Advanced Communication from Lucid Dreams to the Waking World

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Abstract

This whitepaper explores advanced modes of message transfer between the dream and waking worlds through lucid dreaming and 2D eye signals. While previous studies have demonstrated simple signal transmission from the dream state using physiological cues such as eye movements and changes in breathing, this paper presents three advanced methods to facilitate more complex message transfer. These methods include drawing/writing with the eyes using reconstructed 2D patterns, the swEYEpe method for eye movement-based messaging over a keyboard, and a simplified swEYEpe variant. Advantages and disadvantages of each method are discussed, along with practical considerations for signal acquisition and processing. The proposed techniques hold the promise of unlocking profound communication possibilities between dreams and reality.

This whitepaper will be updated as soon as new data or methods on the topic are available. Version: v0.1

1 Introduction

Lucid dreaming is a state in which dreamers are aware of being inside a dream world, knowing that a waking world exists beyond it. During Rapid Eye Movement (REM) sleep, which is the phase when most lucid dreams occur, the body is paralyzed, making traditional speech or sign language impossible for communication from the dream to the waking world. However, past studies have shown that simple signals can be sent from within a lucid dream using physiological cues like eye movements, which can be recorded using electrooculography (EOG). Additionally, researchers have explored presenting stimuli to sleeping study participants, showing that these cues can be incorporated into the dream to some extent. Nonetheless, current communication methods suffer from limitations in speed and complexity, restricting the messages to simple forms like yes/no responses, small numbers, or single morse-coded signs (see Konkoly et al. (2021) for an in-depth analysis of such dream signals).

This article introduces three novel lines of thought to enable more complex message transfer and shows preliminary piloting data to support these concepts.

2 Drawing/Writing with Reconstructed 2D Patterns

One approach to facilitate advanced communication involves drawing or writing with the eyes using reconstructed 2D patterns. LaBerge and Zimbardo (2000) demonstrated that a basic shape like a circle could be reconstructed from horizontal and vertical (2D) EOG data recorded during lucid dreaming. The same could be done with more complex shapes and even "handwritten" words, as preliminary data recorded during wakefulness with 2D EOG suggest (see Figure 1 for the word "hello" recorded during wakefulness with a 2D EOG approach, Figure 2 for the word "dream", and Figure 3 for a shape of a cat (left side: reconstruced 2D eye movements, right side: the stimulus that was displayed on a screen)). Once such 2D images or words are reconstructed, modern image-to-text transformer models could process the data further, enabling automated analysis. Exemplary, I used MiniGPT4 to illustrate such an approach (see Figure 4)

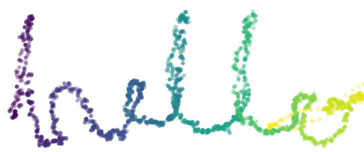

Figure 1: Reconstructed word "hello" that was recorded using horizontal and vertical (2D) EOG. Each dot represents a 2D EOG data point; the color from purple to yellow marks the time.

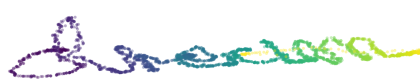

Figure 2: Reconstructed word "dream" that was recorded using horizontal and vertical (2D) EOG. Each dot represents a 2D EOG data point; the color from purple to yellow marks the time.

To enhance the effectiveness of transferring handwritten words via EOG, it is useful to add an accumulating horizontal shift to the Horizontal EOG (HEOG) data. This shift aligns the letters next to each other, avoiding overlapping.

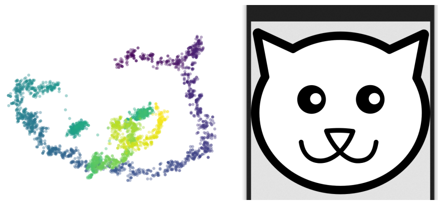

Figure 3: Reconstructed drawing of a cat shape that was recorded using horizontal and vertical (2D) EOG. Each dot represents a 2D EOG data point; the color from purple to yellow marks the time.

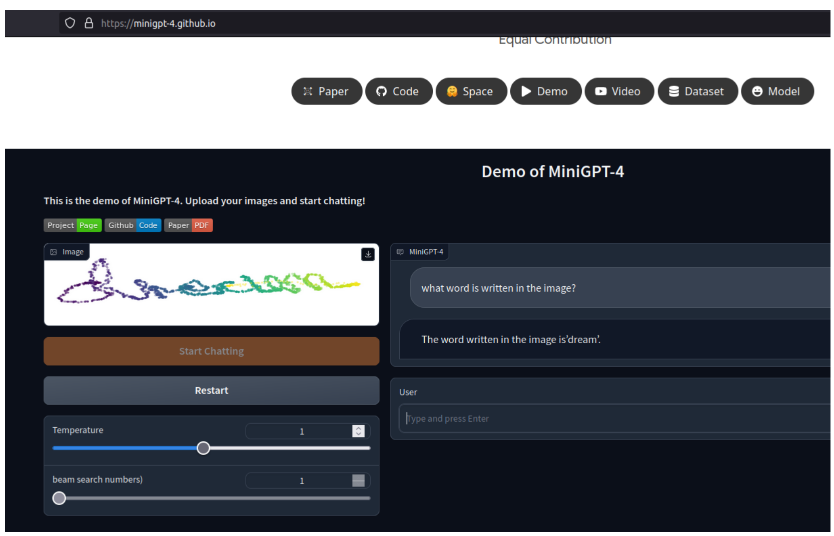

Figure 4: Feeding the reconstructed image into a transformer model makes possible further automated analyses.

3 The swEYEpe Method for Eye Movement-based Messaging

Another technique for EOG-based messaging is the swEYEpe method, inspired by swipe input on smartphones (see Figure 5 for an example). Instead of directly drawing shapes or words, dreamers move their gaze over a keyboard, navigating from letter to letter to spell out the desired word. This method relies on the dreamer's knowledge of the keyboard layout. While dreaming of a keyboard can work, preliminary experiments indicate that such visually present keyboards within the dream may lead to difficulties, as lucid dreamers may experience scrambled or unreadable keys. First lucid dreaming piloting data indicate that "painting into the air" with the finger to the estimated positions of the keys on an "air keyboard" might work better.

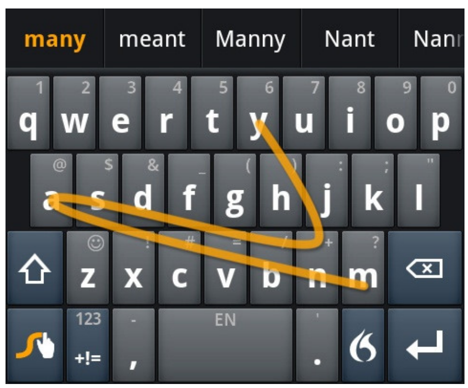

Figure 5: Example of swiping the word "many" on a smartphone keyboard

The swEYEpe method generates (x,y,t) data, with x representing the vertical dimension, y the horizontal dimension, and t the time dimension. Algorithms, similar to those used in smartphone swiping, can be developed to translate this data back into the most likely words. Preliminary data obtained during wakefulness and lucid dreaming demonstrate the feasibility of this approach, as can be seen in Figure 6, which shows first preliminary data that were recorded during wakefulness (left) and lucid dreaming (right) using the swEYEpe method on a real keyboard during wakefulness and an "air keyboard" inside the dream. One can see that the data produced with the swEYEpe method can be translated to the gaze shifts to the single characters on the keyboard. In the "make coffee" example, the gaze first goes to the bottom right (where the "m" is placed on the keyboard), which can be seen as the VEOG signal goes down and the HEOG signal goes down as a result of the eye movement. Next, the VEOG goes up and the HEOG goes up, fitting the position of the character "a" on the keyboard. For the third movement, the VEOG stays roughly the same and the HEOG goes down largely, reflecting the large gaze shift to the right on the keyboard from letter "a" to "k", and so on. Moreover, one can see that the movement pattern look quite similar in both conditions, suggesting that data generated during wakefulness could be used for training a machine learning algorithm that translates the xyt data back into words, just like the smartphone algorithms do.

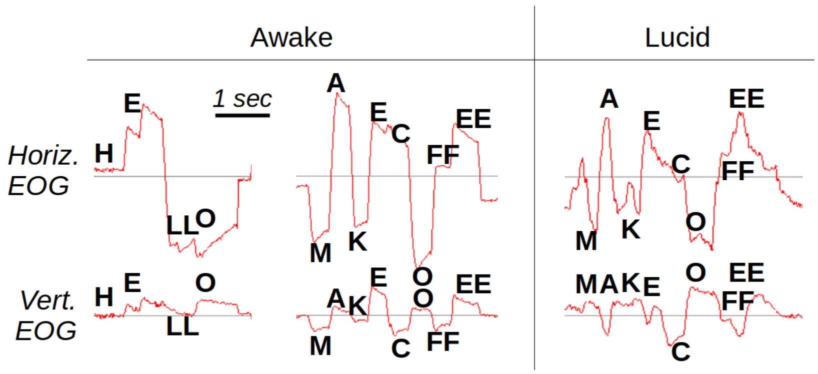

Figure 6: First sweyeping data for the words "hello" and "make coffee" during wakefulness and lucid dreaming (detailed explanation in the text)

4 Simplified swEYEpe Method

An alternative to the swEYEpe method is the simplified swEYEpe method, which employs a 5-grid layout on the keyboard. Letters are grouped into four corners: a-f in the top left, g-l in the top right, m-r in the bottom left, and s-z in the bottom right corner. Dreamers navigate their gaze over this layout, akin to typing on an old mobile phone using the T9 method. An algorithm determines the most likely word based on the sequence of gaze movements. For example, the word "cool" would result in gaze movement top left ("c") to bottom left ("o" twice) to top right ("l"). While this method offers advantages in simplicity, it may result in ambiguities, as several words can share the same gaze movement combination.

5 Advantages and Disadvantages

Each proposed method has its own set of advantages and disadvantages:

5.1 Advantages

1. Eye drawing/writing: Methods involving drawing/writing and 2D patterns are easily interpretable by humans without requiring decoding algorithms, and can transfer any form of content, including shapes.

2. SwEYEpe: The swEYEpe method requires only one gaze shift per letter, making it faster than complete drawing sequences.

3. Simplified swEYEpe: This method does not require learning the complete qwerty keyboard layout and can tolerate inaccuracies in xy data better than the normal swEYEpe.

5.2 Disadvantages

1. Eye drawing/writing: This method is relatively slow compared to swEYEpe.

2. SwEYEpe: Both the normal and the simplified swEYEpe may be harder to learn than simple eye drawing/writing and are not easily decodable by humans without algorithmic help. Moreover, ambiguous combinations of gaze movements could lead to incorrect message interpretation.

6 General Remarks

- Recording a good vertical EOG signal works best with electrodes that are placed directly above and below the eyeball instead of using standard PSG positions.

- Identifying eye signals in EOG data can be achieved by marking the beginning and end of messages with two or three quick left-right eye movements. In practice, a k-nearest neighbor algorithm with dynamic time warping has shown useful for this, as it requires only few training data, is fast, is easy to set up and, most importantly, is robust against stretching of the data in the time domain, i.e. faster or slower left- right eye movements.

- In principle, any ExG device can be used four recording the data. It is helpful to have direct access to the raw data in real-time, e.g. for automated instant processing and plotting or for practicing generating a clear signal. One such device is the Traumschreiber (German word of art, "Traum-schreiber" directly translates to "dream writer", for writing into or from a dream. The similar German word "Flug-schreiber" is "flight recorder" in English, ie a device that records all important data from an aircraft during the flight) that was originally designed for exactly this purpose (Appel, 2018).

7 Conclusion

The new approaches presented in this article offer promising avenues for advanced communication between the dream and waking worlds. By capitalizing on reconstructed 2D patterns and eye movement-based messaging, these methods open up the possibility of transmitting more complex messages with potential applications in diverse fields. While further research and development are required to overcome existing limitations, these initial findings hold significant promise for the future of dream communication.

References

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