Sleep and the Neural Representation of Self

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Ever since man could think and pose questions,
he wondered about sleep and the sky; they painted sleep first.
Neuroscientists started studying sleep in earnest late in the mid 20th century .



Our recent studies of sleep forced us into unifying and generalizing concepts from developmental psychology to arrive at a new framework for learning that includes a fascinating description of sleep; in this view sleep is the guardian of our identity [1].

Morpheus in action: Delicate and precise operations at each sleep stage morph a stable, yet modifiable neural representation of the self (NRS). Below, we describe how the role of sleep in maintaining and guarding the NRS emerges from our recent findings. The new findings and the unified framework that emerges paves the way for new approaches to medicine and help explain some of the hitherto mysterious claims of neurofeedback. The follow-up work now is ongoing promises to help monitoring the mental health of astronauts on long space missions. Projects are planned for psychiatric applications on earth.

The unveiling of NRS and its guardians in two recent sleep studies

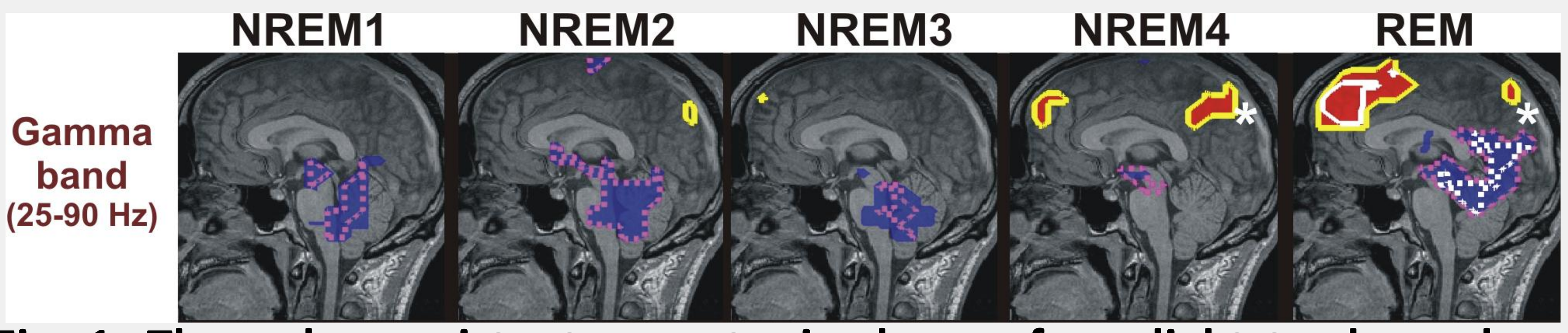

Fig. 1: The only consistent monotonic change from light to deep sleep and REM. The increase in gamma band during REM defines NRS: red areas within white outline (front) and yellow outline (back) [2].

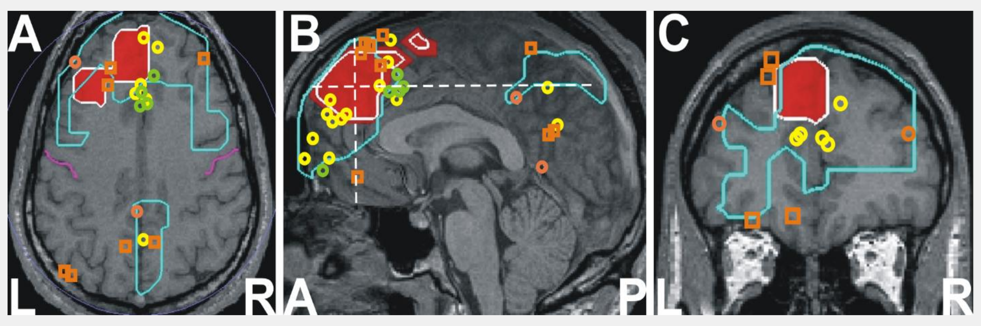

Fig. 2: The anterior part of NRS (red in white outline) is surrounded by Theory of Mind (ToM, yellow dots) and general Default Mode Network (DMN, green dots).

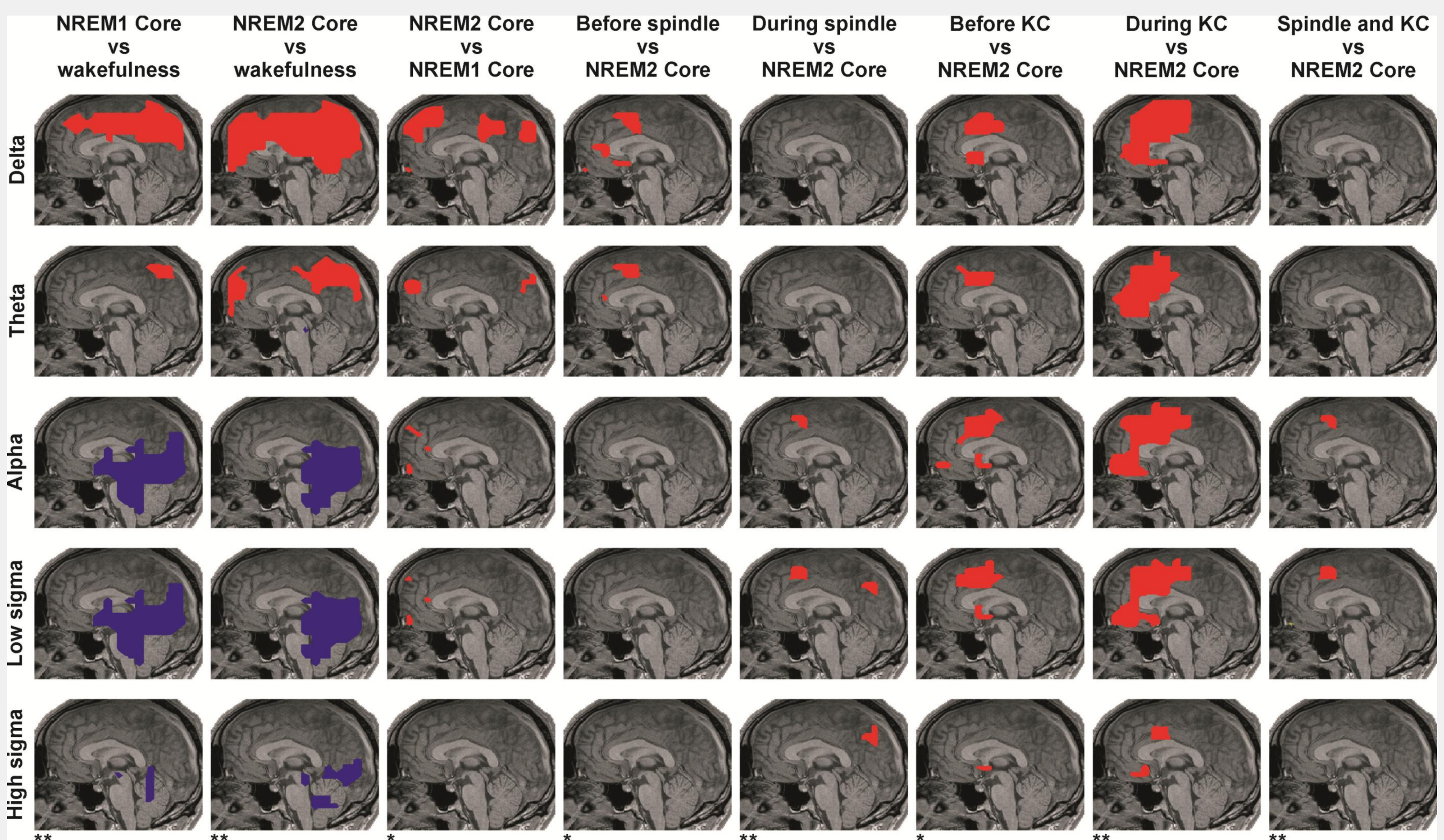

Fig. 3: A panoramic view of changes in the lower frequency bands reveals a "cautionary" approach to memory consolidation [3].

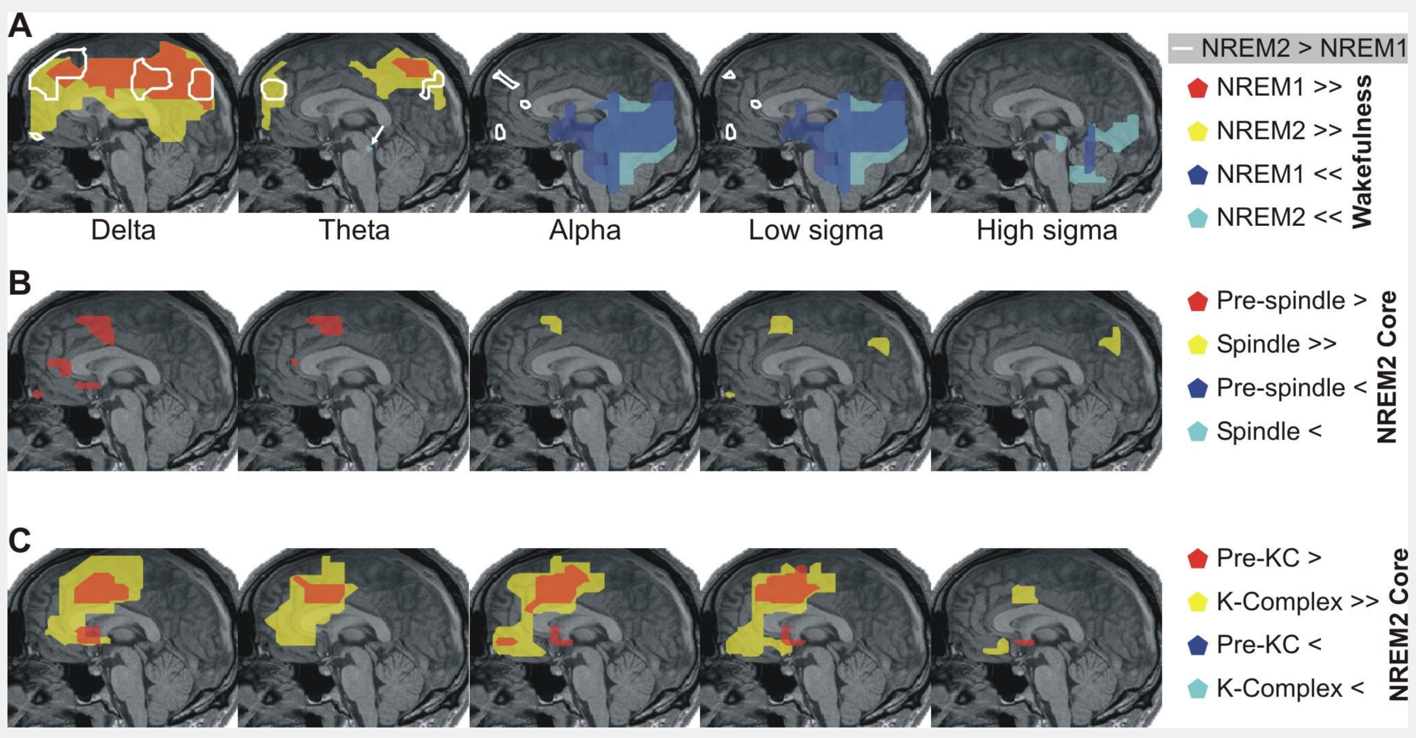

Fig. 4: The key changes during light sleep (core states (top), before and during spindles (middle) and KCs (bottom)) [3].

Summary of what sleep does for NRS

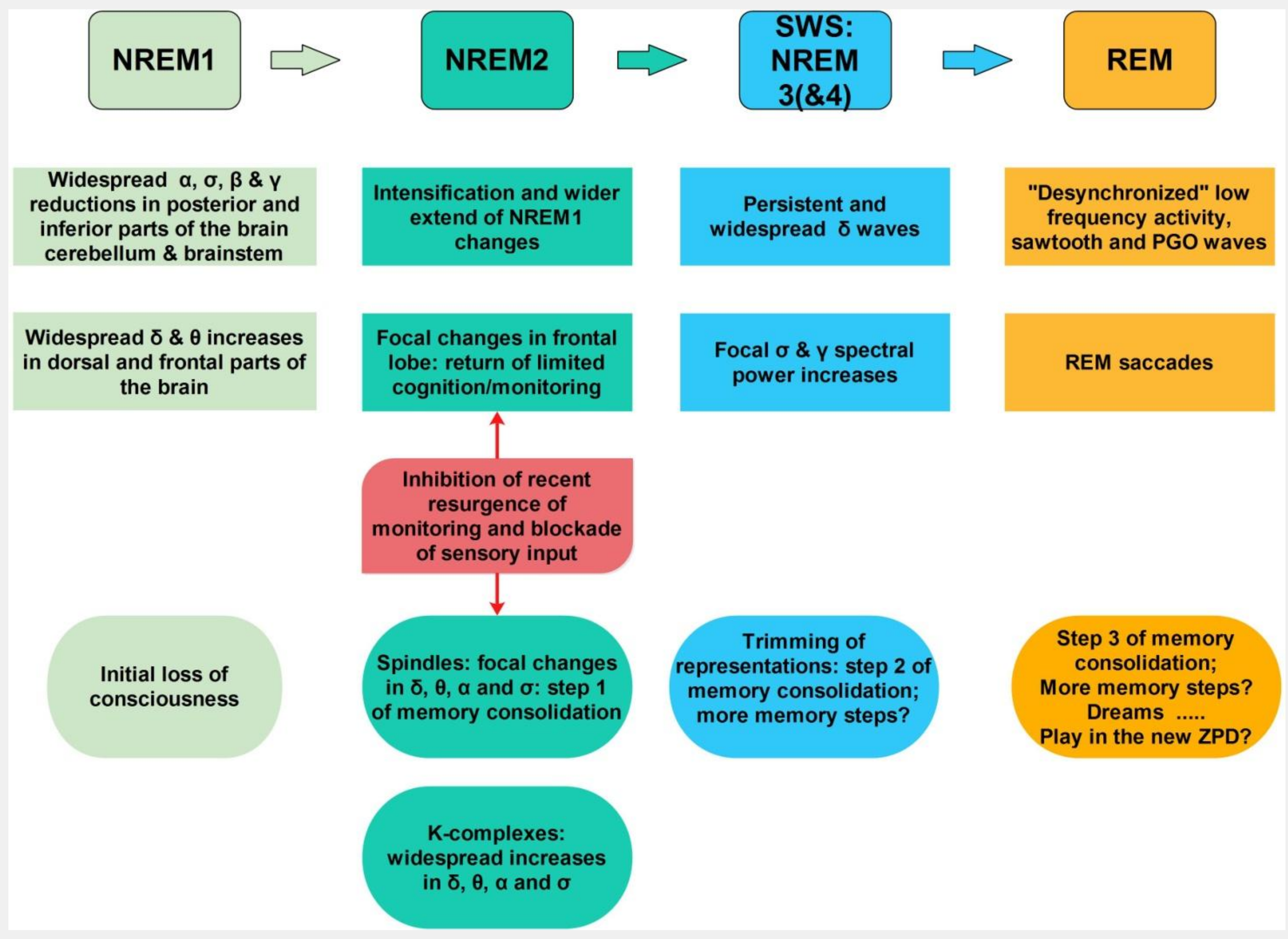

Fig. 5: The processes related to NRS during light sleep (Fig. 3-4) and during deep sleep [4, 5] with speculations about REM [1].

Excursions in the zone of proximal development (ZPD) during awake state

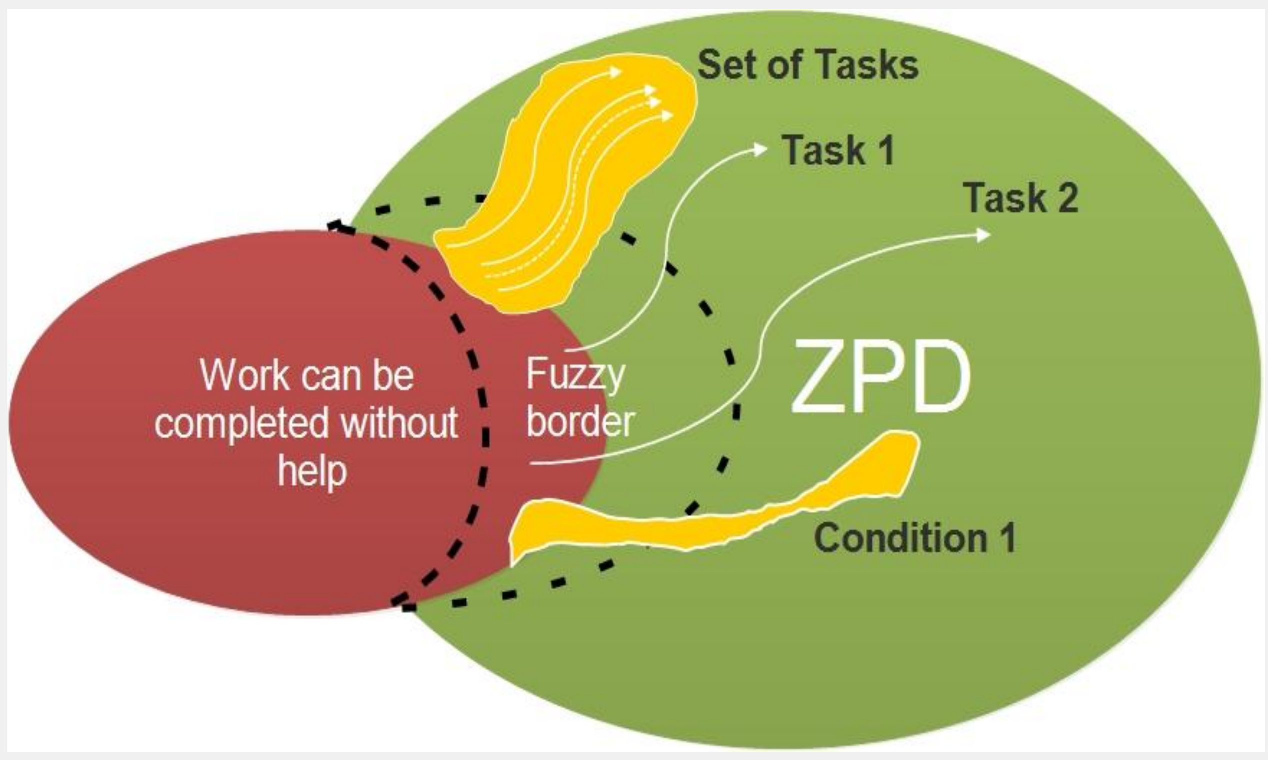

Fig. 6: When engaged in a task or rests, the brain goes through states shown as traversals (for tasks) or explorations in patches (for resting states). These are captured by EEG but, because of high variability, a single EEG recording cannot map accurately traversal and patches in state space [5].

Evaluation of interventions

Performing a carefully planned sequence of resting states before and after active tasks can yield a measure of brain's reactivity to the specific set of active tasks. Repeating the same experiment before and after intervention provides the first and second differential of changes that can quantify the effectiveness of intervention [5]. Recent results suggest that changes related to the ones expected in sleep can also be identified in evoked response experiments in the awake state which could simplify applications [6].

References

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Acknowledgements

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