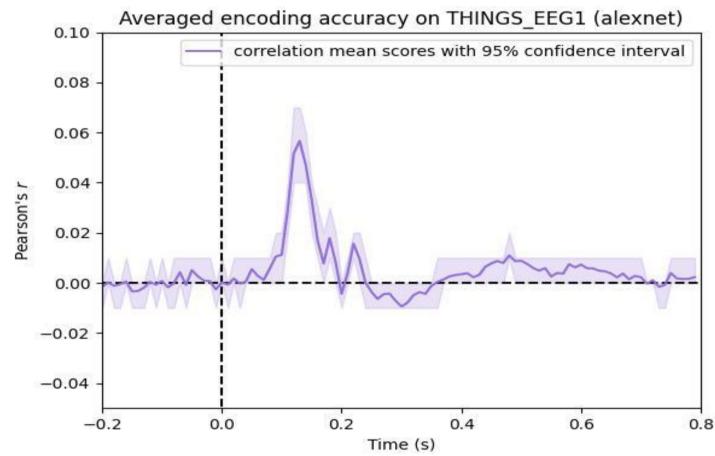


Model trained on THINGS EEG2 is tested on THINGS EEG1



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.

"I'm in a room. Uh... I need to find out information about something... uh... I'm with uh random people that I don't know and uh we're trying to figure something out. Um...they were opening files to look at it, and we're... I was waiting on them to open it up so we can look at it. Umm and it was kind of secretive. It was open, a lot of light, yellow walls, or tan, high ceiling, window, there was about 3 people. Ummm they seemed older and they were guys and umm I don't know what we're doing specifically, what we're looking for. They had a weird accent, similar to like an English accent, similar to a movie I watched last night. Um yea I think that's...that's all I can remember. '

Raw dream report

Convert this dream report into a text prompt as input for an AI text-to-image generator.

First-person perspective in a spacious room with high ceilings, bathed in abundant natural light. Walls painted in a warm shade of yellow or tan. A large window letting in the light. Three older men, engrossed in opening files, their faces focused, their accents vaguely English. The atmosphere is somewhat secretive, as if engaged in solving a mystery or uncovering hidden information. High resolution, realistic image.

Stable Diffusion prompt generated by Chatgpt from dream report



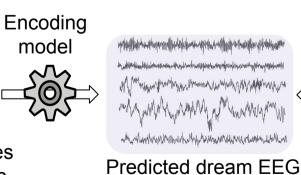
Al generated dream

visual content

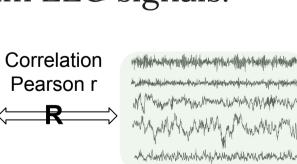
Dream images feature maps

(input X)

RDMs of real dream EEG and synthesize dream EEG



signals (output Y)



Real dream EEG signals

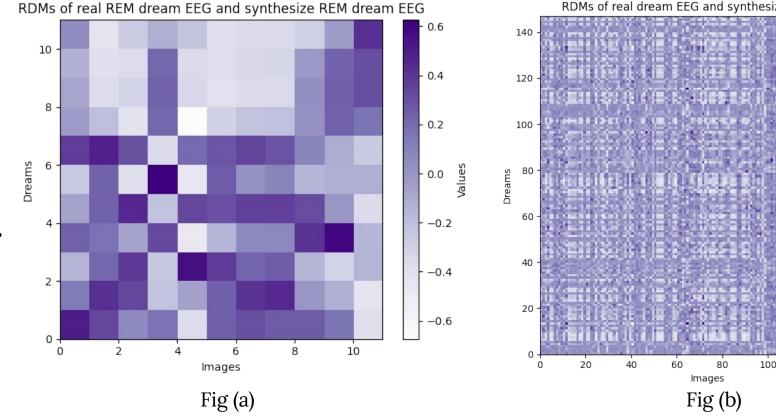
REM dreams clusters

EEG recordings

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).



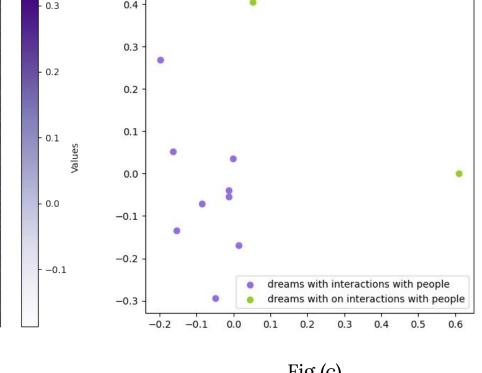


Fig (c)