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NEWSLETTER

NeuroTech Frontiers: The Race to Capture Your Thoughts

At Orbitai, we recognize that 'mind reading' has ceased to be 'magic' and has become a data engineering and neuroscience problem. Today, we contrast two recent studies (2024-2025) addressing this topic: mental image reconstruction.

Is it better to analyze the 'pixels' the brain sees or the 'meaning' it interprets? We analyze the hard data.

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The EEG Challenge: When Temporal Resolution Falls Short

In a master's thesis presented at the Université de Montréal (2025), researcher Audrey Lamy-Proulx attempted to reconstruct natural scenes using EEG and the 'Bubbles' method. The approach was ingenious: correlating brain activity during partial perception (random visual masks or 'bubbles') with pure imagination, hypothesizing that independent sampling of visual features would enable reconstruction. However, the results offer valuable lessons regarding current limitations:

- The Complexity Wall: The method failed to generate meaningful reconstructions of mental images.
- The Cause: Natural scenes proved too complex, and the 'bubbles' sampling was too coarse to capture the necessary fine details.
- The Perception-Imagination Gap: No evidence of significant cross-decoding was found, suggesting that, under this paradigm, the mental representations of perception and imagination were not sufficiently similar to allow for generalization. The study concludes that future EEG attempts would require simpler stimuli and sampling tailored to individual performance."

The Quantum Leap: fMRI + Bayesian Inference + Semantics.

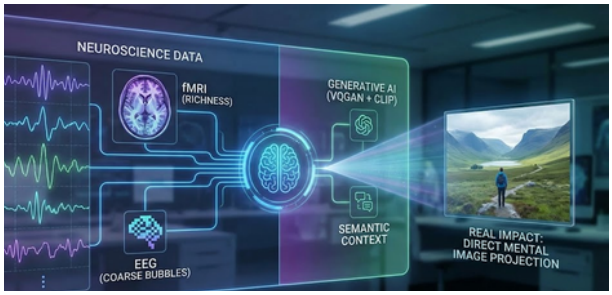
While EEG struggled with spatial resolution, a study published in Neural Networks (2024) by Koide-Majima and the research team achieved the reconstruction of arbitrary mental images with astounding accuracy using fMRI (functional magnetic resonance imaging). What was their secret to overcoming previous failures that only generated blurry silhouettes? They shifted the strategy from relying solely on low-level visual information to incorporating semantic information:

1. The Semantic Key (The CLIP Factor). The team discovered that previous methods failed because they did not efficiently utilize the semantic information recruited during imagery. To solve this, they extended the method to a Bayesian estimation framework and introduced semantic information assistance via the CLIP model.

2. Superior Results. The difference in image identification was staggering:

- Viewed Images: The new method reached 90.7% accuracy, compared to 64.3% for previous methods.
- Imagined Images: A 75.6% accuracy was achieved (far superior to the 50% chance level), allowing for the externalization of mental imagery.

A fascinating fact discovered by Koide-Majima and their team is the "sharpening" effect. Upon analyzing the reconstructions of imagined shapes, they noticed that linear components (edges) were stronger and more emphasized than in reconstructions of merely viewed images. This suggests that imagination involves a top-down process that "sharpens" or exaggerates the key features of objects in our mind.



The Hybrid Future of BCI

When contrasting the Lamy-Proulx (2025) study with that of Koide-Majima (2024), our take on Brain-Computer Interfaces (BCI) considers that:

- Granularity matters: The coarse sampling of the "bubbles" method in EEG still does not compete with the data richness of AI-assisted fMRI for complex scenes.
- The future is hybrid and semantic: Success lies not only in reading the biological signal but in using deep generative models (like VQGAN and CLIP) to provide the semantic context missing from the raw signal.
- Real Impact: These technologies are the foundations for allowing non-verbal patients to communicate by directly projecting their mental images, a goal shared by both research groups.

At Orbitai, we remain committed to this convergence between Neuroscience and Generative Artificial Intelligence.

What do you think?

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