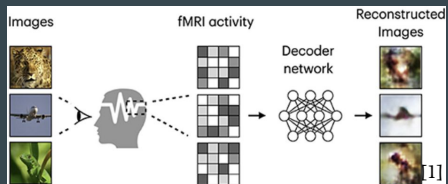


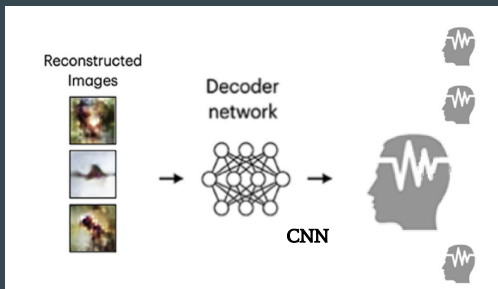
The Identification of Individual Subjects Based on Image Reconstructions

1. Topic: Reconstruction of Visual Stimuli from Brain Activity using Machine Learning.

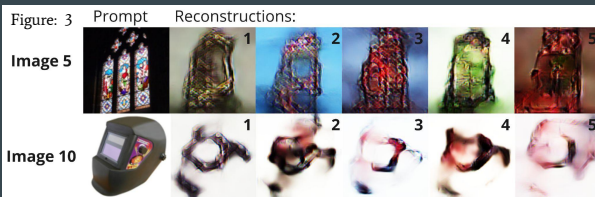
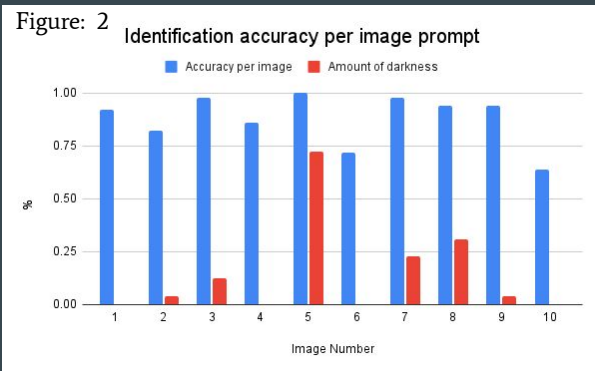
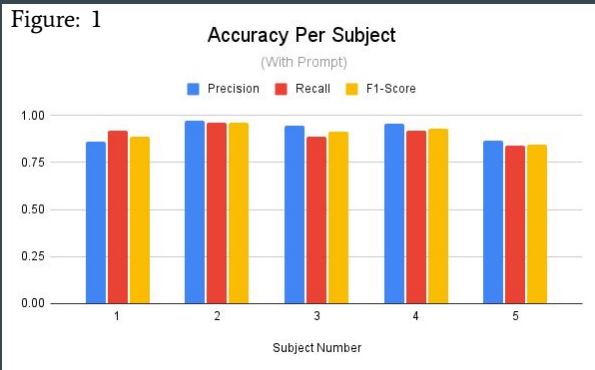


Functional Magnetic Resonance Imaging (fMRI) scan of the subjects brain activity is taken while they look at an input image. A network model [2] then decodes the features of the scan and reconstructs the input image.

2. Question: To what degree can we identify the subject that served as input for the reconstructed image.



A CNN decodes the personal signatures found in the reconstructed images and classifies the input as one of the possible subjects.



3. Motivation:

Ethical issues and data privacy.

Learn more about how humans see images. Furthering work in **computer-brain interfacing** or helping people with **neurological conditions that affect sight**.

4. Results:

Image reconstruction quality [3] of 74.4% with an average rank of 1.45.

Average **Identification accuracy of 90.4%** across 10 runs.

5. Conclusion:

Different subjects have different identification accuracies (Figure 1). Reconstruction quality helps identification accuracy.

Different image prompts have different identification accuracies. Darkness could help carry personal features (Figure 2). Colour emerges from dark areas in prompt (Figure 3).

Suggested Theories:

- Brain background noise.
- Remnants of model strategy.
- Generative process of the brain.
- 'Memory colour' [4] present in visual cortex.

Citation:

[1] Rakhimberdina, Z., et al, "Natural Image Reconstruction From fMRI Using Deep Learning: A Survey. Frontiers in neuroscience," Frontiers in neuroscience, vol. 15, no. 795488, 2021.

[2] G. Gaziv and M. Irani, "More Than Meets the Eye: Self-Supervised Depth Reconstruction From Brain Activity," arXiv preprint arXiv:2106.05113, 2021.

[3] R. Zhang, et al, "The unreasonable effectiveness of deep features as a perceptual metric," 2018.

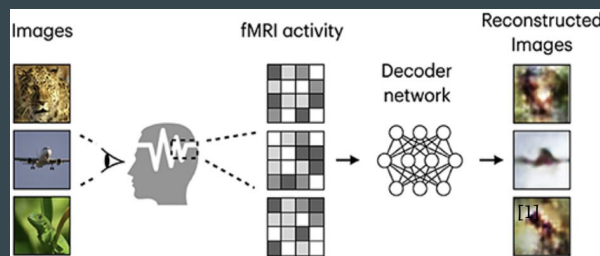
[4] . B. Michael M. Bannert, "Decoding the yellow of a gray banana," Current biology, 2013.

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Supervisor: Xucong Zhang Examiner: Nergis Tömen

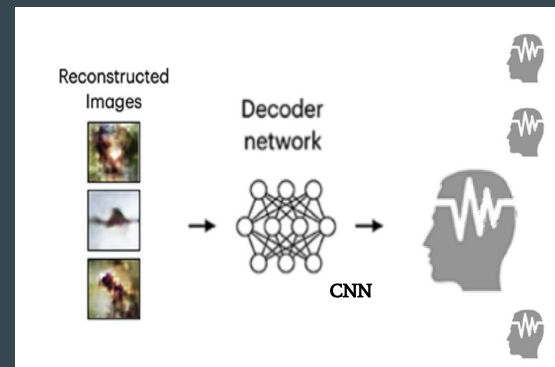
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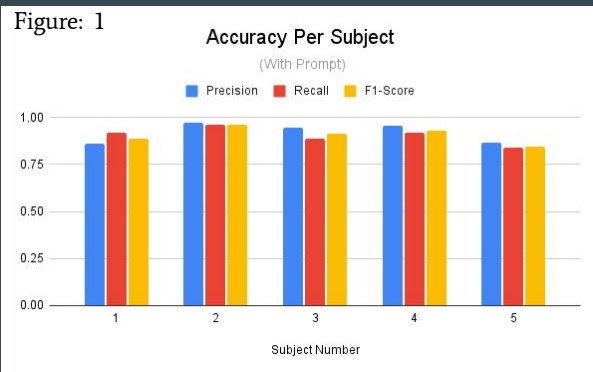
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The Identification of Individual Subjects Based on Image Reconstructions

Figure: 1



3. Motivation:

Ethical issues and data privacy.

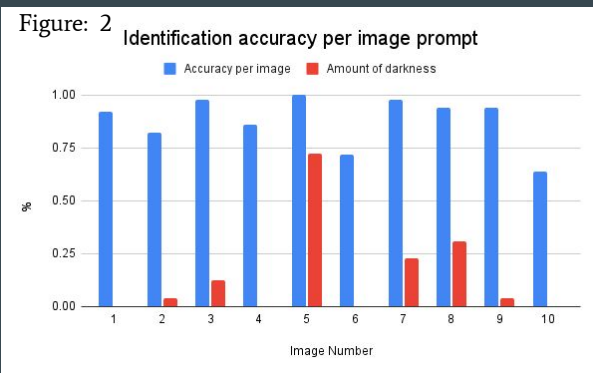
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Figure: 2

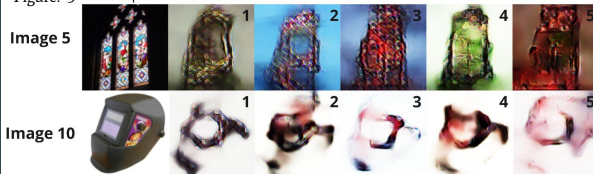


5. Conclusion:

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Different image prompts have different identification accuracies. Darkness could help carry personal features (Figure 2). Colour emerges from dark areas in prompt (Figure 3).

Figure: 3 Prompt Reconstructions:

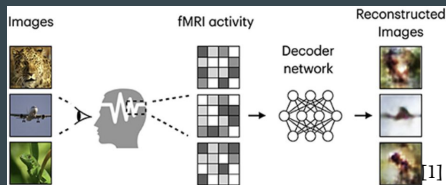


Suggested Theories:

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- Remnants of model strategy.
- Generative process of the brain.
- 'Memory colour' [4] present in visual cortex.

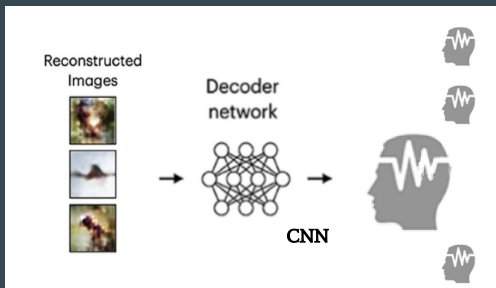
The Identification of Individual Subjects Based on Image Reconstructions

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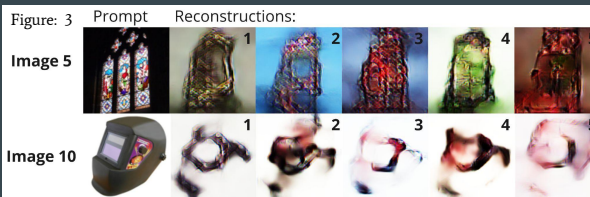
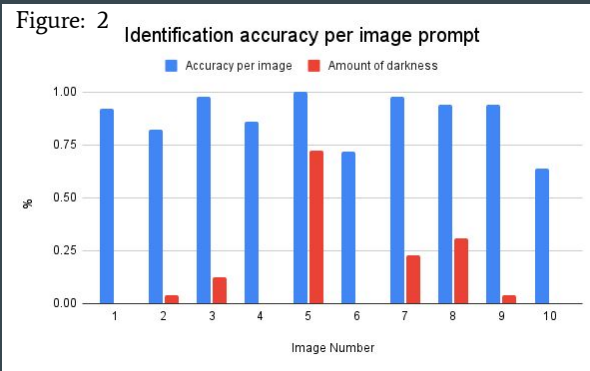
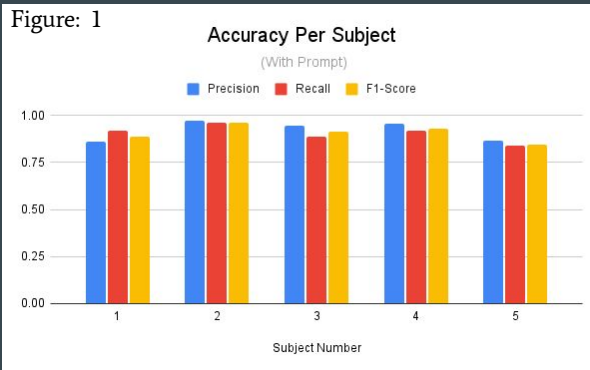


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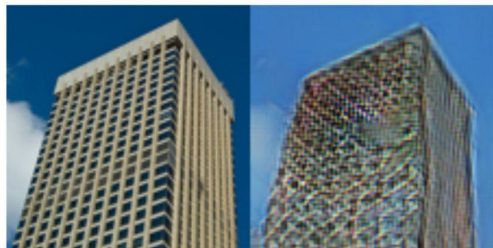
Supervisor: Xucong Zhang Examiner: Nergis Tömen

Questions

Training:

Prompt:

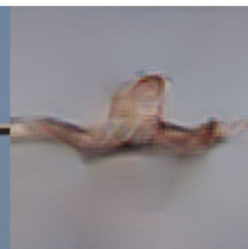
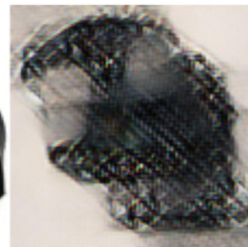
Reconstructed:

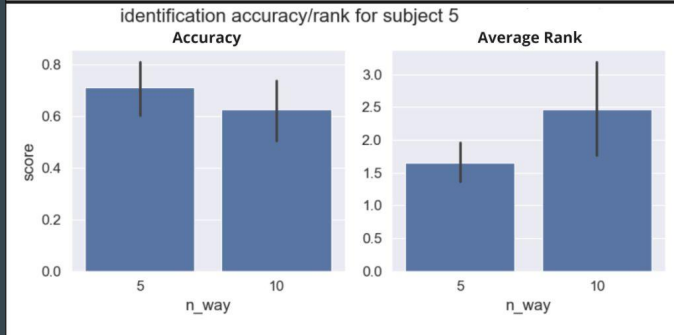
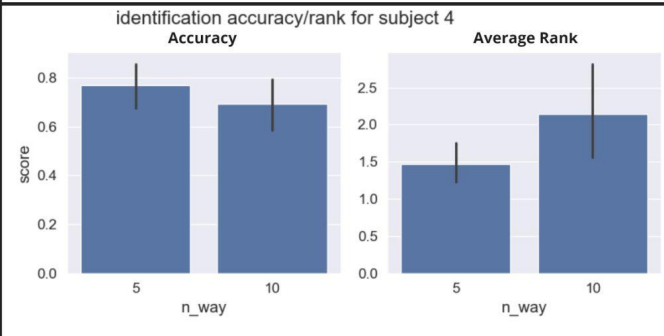
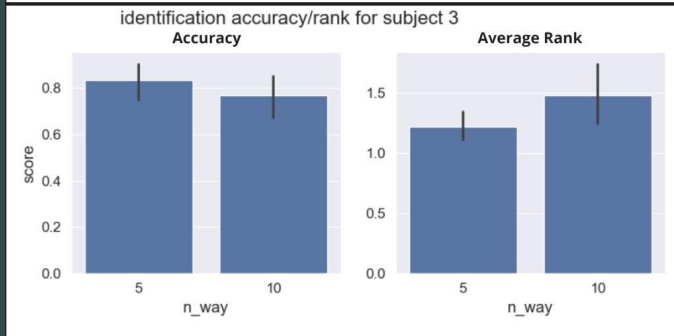
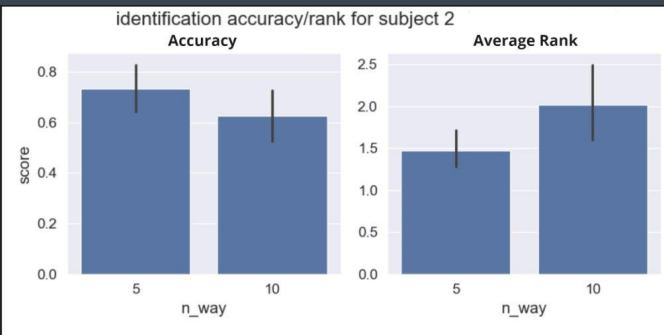
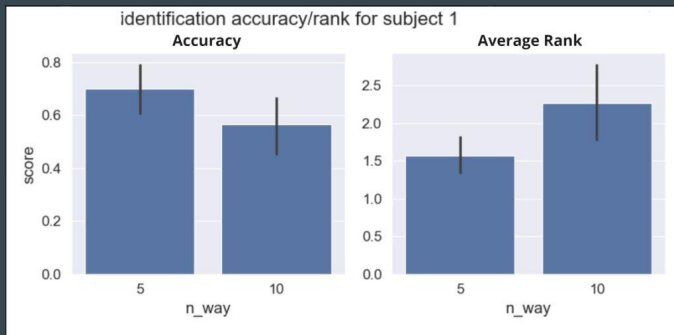


Test:

Prompt:

Reconstructed:





N-way comparison: Reconstructed image is compared to n candidate images including the original prompt image.

Accuracy: The similarity accuracy of the reconstructed image to the prompt image using Perceptual Similarity metric

Average Rank: Candidate images were ranked by similarity to the reconstructed image using the Perceptual Similarity metric. The average rank score denotes the average rank of the prompt image.

The average accuracy between all subjects was 74.4% for the 5-way comparison and 66% for the 10-way comparison.

The average rank between all subjects was 1.45 for the 5-way comparison and 2.05 for the 10-way comparison.

Image 5

Prompt

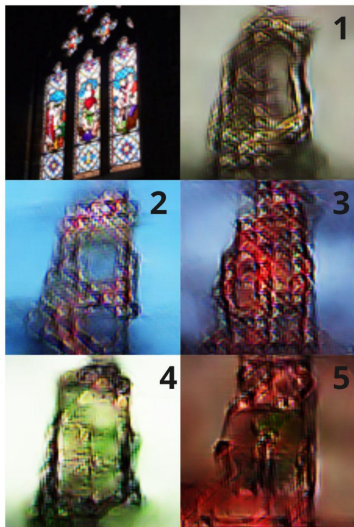
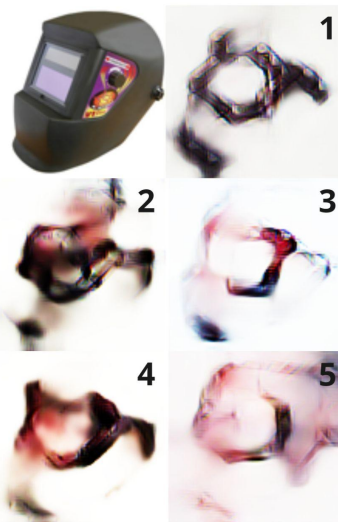
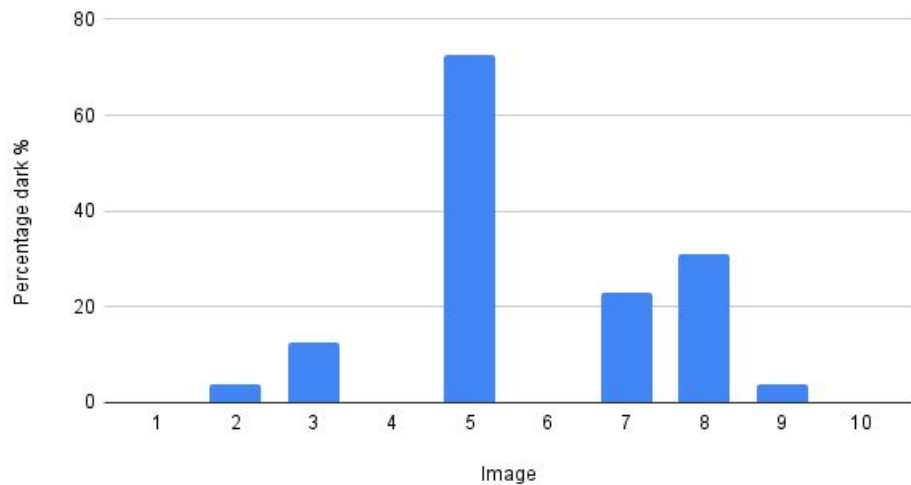


Image 10

Prompt

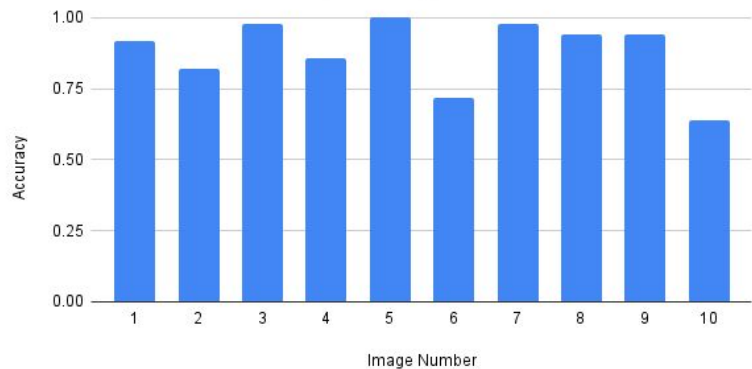


Amount of darkness per image



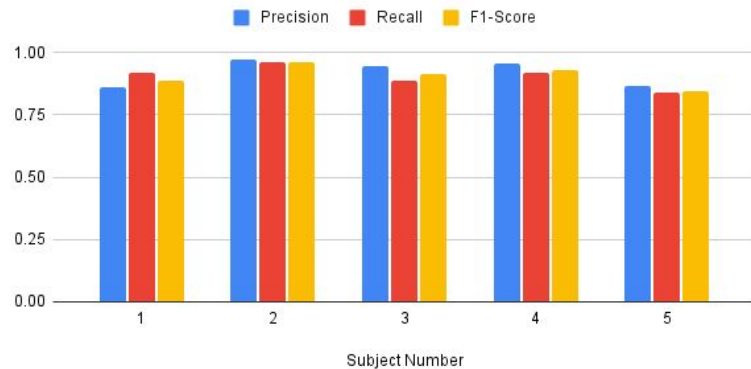
Accuracy Per Image

(With Prompt)



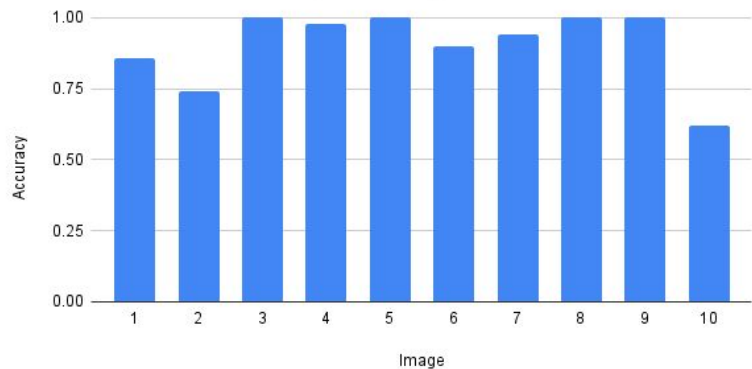
Accuracy Per Subject

(With Prompt)



Accuracy per Image

(Without Prompt)



Accuracy Per Subject

(Without Prompt)

