

Intentional Dreaming During REM Sleep: A Scientific Investigation of Dream Yoga

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Abstract

Mindfulness and cognitive-behavioral therapy can improve well-being; sleep may offer complementary strategies. Here we describe an initial scientific investigation of Dream Yoga, a contemplative practice that includes a set of prescribed mental exercises. These exercises are planned in advance and then enacted during lucid dreams—when an individual recognizes that they are dreaming while concurrently staying asleep. We applied polysomnography and two-way communication during dreams to study six individuals with extensive Dream-Yoga training. Recordings from 19 overnight sessions documented when they instigated unusual dream experiences not conforming with standard waking-state expectations. To timestamp these experiences during physiologically verified rapid-eye-movement sleep, participants produced distinctive ocular and respiratory signals and then described their dreams in detailed microphenomenological interviews after awakening. Results confirmed the viability of intentional dreaming as part of a contemplative practice traditionally aimed at adjusting the individual's habitual ways of conceptualizing their waking experiences.

Keywords: lucid dreaming, REM sleep, contemplative practices, analytic meditation, dream yoga

Research Transparency Statement

General Disclosures

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Study Disclosures

Preregistration: This study was not preregistered. **Materials:** All study materials are publicly available (https://osf.io/tfujy/overview?view_only=a3f082bad8424de081afba89ecad8971). **Data:** All primary data are publicly available (https://osf.io/tfujy/overview?view_only=a3f082bad8424de081afba89ecad8971). **Analysis scripts:** All analysis scripts are publicly available (https://osf.io/tfujy/overview?view_only=a3f082bad8424de081afba89ecad8971). **Computational reproducibility:** No computational models were used in this study.

Introduction

Dreams can be bizarre, thrilling, profound, or mundane. Yet, contemporary psychological science focuses predominantly on waking experiences. Likewise, in contemplative science, an extensive body of research has examined meditation and mindfulness practices performed during wakefulness in both healthy and clinical populations (Dossett et al., 2020; Zhang et al., 2025). Despite the fact that humans spend approximately one third of their life asleep, little attention has been given to contemplative practices performed when not awake.

We introduce the term *Contemplative Sleep Practices* (CSPs) to refer to the general category of structured sleep-based methods to cultivate the ability to consciously perceive, feel or know objects, thoughts or sensory patterns with intentionality and metacognition insight. Within this category, *Dream Yoga* refers to a specific collection of volitional mental exercises performed during *lucid dreaming*—when one recognizes a dream while remaining asleep. Extensive descriptions of Dream Yoga are found in the context of Tibetan-Buddhist Philosophy (Holecek, 2016; Norbu et al., 2002; Wangyal, 2010). Dream-Yoga practitioners purportedly train to increase the frequency of lucid dreams and develop an impressive degree of control over the unfolding dream narrative during lucid dreams. Yet, there is little empirical evidence to document Dream Yoga beyond first-person descriptions of the experiences. For example, it is unknown precisely when these dreams occur relative to physiological indicators of sleep. First-person descriptions are insufficient for rigorously inferring whether these dreams occur in REM (Rapid-Eye-Movement) or Non-REM sleep, or even whether they occur during sleep, wake, or some intermediate state. Focused scientific investigation is needed to evaluate the validity of this intentional form of dreaming, which could open the door to additional studies of these intriguing conscious experiences and the therapeutic benefits that might be achieved through such strategies.

Dream Yoga is particularly well-suited for scientific investigation. In many cultural contexts, dreaming has been regarded as a mode of experience that can be complementary to ordinary wakefulness and shape how waking

reality is understood (Magaña, 2014). In the Tibetan-Buddhist literature, books dating from the 11th century onwards provided not only detailed instructions for Dream-Yoga practitioners but also included an extensive conceptual framework for contemplative practice with an orientation toward empirical investigation from the first-person perspective. One core idea is that ordinary human experiences, both during waking and dreaming, are mentally constructed, shaped by habitual patterns of perception, cognition, and embodiment.

Current thinking in cognitive neuroscience offers relevant parallels. Both types of conscious experience are taken to depend on complex neural mechanisms currently under active investigation. Whereas neurological case studies show that implicit abilities can remain in the absence of conscious experiences, there is still much debate about how those experiences are constructed. Yet, the constructive nature of experience makes it inherently fallible and prone to systematic biases (Laukkonen et al., 2025; Summerfield & de Lange, 2014). Predictive-processing frameworks postulate further that predictions about the world are continually generated and updated, such that experience can be considered a result of unconscious prediction and inference as opposed to a direct read-out of reality.

Dream-Yoga practices go further by leveraging this constructed nature of waking and dreaming. Practitioners gradually learn to intentionally work with dream experiences. Whereas it is rare for individuals to experience lucid dreams frequently, at least as assessed in one large sample (Schredl & Erlacher, 2011), experts in Dream Yoga refine their ability to achieve and maintain lucidity in order to thoroughly explore their dream experiences. Virtuosos in Dream Yoga claim to repeatedly engage in deliberate dream activities. Behavioral strategies allow many individuals to use lucid dreams for recreational purposes (Tan & Fan, 2023). In contrast, Dream Yoga is embedded within a broader contemplative agenda to reveal and transform the habitual tendencies that shape one's understanding of the self and the world.

Our tactics for investigating Dream Yoga take advantage of recent methodological breakthroughs in dream research (Mallett et al., 2024). Whereas an over-reliance on post-sleep dream reports can be problematic, here

we included real-time communication with practitioners in the midst of a dream. Konkoly and colleagues (2021) showed that dreamers can understand softly presented questions and answer them using pre-defined signals. Specific dream experiences can thus be time-stamped so that concurrent neural activity can be analyzed (Konkoly et al., 2026). By using volitional signals and polysomnography, we aimed to pinpoint when dream-yoga experiences occurred. We also used post-sleep microphenomenological interviews to yield fine-grained dream accounts (Demšar, 2024; Northoff & Ventura, 2025).

Our approach goes beyond historical accounts of Dream Yoga by including measures of sleep physiology and behavioral responses from dreamers during and after their dreams. Still, those accounts provide a context for understanding dream-yoga practices. Whether Dream-Yoga practices ultimately produce transformative benefits for long-term practitioners is not the focus of the present investigation. Enhanced cognitive or emotional abilities, even if demonstrated in the experts studied here, could not be attributed to Dream Yoga. Longitudinal studies would be required. The present study is instead intended to characterize these practices with contemporary scientific methods, to map them onto measures of sleep physiology such as indications of REM sleep, and to provide a foundation for future investigations.

Results

Lucid Dreaming and Volitional Signals in Expert Practitioners

Polysomnographic recordings were obtained from six adults with extensive training in Dream Yoga. During pre-experimental interviews, they recounted their history of contemplative sleep practices, including regularly performing specific Dream-Yoga exercises in their lucid dreams. Each participant visited the sleep lab for 3 or 4 consecutive overnight sessions. Prior to the visit, we instructed them to practice making ocular and respiratory signals about their dream experiences, based on methods used in prior studies (Konkoly et al., 2025; Morris et

al., 2025). To signal a lucid dream, participants performed a Left-Right-Left-Right (LRLR) eye-movement sequence, looking far to the left, then far to the right, twice (Hearne, 1978; La Berge et al., 1981). To signal the start of a contemplative exercise, they executed two rapid nasal inhalations and exhalations (sniffs). Before going to bed, participants chose the Dream-Yoga exercise they intended to perform and rehearsed the signals they were to make.

We also used the method known as Targeted Lucidity Reactivation or TLR (Carr et al., 2023; Konkoly et al., 2025). In the first step of TLR, conditioning trials allowed specific auditory or visual stimuli to be associated with a *lucid mindset*, defined as carefully attending to one's experiences with a critical intention to discern and evaluate relevant features that might differentiate dreaming from waking experiences. The premise of TLR is that a lucid mindset during sleep can increase the chances of recognizing that one is dreaming. Accordingly, TLR stimuli were presented during REM sleep, when the probability of post-sleep recall of an immersive narrative dream is highest. To avoid awakening, sound intensity was initially set at the participant's detection threshold and gradually increased. We also presented auditory stimuli associated with specific Dream-Yoga exercises (specific stimuli described below).

Approximately 4 hours after falling asleep, participants were awakened to engage in a contemplative practice of their choosing. A primary focus was generally on cultivating intentions for having a lucid dream and performing specific exercises in the upcoming dream, as such intentions are taken as powerful aids for Dream Yoga practitioners. Practitioners can also strengthen these intentions by emphasizing their altruistic desire to promote compassion broadly. After approximately 30 min, they returned to sleep.

Across 19 overnight recording sessions, a total of 84 REM periods were identified. Twenty-one lucid awareness episodes were reported across participants (**Table 1**). Of these, five occurred during REM–wake transitions and 11 during REM sleep. Participants reported volitional signaling during REM episodes, of which seven were objectively verified by concurrent physiological markers recorded in the polysomnography. Across the REM

episodes, participants reported 20 volitional signals, 15 of which were objectively detected in the physiological recordings, corresponding to a detection rate of 75%.

Four participants also described three dream-formation experiences, characterized by the gradual emergence of dream imagery and narrative content from an initially empty or contentless experiential state presumably in NREM sleep. However, these episodes were not signal verified (**Table 1**).

Dream reports collected after awakening often included veridical descriptions of polysomnographic signals produced by the participant during periods of REM sleep. In these signal-verified lucid dreams, participants performed Dream-Yoga exercises as described below.

Participant #	Night	Total REM Periods	REM Period #	Duration (s)	Signals Reported	Signals Detected	Sleep Stage	Cues Presented	Cue Incorporation	Figure
1	2	4	1	1005	LRLR	LRLR	REM/W	7x beeps	yes	
			2	389	LRLR	LRLR	REM/W	4x verbal, 5x beeps	yes	
			3	360	LRLR	LRLR	REM/W	3x beeps	no	
			1	1392	LRLR	LRLR, 2 sniffs	Wake	no cues	no	
2	1	5	3	1218	LRLR	none	REM	60x lights, 15x beeps	yes	
	3	7	5-6	3599	no	none	NREM	no cues	no	
3	1	3	na	unknown	no	none	NREM	no cues	no	
	2	5	3	479	LRLR, 2 sniffs, LRLR	LRLR, 2 sniffs	REM	3x lights	no	6
	3	2	1	2129	no	none	REM	15x lights, 2x music	yes	
			2	1040	no	none	REM	no cues	no	
4	1	3	3	179	LRLR, 2 sniffs, 4 sniffs	LRLR, 2 sniffs, 4 sniffs	REM & Wake	no cues	no	1
			na	unknown	no	none	NREM	no cues	no	
	2	4	3	609	LRLR, 4 sniffs	LRLR, 4 sniffs	REM	5x beeps	no	5
			5	630	LRLR	LRLR	REM/W	11x Light	no	
	3	8	4-5	3120	finger twitches	none	NREM	no cues	no	
			6	335	LRLR, 2 sniffs, 4 sniffs	LRLR, 2 sniffs, 4 sniffs	REM	no cues	no	7
5	1	4	2	1304	no	none	REM	no cues	no	
	2	6	6	463	LRLR, 2 sniffs, 4 sniffs	2 sniffs, 3 sniffs	REM	6x music	yes	3
	3	5	4	1889	LRLR, 2 sniffs	unclear	REM	15x music, 9x beeps, 13x lights	no	4
6	1	3	2	790	2x LRLR, 2 sniffs	2x LRLR, sniffs	REM	no cues	no	2

Table 1. Summary of reported lucid episodes across all overnight sessions. Reported episodes are shown by participant and recording night, together with the corresponding REM period, duration, volitional signals reported after awakening and objectively detected in the polysomnographic recording, sleep stage, external cue presentation, and cue incorporation into ongoing dream content. Shaded rows indicate episodes occurring during REM sleep. Signals initiated during a REM period but completed in an epoch scored as wake are designated REM & Wake, whereas episodes occurring during the transition between REM sleep and wakefulness are designated REM/W. Objective signal detection was based on polysomnographic identification of pre-specified eye movement (LRLR) and respiratory (sniff) signals. Abbreviations: LRLR = left-right-left-right eye movement sequence; REM = rapid eye movement sleep; REM/W = REM–wake transition; N1 = stage N1 sleep; N2 = stage N2 sleep; NREM = non-rapid eye movement sleep; na = not applicable.

Impossible Actions: Moving Through Solid Objects

Lucid dreams can be fleeting, but skilled practitioners become proficient at avoiding a return to nonlucid dreaming or waking up. When the practitioner maintains the lucid-dreaming state, a series of training regimes are engaged. By completing various exercises, the practitioner works on their ability to influence their dreams with specific intentions. Some of these exercises defy the normal laws of physics. For example, the practitioner can attempt to put their hands through solid objects, walk through walls, or walk on water. Because such actions are impossible while awake, and because of our ingrained or habitual understanding of those impossibilities, they may commonly be experienced as impossible in the dream too—but they are nevertheless possible.

To provide context, we first consider why practitioners engage in dream exercises that involve impossible actions. These exercises can be considered as steps in a process of loosening expectations about the world that have been acquired over many years. These expectations represent assumptions about waking reality that carry over into assumptions about dream reality. Although these assumptions are generally adaptive, there is also a sense in which unquestioned assumptions may form maladaptive constraints. Figuratively speaking, maybe the walls of our perceptions could beneficially be regarded as permeable. Of course, the goal is not to return to the waking state willing to try to walk through walls. Rather, these practices are stepping stones to the potential loosening of some higher-order assumptions. By challenging standard conceptions of reality, casting alternative light on our experiences, one might free up resources to reduce self-centeredness and reveal options for healthier behavior, as discussed further below.

We observed Participant 4 experience four lucid dreams on three different nights in the sleep lab, each verified with real-time LRLR signals and concurrent determination of REM sleep according to standard criteria. On the first overnight session, he dreamt of sitting up in bed in the lab with his palms resting on a wooden table. He

recognized the table and surrounding environment as the lab setting, which for him constituted a *dream sign*—defined as a dream experience that triggers the insight that one is dreaming. At this moment in the dream, he produced a deliberate LRLR eye signal, as shown in **Figure 1**. No cues were presented in this night.

In the dream report, Participant 4 described subsequently remembering the exercise he intended to perform in the dream, and he recounted the sense of duty he felt to follow the protocol (“I want to be a good lab rat”). He performed two sniffs to mark the start of the exercise, which was to pass his hands through a solid object. He started by “putting palm prints in the wood” and continued to insert his right index finger and then left into the wood. Feeling concerned about damaging the table, he leapt to the ground while dragging both hands through both the floor and the wall of the lab. His lucidity remained stable with a clear first-person embodiment and point of view. At some point, he heard background voices that sounded like TV-chatter, which he found annoying, and he shouted the Italian word “*silenzio!*” He deliberated on whether to pursue a second Dream-Yoga exercise but chose to execute four sniffs to indicate the end of the walking-through-walls exercise (**Figure 1**, right panel). This signal occurred in a period that was scored as wakefulness, though the participant perceived it to be during the dream state.

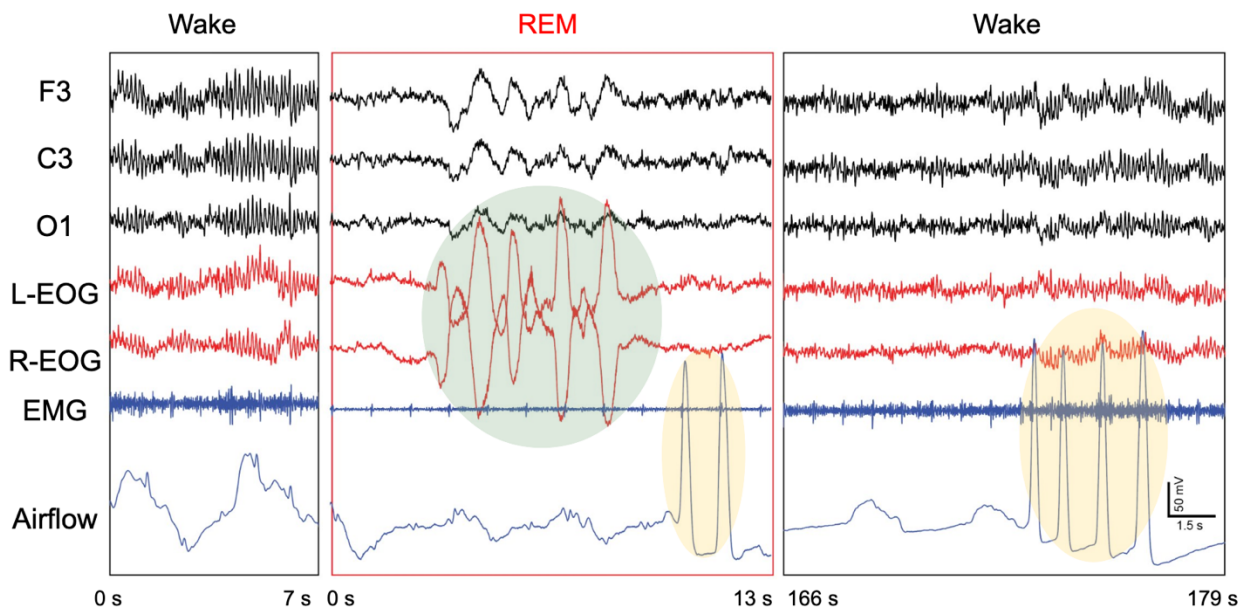


Figure 1. Polysomnographic recordings from Participant 4 documenting the Dream-Yoga exercise of moving through solid objects.

Recordings depict data from 3 scalp EEG channels (F3, C3, and O1), two electro-oculographic channels (left and right, L-EOG and R-EOG), a chin electromyographic channel (EMG), and airflow from a nasal cannula. For comparison, the left panel shows a wake period prior to sleep, with high EEG alpha and high muscle activity indicative of wakefulness and a normal breathing pattern. About 500 min after sleep began, in the third REM period (center panel), he produced the signal of lucidity, multiple LR eye movements highlighted in the green circle. Seven seconds later, the dreamer produced two sniffs (yellow oval) to indicate the initiation of the exercise. After 2.7 min, four sniffs were performed to mark the end of the exercise (right panel). The 2-sniff signal was clearly during a REM period, with minimal muscle activity. The 4-sniff signal was during a period of wakefulness, 23 s after a prominent increase in alpha and theta EEG activity. No cues were presented on this night.

Participant 6 also moved through solid objects in a dream while we monitored her sleep. During the first night, no cues were presented. She reported a dream initially characterized by intermittent transitions between lucid and nonlucid states. The dream experience started as a two-dimensional image (“early in the dream formation,” as she noted later in her dream report). Recognizing that she was dreaming, she waited for the environment to “solidify” and become three-dimensional. She walked through an enlarged lab room to a vast warehouse-like space. To stabilize the dream environment, she intentionally used her hands to squeeze her arms and verbally requested a “lucidity boost” within the dream in an effort to increase her lucidity. She then performed the LRLR eye signal twice, followed by two sniffs to mark the start of the exercise (**Figure 2, right panel**).

She then carried out a series of Dream-Yoga exercises, successfully walking through a wall, hands first, and then doing so again along with the thought, “the dream body, the wall, are made of mind; there is no physical object.” Next, she attempted to pass through a pile of luggage. Her hands went through, but her head bumped against them. She overcame resistance by mentally reaffirming her understanding of the dream's fundamental openness, recognizing that the apparent solidity of the wall was a mental construction in the dream.

She subsequently shifted to the Dream-Yoga exercise of transforming an object. She attempted to enlarge a backpack twice but was unsuccessful. The intensity of these attempts seemed to destabilize the dream, as colors

faded and the dream flattened back to a two-dimensional image followed by darkness. In the darkness, she resolutely remained lucid and tried to precipitate another dream. Her attempts at dream stabilization through techniques such as physically interacting with objects were unsuccessful, and she eventually felt “pulled back” into her sleeping body.

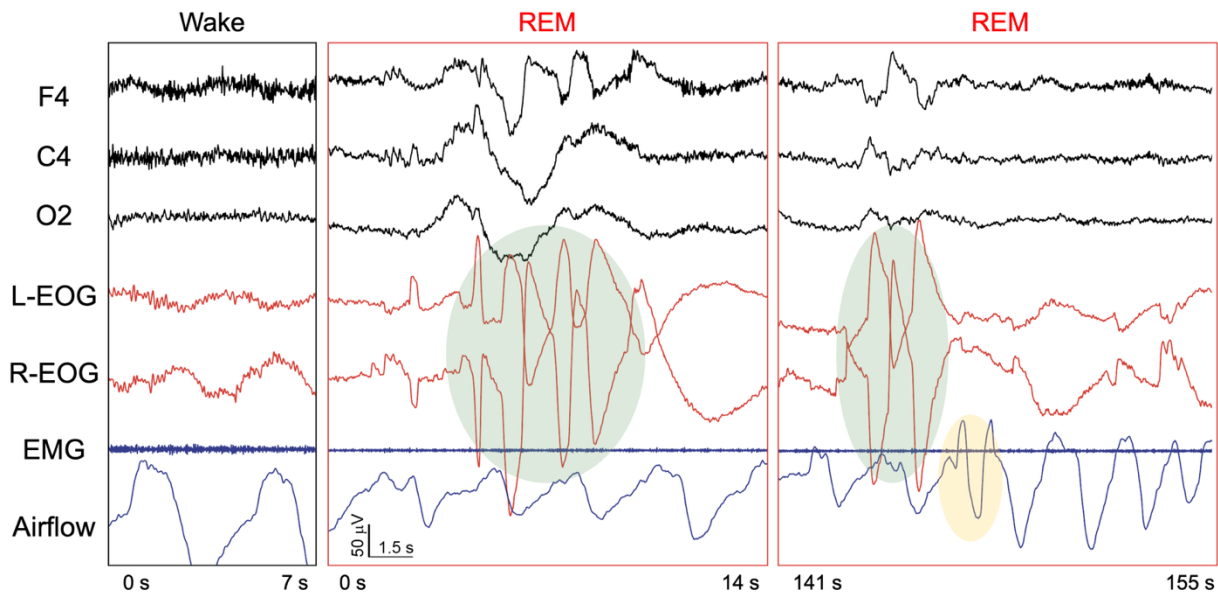


Figure 2. Polysomnographic recordings from Participant 6 documenting the Dream-Yoga exercise of moving through solid objects (same channels as in Figure 1). Left panel shows a period of wake with high EEG alpha and muscle activity. In a REM period approximately 442 mins after bedtime (center panel), she produced the LRLR signal to indicate lucidity and then did so again 134 seconds (green ovals). Following the second LRLR signal, she performed two sniffs (yellow oval) to indicate initiating the dream exercise.

Impossible Actions: Flying

Another facet of a Dream-Yoga practice is to expand proprioceptive awareness in novel ways. These experiences, like feeling one’s body floating or flying around, defy the normal waking experience of gravity and challenge the fixity of one’s body sense. By violating the extent to which one’s body is subject to physical laws,

practitioners may loosen their attachment to the perceived status of the self in waking reality, and they may begin to transcend their default sense of a permanent, unchanging self, at least according to the historical accounts. An advanced contemplative goal is thus to recognize how both dreaming and waking experiences are constructed, how experiences are not as limited and constricted as they can appear.

Participant 5 had a signal-verified lucid dream in REM sleep during her second overnight session. She recalled the beginning of the dream when she found herself standing in a room that resembled the sleep lab but was altered. There were brick-colored walls, gray cement floor, no bed, and a few white feathers. While picking up and observing the beauty and strangeness of one feather, she heard children and an old-style phone ring “everywhere in space.” She noticed a resemblance between that sound and her chosen cue sound, which included child-like voices. Sleep physiology data in **Figure 3** shows the timing of one cue sound followed by multiple sniff signals. Given that six auditory cues (music excerpts) were presented during that REM period, there is ambiguity about the timing of her dream experiences relative to specific cues. After attaining lucidity, her attention shifted to her preselected Dream-Yoga exercise, flying, during which she reported making two sets of sniffs. She also noticed a door with no handle, so grabbed a foot-pull to open it, and then observed “black emptiness” beyond. To stabilize the dream, she twirled her arms slowly before turning to walk down a hallway. She reported producing the eye signal with eyes closed (not evident in recordings), opening her eyes, and taking a few heavy steps into a horizontal flight (“superwoman-like” at low altitude), gradually gaining speed. She briefly considered continuing to fly and going through the roof, but chose to stay in the hallway while focusing on not losing lucidity. As the hallway started to fragment and dissolve into blackness, she experienced a sense of urgency and stopped flying, transitioning to a standing position from which she performed sniff signals again, and then she reported experiencing an immediate awakening.

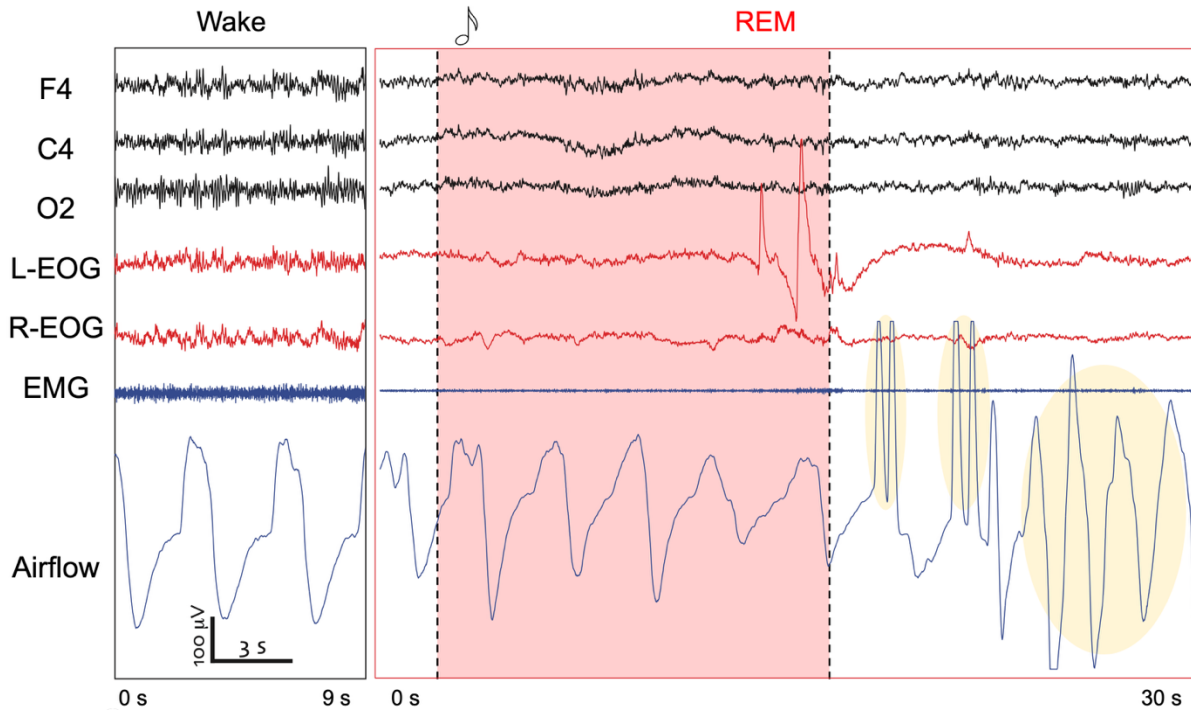


Figure 3. Polysomnographic recordings from Participant 5 during a flying exercise (same channels as in Figure 1). Left panel shows a period of wakefulness with high EEG alpha and muscle activity. Right panel shows a period of REM sleep when a sound cue was presented (red shading with dashed lines at onset and offset, the sound was that of low-pitched chanting). After awakening, the dreamer reported performing eye-movement signals of lucidity; none were detected, although an ambiguous signal was evident near the end of the sound presentation. A moment later she produced two quick nasal sniffs followed by additional sniffs (yellow ovals), and she woke up 73 seconds later.

During her third overnight session, 24 auditory cues (15 music excerpts and 9 beeping sounds) and 13 lights were presented to Participant 5. She reported a lucid dream in which she found herself standing on a grassy hill overlooking an ocean. The ocean was a personal dream sign for her, provoking the insight of lucidity and then a focus on the agreed-upon exercise, to fly. She ran downhill, twirling her arms, and then jumped. Instead of flying, she experienced slowly floating upward into the sky (Mary Poppins style). As she described further in her dream report, she floated up for about 10 seconds and then remembered the experimental context, so performed the LRLR signal. Concerned the signal might have been too slow, she made some sniff signals.

Polysomnographic recordings showed only partial correspondence, as signals were more ambiguous than in other nights, but REM sleep was confirmed (**Figure 4**). There was no mention of sound cue incorporation. The dreamer described an extensive set of flying experiences next. She transitioned to horizontal flight at medium speed over the ocean and islands amid clouds. Following a sense of curiosity, she thought, “I wonder what it would be like if I fly into space,” so she went vertical again and ascended. At some point, she became concerned about not being able to breathe in space, but this concern abated when the knowledge that she was in a lucid dream relaxed her and broadened her attention as her dream body dissolved. With a sense of amazement and awe, she perceived the sky shift from blue to whitish-gray to black with stars in all directions. Then she felt a drop in temperature as Star Wars theme music swelled, prompting laughter, joy, and a playful sense of compassion. Then she heard a bell sound as Tinker Bell appeared abruptly in front of her, followed by a peaceful and gradual awakening.

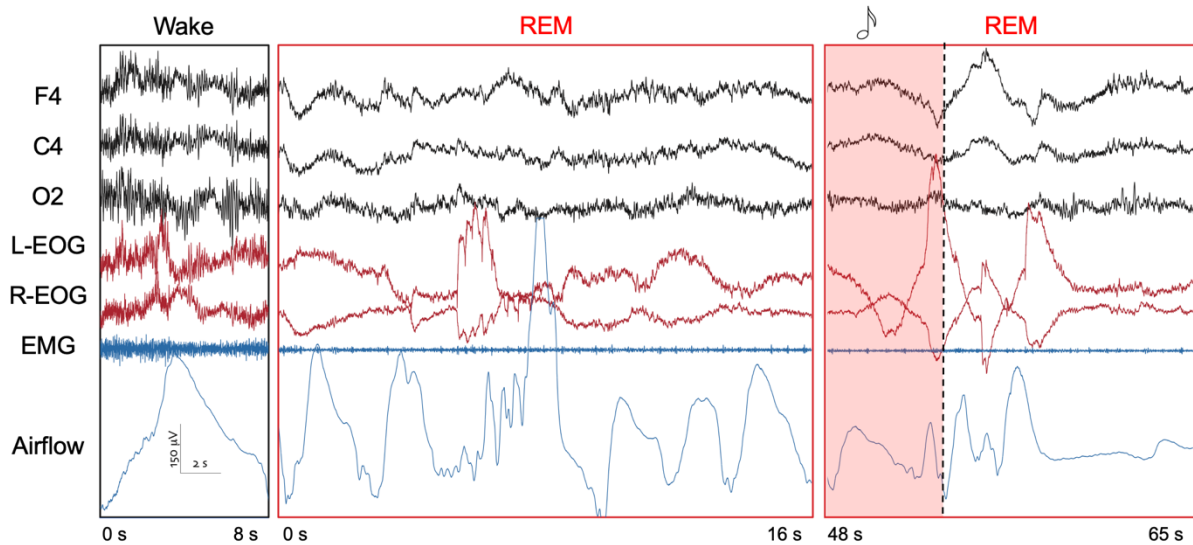


Figure 4. Polysomnographic recordings from Participant 5 documenting a Dream-Yoga flying exercise during REM sleep (middle and right panel) contrasted with a wake period (left panel) with high EEG alpha and high muscle activity (same channels as in Figure 1). Thirty-seven auditory and light cues were presented (red shading, soundtrack comprised mostly of harp music), the dreamer reported becoming lucid and producing signals (LRLR and sniffs) in the context of a sequence of dream experiences, but recorded signals were unclear.

On his second overnight session, **Participant 4** planned to perform the Dream-Yoga exercise of walking through walls. During a period of REM sleep, approximately 3 hours after the wake-back-to-bed procedure, he was cued with a beeping sound associated with the lucid mindset four times. After awakening, he did not describe hearing the sound in the dream. The first recalled moment of the dream was a non-lucid experience of lying outdoors on the ground, embracing his high-school sweetheart while enjoying warm, affectionate bodily closeness. They both heard a teacher's voice from behind and above, so he decided to float up to investigate. He soon recognized the impossibility of floating ("hey, wait a second, I can't do this... I'm dreaming!"), so quickly produced a LRLR signal (**Figure 5**). Floating further, he approached the teacher, who now appeared as a large Tibetan Buddha statue covered with snow. He remained lucid, but did not recall the experimental context, and instead spent some time delicately dusting the snow off the face of the statue with great devotion, while admiring the radiance of the statue. He then flew down to join his high-school sweetheart along with a second woman, who embraced him affectionately. At this point, some aspects of the dream dissolved, including the two dream characters. Then, he remembered the experiment and shifted his attention to performing the four-sniff signal, indicating completion of an exercise. He explained in his dream report that he chose to give the four-sniff signal, even though he didn't complete the exercise of walking through walls, intending to explain the substitution of flying afterward. At this point, he was already awake, and the experimenter prompted him to give a dream report.

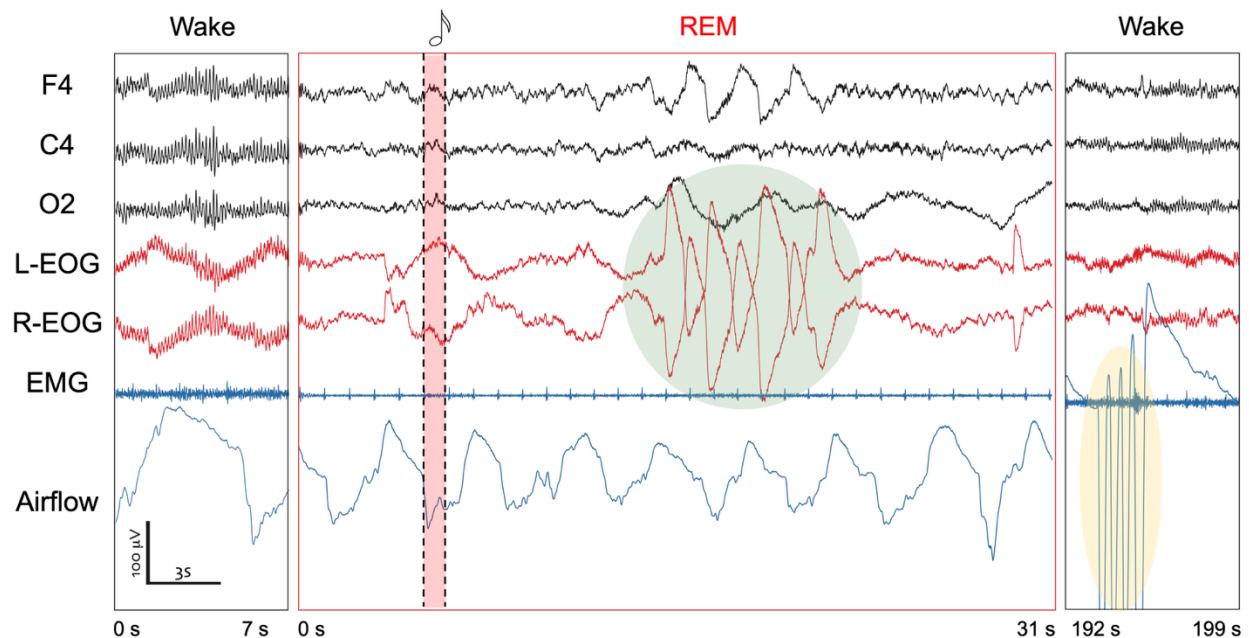


Figure 5. Polysomnographic recordings from Participant 4 documenting a Dream-Yoga exercise of flying during REM sleep (middle), contrasted with prior data from wake (left panel) showing high EEG alpha and high muscle activity (same channels as in Figure 1). During REM sleep, brief task cues were played (3 beeps indicated in dashed lines and red shading), and 7 seconds later the participant produced a LRLR signal (green circle) to indicate lucidity. The participant signaled the end of the exercise with four sniffs (yellow oval) during a period of wakefulness 193 seconds after the lucid signal.

Dream Yoga for Mental Stability and Nonreactivity

Dream-Yoga practitioners use various methods to establish and maintain dream lucidity, while also working with specific mental states. In an exercise known as *nonreactive witnessing*, the practitioner may be embodied and move through the dream environment while attempting to sustain , nonreactive, non-judgemental awareness. Importantly, there is no attempt to alter dream content. Rather, one cultivates this mode of awareness in relation to whatever happens in the dream. This exercise can be particularly challenging because of the pervasive tendency to react to, grasp, seek out, or avoid certain aspects of one’s experience. By engaging in this exercise, however, practitioners seek to develop high-level skills in remaining stable, nonreactive, and nonjudgemental. Furthermore, this skill is thought to facilitate a practitioner’s progress with advanced Dream-

Yoga practices such as transforming into another individual and developing prosocial qualities such as boundless compassion.

A signal-verified lucid dream in REM sleep was observed in **Participant 3** during her second session where three red light cues were presented. Her dream report began with vague feelings of warmth and heaviness, but with no other content or detail. She recalled the moment when she became aware of moving her eyes laterally, realizing that she was dreaming. She then deliberately completed the LRLR eye signal (**Figure 6**). A visual scene emerged in which she engaged with the dream as a witness-observer rather than trying to direct or interact with the dream. She described the experience as “a lucid dream within a non-lucid one” with a muffled quality. She maintained a detached perspective from above (autoscopy), witnessing her body walking slowly and deliberately through a softly lit white space. She identified partially with the walking body but mostly with the observer. She awoke while noticing her own unintentional eye movements, uncertain about the immediately prior dream segments. Two sniffs were recorded just prior to awakening.

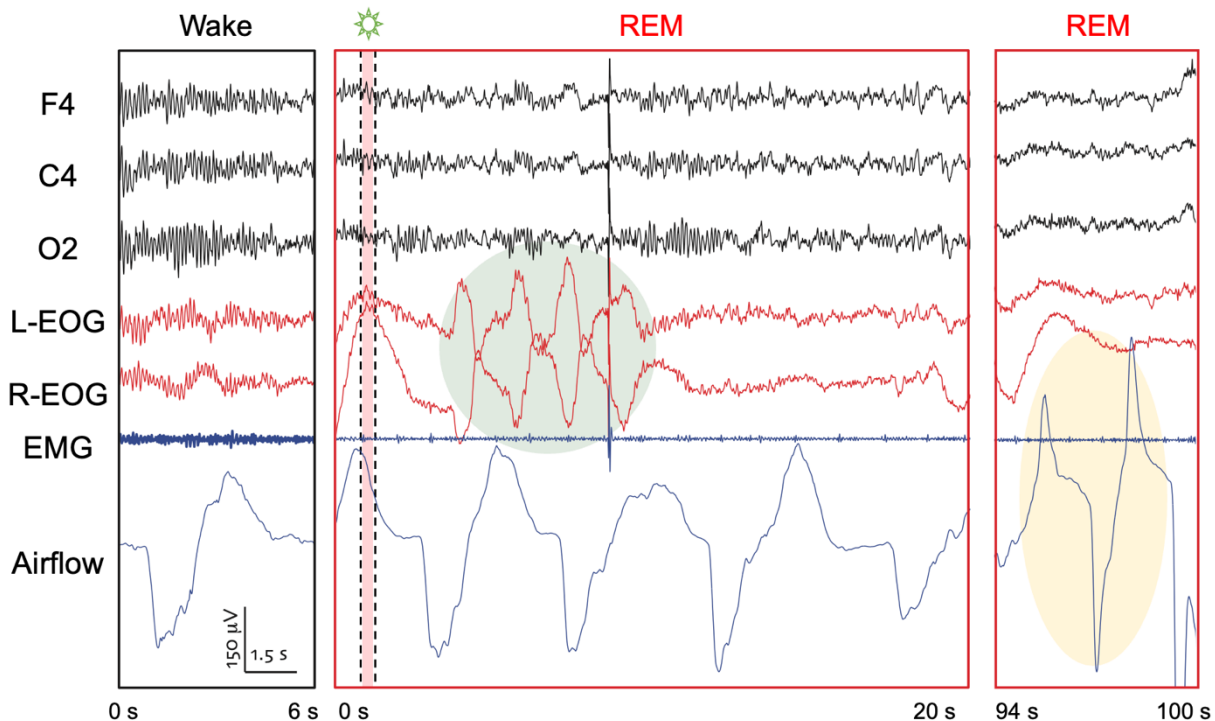


Figure 6. Polysomnographic recordings from Participant 3 documenting nonreactive witnessing as a dream-yoga exercise during a REM period (middle and right panel) contrasted with wake (left panel) with high EEG alpha and high muscle activity (same channels as in Figure 1). During a REM period 286 min after bedtime, a series of red light cues were flashed (red rectangle). The participant performed LRLR eye signals three seconds after the cue to signal lucidity (green oval). She also reported producing a two-sniff signal, which was observed 90 seconds later (yellow oval), followed immediately by an awakening.

An example consistent with disembodied, nonreactive witnessing was reported by **Participant 4** during his third overnight session (**Figure 7**). During the fifth REM period, 11 light cues were presented. Because the participant had specifically requested not to be awakened during this REM period, no dream report was collected at that time. At the end of the subsequent REM period (REM 6), the participant reported that following the light cues he had experienced a series of approximately 10–15 brief lucid dream episodes, which he referred to as "dreamlets." He described these experiences as short visual scenes that emerged and dissolved from a background of darkness, "like popcorn popping up and disappearing," rather than as a single continuous lucid dream.

The participant reported adopting the role of a passive observer, witnessing the appearance and disappearance of these brief dream episodes without actively participating in them. He stated that sustained observation often caused the dreamlets to destabilize, such that "watching them too much" would result in being "pulled out" of the experience and the dream collapsing back into darkness.

The participant judged the final dreamlet to be sufficiently stable, lasting approximately 4–5 seconds, to permit signaling. He reported performing a LRLR eye signal followed by two volitional sniffs (Figure 7, middle panel). According to his report, directing attention toward the eyes and nose in order to execute the signals destabilized the dreamlet. After signaling, he monitored whether the experience would develop into a longer lucid dream; instead, he observed the imagery gradually fading back into a formless state. He then performed four additional

sniffs (Figure 7, right panel) to indicate the end of the episode while the experience was dissolving. Following a brief interval without reportable content, he transitioned to wakefulness upon hearing the experimenter's voice. The dream report was collected approximately 65 minutes after the final light cue presentation.

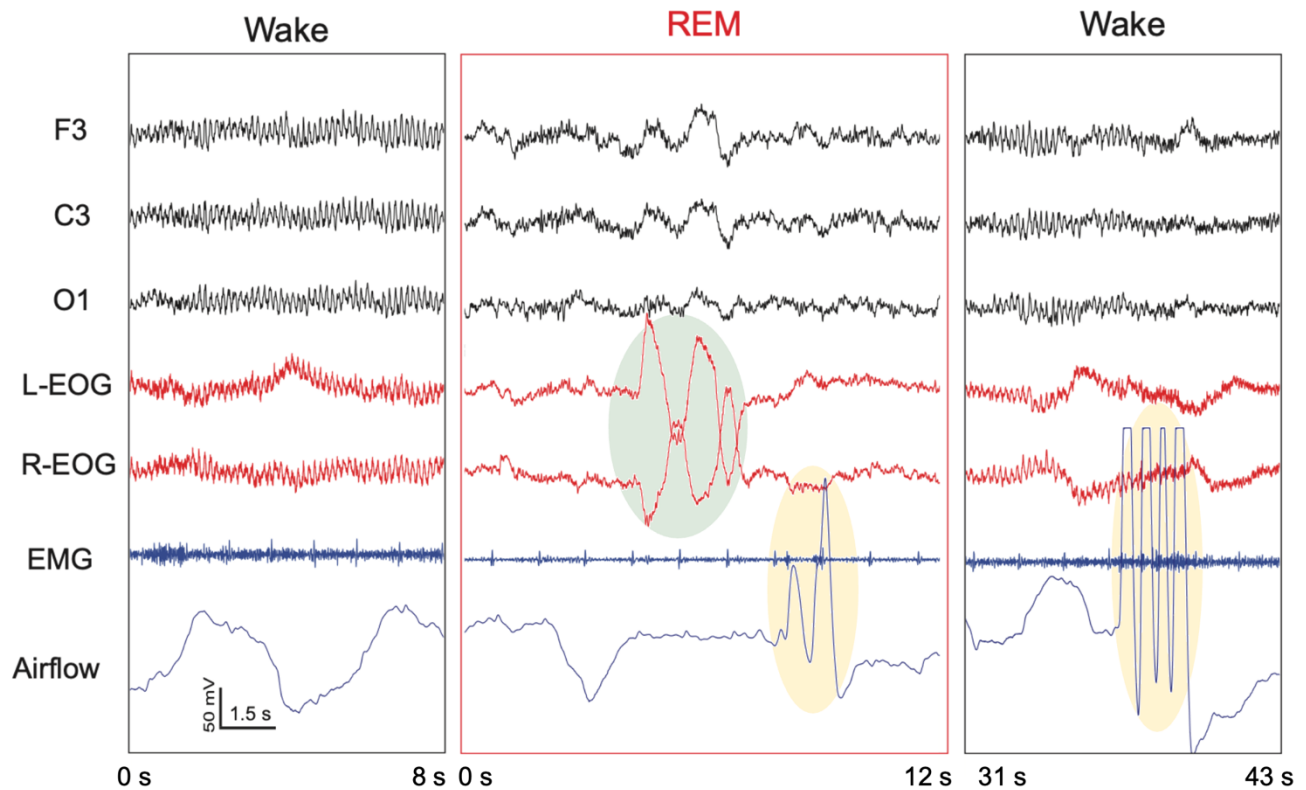


Figure 7. Polysomnographic recordings from Participant 4 documenting disembodied nonreactive witnessing as a dream-yoga exercise marked at the end of a REM period (middle and right panel) contrasted with wake (left panel) with high EEG alpha and high muscle activity (same channels as in Figure 1). During a REM period 525 min after bedtime, the participant performed LRLR eye signals (green oval) followed by two sniffs (yellow oval) one second after. After 36 seconds after the LRLR signal, the participants produced 4 sniffs (yellow oval in right panel) in an epoch scored as wake.

Sleep Quality and Mindfulness in Expert Practitioners

Because Dream-Yoga practitioners make use of sleep interruption, their practices could negatively impact their sleep quality. Our assessment of subjective sleep quality with the Pittsburgh Sleep Quality Index (PSQI) did not support this prediction (**Supplemental Figure S1**). Overall, dream-yoga practitioners showed higher perceived sleep quality compared to a normative sample of 866 US college students (Dietch et al., 2016).

Because Dream Yoga involves both sleep and wake contemplative practices, including meditative techniques of observation and visualization, we assessed traits relevant to these practices by evaluating attention and acceptance using the Cognitive and Affective Mindfulness Scale–Revised (CAMS-R). This questionnaire was developed to measure dispositional mindfulness or an individual's tendency to be mindful in daily life. Dream Yoga participants mean score was significantly higher than data from a normative sample of 298 students (Feldman et al., 2007). Results from measures of cognitive flexibility are included in **Supplemental Figure S1 and Table S1**.

Discussion

Expanding the science of dreaming, we completed an initial investigation of experts engaged in Contemplative Sleep Practices (CSPs). We combined recordings of sleep physiology with real-time communication and post-sleep interviews to document a set of Dream-Yoga exercises. We highlighted six occasions when polysomnographic results demonstrated that volitional signals were made by four participants, implicating REM sleep as the sleep stage when these dreams were experienced. According to various first-person accounts of Dream Yoga (Norbu et al., 2002; Wangyal, 2010), advanced practitioners train to recognize and manipulate dream environments through sustained efforts with multifaceted contemplative regimens, including waking contemplative practices. However, these accounts do not tell us when those dreams occur. Dreams experienced by people with dream-yoga expertise have not previously been linked to the standard physiological observations used to assess sleep in clinical and research contexts. Such observations are needed because individuals can

have dream-like experiences in all stages of sleep as well as during periods categorized as waking states by polysomnography (Lacaux et al., 2024; Picard-Deland et al., 2023). Further results based on post-sleep microphenomenological strategies will be presented in depth separately (Demšar, 2026).

Our principal findings characterized contemplative practices of Dream Yoga in a select group of advanced practitioners who intentionally explored their dreams with specific objectives. As documented by the set of examples above, we obtained 46 dream reports after periods of REM sleep along with seven recordings of physiological signals during unambiguous periods of REM sleep. On two different occasions, signals were produced during periods that were polysomnographically scored as wake (e.g., Figure 1) but were subjectively reported as occurring within a dream state. In line with this view, recent work has suggested that sleep may be better understood as a dynamic process involving gradual transitions and intermediate forms of conscious experience rather than as a sequence of discrete states (Lacaux et al., 2024).

In this study, four reports from participants described the dream experiences during NREM sleep. These reports provided a descriptions of a dream unfolding from an initially contentless state. We were unable to identify clear volitional signal of dreaming outside of REM sleep. The present study was not specifically designed to establish communication with participants during sleep stages other than REM sleep. However, previous studies have demonstrated that signals can be obtained during different sleep stages (Turker et al., 2023).

Given the unusual nature of the dream experiences conveyed by the practitioners, one might expect corresponding alterations in their sleep physiology. However, standard aspects of sleep physiology and sleep quality did not appear markedly different from normative values. Despite the inherent sleep fragmentation of Dream-Yoga practices, overall sleep quality was generally satisfactory. Dreaming in these individuals was not passive; rather, involved complex goal-directed behavior consistent with their learning objectives. These preliminary findings suggest that unusual dream experiences can occur in the absence of obvious abnormalities

in sleep architecture or perceived sleep quality, although larger controlled studies are needed to confirm this observation.

Given that Dream Yoga practitioners were subjected to the challenge of sleeping under unusual circumstances in the sleep lab with physiological monitoring and sensory cue presentations, and sometimes with jet lag from traveling to the lab, it is remarkable that they were this successful with their dreaming. As a group, they demonstrated a remarkable proficiency in recognizing the dream state and influencing events that transpired in their dreams. Despite the unpredictably changing nature of their dreams, they were able to adapt and maintain their focus on completing goals they had set in advance, which demands metacognitive expertise and flexibility. As a hypothesis for future investigation, we propose that CSP training may strengthen practitioners' capacity to modify their behavior in response to shifting environmental demands. This capacity may be reflected in increased cognitive flexibility in the waking state. Such flexibility is thought to rely on a set of talents, including cognitive shifting, inhibition, working-memory control, attention, and salience detection (Uddin, 2021). The ability to navigate diverse dream scenarios and landscapes, switching them at will, and responding adaptively within the dream context when a desired outcome is not forthcoming may likewise depend on refined cognitive flexibility. Future work employing larger sample sizes, richer task batteries, and longitudinal designs will be essential for exploring possible changes in cognitive flexibility produced by these practices.

When people succeed in exploring dream experiences, as did our participants, they directly engage with the constructed nature of dreaming and have the opportunity to reshape their habitual perceptual and cognitive schemas. It is tempting to speculate that lucid dreams may be used as a tool to volitionally update our waking predictions, extending the standpoint of predictive processing. Normally, perception is shaped by updating priors in an ongoing effort to minimize prediction error. In Dream Yoga, one can volitionally alter one's beliefs within the lucid dream and update those priors, such as believing one can walk through solid objects, trains this kind of flexible updating. These processes can be extended to reduce maladaptive patterns such as rumination

and rigid self-referential thinking, which are implicated in multiple mental health conditions including depression and anxiety. In a Dream-Yoga practice, fears and phobias, volitionally conjured by the practitioners or represented in nightmares, can be faced and processed in the safe and virtual environment of a lucid dream. Thus, Dream Yoga-based interventions may offer a potentially novel and scientifically underexplored pathway to improve mental health.

Our results face several limitations. Although proof-of-concept was established, the small sample size and selective recruitment of experienced practitioners limit generalizability. Second, the cross-sectional and descriptive nature of the study precludes conclusions about whether these practices can change mindfulness, cognitive flexibility, or any other personality characteristics. Longitudinal studies and controlled interventions will be necessary to ask those questions. A further limitation concerns the objective verification of subjective experiences during sleep. Although physiological signals successfully verified several lucid dreams, signal detection reliability varied across nights, and in some cases subjective reports did not correspond clearly to physiological markers as shown in reports where signals were given in an epoch scored as wake, but the participants reported being asleep. These findings highlight the challenges of studying unusual conscious experiences during sleep and underscore the importance of developing reliable methods for real-time communication and objective verification across sleep stages.

In summary, this research lays foundational groundwork for a multidisciplinary science of intentional dreaming. Following Thompson's (2015) recommendations, we envision a research agenda integrating contemplative knowledge with empirical neuroscience, expanding the landscape of cognitive training beyond waking states.

Methods

Participants

Screening was conducted with 20 candidates who were identified as potential experts through word-of-mouth. Interviews were conducted to assess expertise in contemplative practices and types of prior contemplative training. Each interview was conducted individually via videoconference and lasted approximately 45 minutes. A semi-structured interview guide was followed to ensure consistency while allowing flexibility for follow-up questions, including the following core items.

- At what age did you begin lucid-dreaming practices?
- In which traditions of Dream Yoga were you instructed, and which are you currently practicing?
- How frequently do you experience lucid dreaming?
- Which specific Dream-Yoga practices are you most familiar with?
- What is the frequency of similar practices in your regular routine?
- Are you able to intentionally induce sleep during the day?
- How have dream experiences influenced your waking life?

We selected six advanced practitioners (4 females, 2 males, 43 ± 14 mean years of age) who identified as White and were from Western cultural backgrounds. One participant reported immigrant status, having moved to a different country 7 years prior. They were invited to our sleep research laboratory located on the Northwestern University campus in Evanston, Illinois, for 3 or 4 consecutive nights. During the weeks leading up to their visit to the sleep lab, they were asked to practice the LRLR and sniffing signals during their lucid dreams and to complete standardized questionnaires. The study was approved by Institutional Review Boards at all three institutions and informed consent was obtained.

Questionnaires

Two weeks prior to the lab visit, participants completed a battery of self-report questionnaires to assess sleep quality, lucid dreaming, and cognitive flexibility. Questionnaires were administered online via encrypted forms (Qualtrics).

The Frequency and Intensity of Lucid Dreaming (FILD) questionnaire was administered along with custom questions about frequency of lucid dreams and of deliberate attempts to induce lucidity over the past month. Questions assessed typical dream recall, the number of lucid dreams per week, the frequency of deliberate induction attempts, and subjective ratings of lucidity confidence. Participants were also asked to estimate the typical duration of their lucid dreams, described in terms of dream scenes or narrative segments (FILD Mean Score: 6 ± 0.89). Four participants reported successfully attempting and achieving lucidity two or more times per week. The other two participants reported attempting and succeeding between one to four times per month. Participants reported high confidence in their lucidity for the majority of their lucid dreams. Participants reported confidence in 80%-100% of their lucid dreams, and one participant reported confidence in 60%-70% of their lucid dreams. The duration of lucid dreams was typically described as spanning 3 ± 0.89 dream scenes (**see supplemental table S3 further details**).

Another questionnaire, the Lucid Dreaming Skills Questionnaire (LUSK), was used to compare Dream-Yoga participants to a normative sample of 675 German individuals (Schredl et al., 2018). The LUSK is a 10-item self-report measure designed to assess skills such as dream awareness, control over dream content, and intentional action within dreams. The normative sample had a mean score of 1.51 ± 0.88 , whereas Dream-Yoga participants scored dramatically higher, with a mean of 28.80 ± 6.78 . Higher LUSK scores reflect greater proficiency in various aspects of lucid dreaming, including recognizing the dream state, maintaining lucidity, exerting control over dream content, and performing intentional actions while dreaming.

Polysomnographic recordings

Participants slept for three consecutive nights, except for one participant who slept for one additional night.

Polysomnography included electroencephalography (EEG), electromyography (EMG), electrooculography (EOG, horizontal and vertical), and electrocardiography (ECG). EEG was recorded from 18 electrodes placed according to the international 10–20 system (F3, F4, C3, C4, O1, O2, T5, T6, and both mastoids), with a right-mastoid reference. Two submental EMG channels were on the chin. Airflow was measured via a nasal cannula connected to a nasal airflow pressure transducer (BiNAPS). Data were collected using a Neuroscan SynAmps system with a 1000-Hz sampling rate and bandpass at 0.1–100 Hz for EEG and EOG, 10–100 Hz for EMG, and 0.05–50 Hz for airflow.

Contemplative Sleep Procedures and Interactive Dreaming

On the first night, participants were asked to sleep normally and were encouraged to follow their usual nightly practices. Four participants received no sensory cues and were not disturbed in any way. Two participants had a lucid dream in the first night and woke naturally to report the dream.

On some nights, Targeted Lucidity Reactivation (TLR) was used to increase lucid dreaming (Carr et al., 2023; Konkoly et al., 2021). As described above, participants associated a specific sound such as 3-beep sound or a light cue with a lucid state of mind prior to sleep. TLR stimuli either auditory (beeping sound or a chosen soundtrack) or visual (light flashes), were presented overnight to return participants to this lucid state of mind. Sound cues were chosen by participants. Before sleep, we adjusted sound intensity to determine each participant's threshold for detection. Sound levels were titrated to each participant's comfort level and kept low to avoid awakening. Sounds were played from a speaker located on the ceiling of the sleep chamber. Visual cues were brief pulses of light presented via a soft LED near the bed. If a participant did not spontaneously produce

the lucid signal, lucid cues (auditory and visual, or just auditory) were presented during REM periods to help promote lucidity.

Dream Reports

Dream reports were recorded after participants were either awakened at the conclusion of a REM period or after an arousal. The experimenter whispered the participant's name softly to wake them up. The following questions were asked.

1. Please describe your experience, including any dreams, sensations, feelings, thoughts, or emotions from the last few moments or since we last spoke.
2. (If relevant) Please try to recount in sequence in as much detail as possible how you became lucid, signals you completed, and everything you remember about the tasks you completed.
3. Did you notice any cues while you were asleep?
4. (If relevant) Please describe which cues you noticed, how many times, and how you experienced them.
5. (If lucid) During your dream, how aware were you that you were dreaming? (Scale: 0 = not at all, 4 = very much so).
6. (If lucid) During your dream, how much were you able to control your actions or what happened? (Scale: 0 = not at all, 4 = very much so).
7. Do you remember anything else?

After answering the questions, participants returned to bed so that cues could be presented during the subsequent REM period.

Microphenomenological Interviews

Participants took part in a one-on-one micro-phenomenological interview after each overnight session. The interview was conducted by an experimenter with extensive experience in such interviews. The interview took place via a private video call during the day following the overnight session. Each interview lasted approximately 1.5 hours. Interviews followed a structured micro-phenomenological protocol (Petitmengin, 2006; Petitmengin-Peugeot, 1999) adapted to the dream-research context to elicit detailed reports (Demšar, 2024). The protocol aims to guide participants in an unbiased way through the recollection process of the dream, focusing on particular examples of Dream-Yoga practices, perceiving stimuli during a dream, and producing volitional signals. Instructions from the interviewer encourage participants to focus on their immediate, lived experience rather than preconceived notions or interpretations. This technique may reveal subtle or overlooked aspects of an experience that otherwise can be difficult to articulate (Petitmengin, 2006; Petitmengin-Peugeot, 1999). The reports presented here are based on overnight dream reports complemented by microphenomenological interviews conducted the following morning.

EEG Data Processing

Electrophysiological data were preprocessed with additional bandpass filters using ERPLAB (Lopez-Calderon & Luck, 2014). EEG data were filtered from 0.3 to 35 Hz and EOG data from 0.3 to 15 Hz. To improve the signal-to-noise ratio, an Infinite Impulse Response (IIR) Butterworth bandpass filter was applied to improve the signal-to-noise ratio while preserving frequency dynamics relevant for sleep scoring. In cases where certain channels showed persistent noise, typically due to movement artifacts or poor electrode contact, targeted filtering was applied to those specific channels to suppress contamination.

Sleep Staging

Sleep staging and signal detection were performed manually using SleepSMG, an open-source graphical interface for EEG-based sleep analysis. Sleep stages were scored according to AASM criteria in 30-s epochs by three trained scorers (KK, SGTP, and DM). Discrepancies in sleep-stage classification or signal identification were resolved through discussion until consensus was reached. REM periods were identified from the consensus scoring, and REM duration was calculated as the time elapsed between the onset and termination of each REM period. Electrodes displayed in figures were selected based on signal quality.

Behavioral Tasks

We used an online version of the Wisconsin Card Sorting Test called the Berg Card Sorting Task (Bechara & Damasio, 2002). Participants sorted 128 stimulus cards by matching them to one of four target cards according to color, shape, or number, with correct/incorrect feedback but without explicit instruction about the current rule. After achieving a set of 10 correct responses, the sorting rule changed, requiring participants to flexibly learn the new rule. Decision-making under uncertainty was assessed using the Iowa Gambling Test, where participants aimed to maximize earnings by choosing cards from decks that varied in rewards and losses. Psychology Experiment Building Language open-source software was used for these tests.

Statistical Analyzes

Statistical analyses were conducted using Python (SciPy and NumPy libraries). Normality was assessed using Shapiro–Wilk tests. One-sample t-tests were used for normally distributed data. The Wilcoxon-signed rank test was used for non-normally distributed data. When multiple comparisons were conducted, p-values were adjusted using the Holm–Bonferroni procedure, controlling the family-wise error rate at $\alpha = 0.05$. Effect sizes were calculated using Cohen’s d, with the pooled standard deviation computed as a weighted average of

variances from the sample and the normative group. This approach accounts for differences in group sizes and provides a more accurate estimate of effect magnitude. All measurements were expressed as mean $\pm$ SEM and $p \leq 0.05$ was considered significant in all statistical tests.

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