

## **Waking conscious states and offline memory processing**

### **ABSTRACT:**

#### **Background**

Accumulating evidence suggests that moments of inattention to our surroundings may be essential to optimal cognitive functioning.

#### **Aims**

We investigated the hypothesis that humans spontaneously switch between two opposing attentional states during wakefulness – one in which we attend to the external environment (an “online” state) and one in which we disengage from the sensory environment to focus our attention internally (an “offline” state). We hypothesized that memory consolidation is facilitated by entry into the “offline” state.

#### **Method**

Across two studies, we detected entry into the “offline” state during a ~30min period of wakefulness. Participants completed a verbal learning task and then underwent simultaneous high density EEG and pupillometry recording, and intermittently reporting on their subjective experience. “Online” and “offline” attentional states were defined using a cluster analysis applied to multimodal measures of 1) EEG spectral power, 2) pupil diameter, 3) reaction time (RT), and 4) self-reported subjective experience.

Using a machine-learning classification approach, we determined the amount of time that participants spent in an offline state after learning, and tested whether this predicted memory for the verbal information encoded at the start of the study.

#### **Results**

We report evidence of statistically discriminable “online” and “offline” states matching the hypothesized characteristics. In both studies, the offline state predicted memory retention for previously-encoded verbal information.

#### **Conclusions**

Together, these observations suggest that seconds-timescale alternation between online and offline states is a fundamental feature of wakefulness, and that this may serve a memory processing function.

#### **Keywords**

Memory consolidation, Electroencephalography, Pupillometry, Mind wandering, Daydreaming, Offline memory processing, Machine learning

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### **Published Work:**

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