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# Sleep: Opening a portal to the dreaming brain

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**The retrospective nature of dream reports represents a challenge to the study of dreams. Two-way, real-time communication between researchers and lucid dreamers immersed in REM sleep offers a new and exciting window into the study of dreams and dreaming.**

The study of dreaming is plagued by three major methodological problems. First, the collection of dream reports is fraught with both practical and conceptual problems. Should they be collected after spontaneous awakenings or following experimental awakenings? And can reports collected by either of these methods be confidently assigned to dreaming that occurred immediately prior to the awakening, or might they be from earlier in the night, or even, as some have argued, from the moment of awakening? Second, studies involving the experimental manipulation of dream content — as opposed to correlational designs that characterize much of the field — have yielded few tangible results. Finally, the absence of anything close to consensus on the function of dreaming, or even the existence of any function at all, makes much of dream research an exploration of the nature of dreams, rather than of how such a function is implemented in the brain, which, arguably, is the most important question about dreaming.

Many of these same issues were raised over 50 years ago by American psychologist Charles Tart (Tart[1], p. 88). In a prescient statement, Tart wrote "… to what extent could a 'two-way communication system' be developed, whereby the experimenter could instruct the subject to do such and such while he is dreaming, and the subject could report on the events of the dream while they were occurring? If such a development were possible, dreams would lose their status as a purely subjective event that could only be reported in retrospect…"

The first step in this direction was taken in the late 1970s and early 1980s, when Stephen LaBerge at Stanford University and Keith Hearne at the University of Hull in England independently showed that lucid dreamers (those aware that they are dreaming while still in the dream) in REM sleep could communicate with researchers monitoring their sleep by means of previously agreed upon eye movements that could then be identified from the standard sleep recording of ocular movements[2]. This discovery opened the door to a series of studies into the psychophysiological correlates of dream content[3]. Now, with groundbreaking results reported in this issue of *Current Biology* by Konkoly *et al.*[4], we are that much closer to achieving Tart's vision for the experimental study of dreams. Specifically, by showing that lucid dreamers in REM sleep can not only communicate their dream awareness with experimenters by means of electrophysiological signals, but also do so after having correctly processed information communicated to them moments earlier in REM sleep, Konkoly *et al.* have given us proof of concept for two-way, real-time communication between researchers and lucid dreamers immersed in REM sleep. Konkoly *et al.* delivered simple addition and subtraction problems to subjects in lucid REM sleep by reading the problems to them out loud, and subjects responded with a series of left-right eye movements indicating their answer. For example, one subject responded to the spoken stimulus "8 minus 6" with two left-right eye movements.

While demonstrating that it is possible for lucid dreamers to correctly perceive and respond to queries, including the performance of simple arithmetic calculations, while remaining in REM sleep will undoubtedly lead to exciting follow-up studies, it is not clear how easily these initial findings can be extended to real-life applications or to answer more complex questions regarding the nature and function of dreams. The authors, for instance, suggest that protocols for interactive dreaming could be used to help people practice musical or sporting activities in their lucid dreams. Doing so, however, may be more challenging than anticipated. Several laboratory studies of lucid dreamers, including of proficient lucid dreamers instructed to carry out specific motor tasks in their dreams, have highlighted various difficulties that keep some participants from successfully carrying out their planned tasks (for example, see Schadlich *et al.*[5]). Among these is the ease with which lucid dreamers can get distracted by their dreams or, more simply, forget that they are dreaming while trying to carry out specific motor or cognitive tasks in REM sleep, as well as the difficulty in keeping mental track of the timing and sequence of the eye signals and other actions expected of them throughout the experiment.

Studies requiring lucid dreamers to engage in specific interactions within their dream environment or with characters encountered in their lucid dreams also presuppose a level of stability in the dream's narrative structure and unfolding that is absent from most REM dreams, including lucid dreams. It is also known that even proficient lucid dreamers often experience difficulties controlling or influencing the dream's unfolding and that dream characters (even though generated by the dreaming brain) can act as if they have their own intentions and refuse to go along with the dreamer's requests[6]. Finally, lucid dreaming remains relatively rare[7] with only about 20% of the general adult population experiencing even one lucid dream per month and less than 1% having the abilities to carry out the signaling procedures used to study lucid dreaming in the sleep laboratory.

For all these reasons, it may be necessary to develop tools, pharmacological or otherwise[8,9], to safely and reliably induce lucid dreaming, and Konkoly *et al.* have made progress in this regard. Indeed, 30% of subjects (6 of 21) in the current study, recruited solely on the basis of remembering at least 2 dreams per week, signaled entry into lucidity with multiple left–right eye movements during a nap after being trained that morning with a newly designed, non-pharmacologic protocol. But methods will also need to be developed to help participants *remain* lucid in their dreams, especially if one wants to test the ability of the dreaming brain to perform complex cognitive functions, such as short and long-term memory, planning, reasoning, attention — faculties normally absent from dreams.

But what might most limit the potential advances that this and similar new techniques[10] might produce is the absence of a clear sense of the evolutionary and biological function of dreaming. Replacing psychoanalytic[11] and reductionist[12] models of dream functions with one grounded in the cognitive neurosciences, such as the recently proposed NEXTUP (Network Exploration to Understand Possibilities) model[13], is needed if future dream research hopes to successfully explore the mechanism and function of dreaming.

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# Evolutionary cell biology: Closest unicellular relatives of animals crawl when squeezed

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**Cell motility is critical for animal biology, but its evolutionary history is unclear. A new study reports blebbing motility — a form of cell crawling — in the closest living relative of animals, suggesting that the unicellular ancestors of animals could crawl.**

Many cells move by crawling — a mode of cell motility that is powered by cells deforming their shape and thereby pushing or pulling on solid surfaces[1,2]. Crawling motility is fundamental to many aspects of animal biology, including: embryonic development, during which cells crawl to their appropriate developmental niches; immune system function, which depends on white blood cells crawling to and from sites of infection; and diseases such as cancer, in which cells that crawl out of a tumor can form metastases[1,2]. Because of the central importance of crawling motility to animal physiology, understanding how and when it evolved has been a key question in evolutionary cell biology[3,4] — a question tackled in a recent paper by Brunet *et al.*[5], which reports the discovery of crawling motility in choanoflagellates,