




Intentionally awakening from sleep through lucid dreaming

Cameron Sandell^{1,2} · Tadas Stumbrys³ · Ken A. Paller¹ · Remington Mallett¹ 

Accepted: 31 January 2024

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Abstract

Standard treatments for nightmares focus on waking activities, with consequences for subsequent sleep. An alternative strategy may be to provide people with a novel way to learn to end a nightmare by waking up. People typically think of sleep as a state that they cannot control, but there are exceptions to this rule. For example, the ability to select dream content in a lucid dream might allow one to wake up deliberately, thus countering the typical helplessness of nightmares. However, documented evidence that this strategy can work is lacking. Therefore, we recruited healthy participants to complete a task during their next lucid dream; they were instructed either to attempt to wake up or to clench their fists. In the former case, we offered several options for how to wake up. After sleep, participants responded to a detailed survey about their dream and their subsequent awakening experience. Relative to those who clenched their fists, participants who attempted to wake up from the dream by closing their eyes reported waking up sooner after task completion. Furthermore, higher levels of lucidity and lucid-dream skills while dreaming were correlated with a quicker wake-up time and reduced negative emotions. This research showed that people can succeed in waking up from sleep intentionally while lucid dreaming. Because lucid dreaming is trainable, training for waking up in this way could constitute a viable therapeutic approach to relieve nightmare suffering.

Keywords Lucidity · Nightmares · Dream engineering · Cognitive control · Behavioral therapy

Introduction

Nightmares are associated with a wide range of negative outcomes (Hedström et al., 2021; Kammerer et al., 2021). Although many treatments help people learn to cope with their nightmares, better treatment options are needed (Kim & Kang, 2023). Leading therapeutic options focus on pre-sleep cognitive modification, such that instructions can persist to become operative during sleep. For example, Image Rehearsal Therapy requires people to rescript their troubling dream during wake, such that different expectations impact subsequent dreaming. The exclusive targeting of wake behaviors has roots in the conventional view of sleep as an uncontrollable state, whereas recent findings suggest that

some aspects of sleep can be manipulated in real-time (Carr et al., 2020a; Paller et al., 2021).

Dream engineering encompasses multiple approaches to manipulate a dream while it occurs (Carr et al., 2020a). Some methods of dream engineering involve lucid dreaming (Baird et al., 2019; Mallett et al., 2021). When individuals become lucid (i.e., recognizing the dream as such while still asleep), they often gain the ability to perform deliberate actions in their dreams (Mota-Rolim et al., 2013; Stumbrys et al., 2014), a characteristic that is generally absent in typical dreams. Control in lucid dreams might be beneficial in various clinical settings that look to improve sleep or manage sleep disorders (de Macêdo et al., 2019; Ouchene et al., 2023). In Lucid Dreaming Therapy (LDT), an approach still in its infancy, the insight and control of lucid dreaming are thought to serve a useful route for various nightmare-resolution tactics (Fig. 1). These tactics include manipulating the nightmare content to reduce its negative emotions, witnessing the dream from a neutral rather than responsive standpoint, or waking up from the nightmare. Whether these tactics can succeed is unclear, as there is as yet no empirical support for these approaches. Furthermore, LDT offers no clear guidelines

✉ Remington Mallett
mallett.remy@gmail.com

¹ Department of Psychology, Northwestern University, 2029 Sheridan Road, Evanston, IL 60208, USA

² John Jay High School, Cross River, NY, USA

³ Institute of Psychology, Vilnius University, Universiteto str. 9/1, 01513 Vilnius, Lithuania

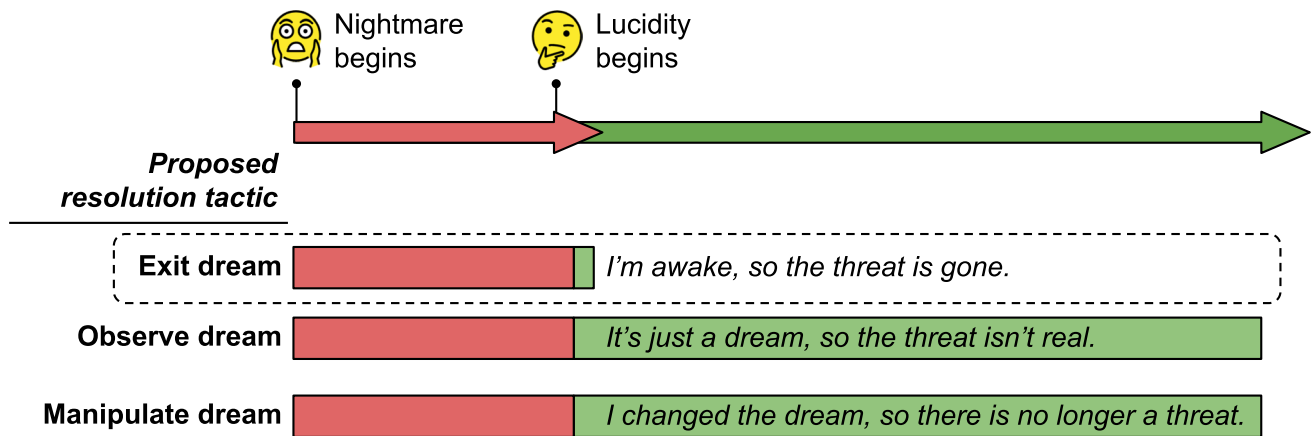


Fig. 1 Previously proposed nightmare-resolution tactics from Lucid Dreaming Therapy (LDT). LDT starts with the premise that a nightmare sufferer becomes lucid and aware of their dream (red to green transition), but it is not rigid about the next steps. To resolve the

nightmare, one might choose from exiting the dream, observing the dream as “just a dream,” or manipulating the dream towards more positive content. The current study focuses only on exiting the dream (dashed box)

as to which tactics should be implemented. Here, we focused on the feasibility of using the “exit” tactic in practice by quantifying the ability of lucid dreamers to wake themselves up out of a dream.

Despite the frequent suggestion that lucid dreamers can deliberately wake up from sleep, it is unclear if this approach is reliable or how one should approach it while dreaming. By reviewing reported strategies from survey studies and online communities, we identified three candidate approaches to waking up intentionally from a lucid dream. Self-reported wakeup strategies frequently include a method where dreamers close their eyes to wake up, as reported for example: “I recognized that it was all just a dream, so I opened my eyes and got out” (Mallett et al., 2022, p. 12). In a survey study concerning “high-level control” strategies for lucid dreamers (Lemyre et al., 2020), one category was “verbal strategies directed toward the dream or the subconscious,” (p. 30) suggesting that the dreamer might be able to wake up by verbalizing the intention. A longstanding hypothesis is that engaging with dream scenery while lucid, or staring at a single point, stabilizes the dream (Tholey, 1983a, b). Thus, inversely, fixating the gaze at a single point while lucid might destabilize or end a dream.

Another consideration is that self-reports of awakening from a lucid dream are confounded by common reports of lucid dreams ending prematurely (Stumbrys et al., 2014). Additionally, lucid dreams are associated with fragmented sleep (Gott et al., 2020) and increased neural activity (Baird et al., 2019). Thus, sleep fragmentation, the neural characterization of lucid dreams, or a general attempt at completing any task might be responsible for the awakening. A direct comparison between two dream tasks – one involving the intention to wake up and one without – can help determine whether deliberate intention contributes to waking up.

In this study, we sought to find out whether individuals can indeed wake themselves up from their dream. We ran a field study in which healthy participants were asked to perform a task at home and answer questions about their experience. The task was either to try to wake up while dreaming or to clench their fists while dreaming. The latter task served as a control condition, allowing us to disentangle the impact of a task and the intent to wake up. We hypothesized that participants who attempt to wake themselves up intentionally from a dream would wake up sooner (after task completion) than those who clenched their fists while dreaming. Our overarching goal of studying this possibility in healthy participants was to provide clarity on LDT strategies and help advance clinical lucid-dreaming applications.

Methods

General procedure

Participants were recruited online and completed a brief questionnaire about demographics and dream recall. Next, participants were randomly assigned one short task to complete in their next lucid dream (Fig. 2). They were also provided a link to the post-task survey that they were to save and then use later after completing the dream task. They were instructed to attempt the dream task at home at their own discretion over the course of 1–3 months, and to complete the post-task survey immediately upon awakening from attempting the lucid dream task (regardless of success). There was no contact between the participant and experimenters other than electronic communication. Detailed descriptions of the dream tasks and the post-task survey are provided below.

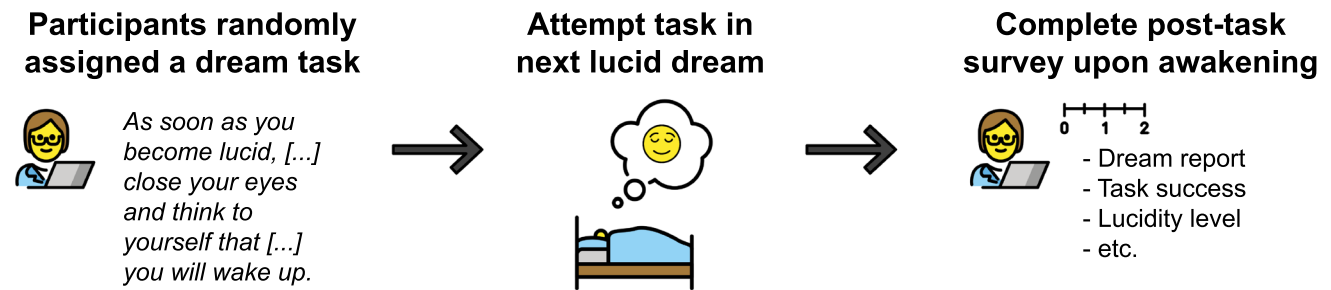


Fig. 2 General procedure. Participants were recruited online via social media and email lists, and all participation was completed remotely. Upon volunteering to participate in the study, participants filled out a brief questionnaire and were randomly assigned to one of four dream task conditions. Participants were instructed to attempt

the task during their next lucid dream and to complete an online survey of details of the experience immediately upon awakening. Participants were provided with up to 90 days to attempt the task and complete the final survey

Participants

Participants were recruited through two rounds of data collection. In the first round, a study advertisement was posted on the lucid-dreaming subreddit (Mallett et al., 2022) in February 2022, and data collection continued for about one month. In the second round (May–August) a broader series of advertisements were posted to social media (e.g., Facebook, Twitter, Discord) and a lab email list. Both rounds of data collection were identical except that in the second round, participants had the option to receive weekly email reminders until they completed the task. All data were aggregated into a single dataset for analysis. All participation was remote, voluntary, and the only requirement was to be 18 years of age or older. IRB approval was provided by the ethics committee of [REMOVED FOR BLINDING]. Ninety-three participants volunteered for the study and each was assigned a task to complete during their next lucid dream. The final sample includes only participants who completed both their lucid dream task and the survey ($N = 20$). Ten participants identified as female, 9 as male, and 1 as non-binary. Three participants reported being 18–24 years old, 10 reported being 25–34, 2 reported being 35–44, 3 reported being 45–54, and 2 reported being 55–64. Dream recall frequency, lucid dream recall frequency, and nightmare recall frequency were all measured using the

Mannheim Dream Questionnaire (Schredl et al., 2014). Fifteen participants recalled dreams almost every morning, 4 recalled dreams several times a week, and 1 recalled dreams once a week. One participant recalled nightmares several times a week, 3 recalled nightmares about once a week, 5 recalled nightmares two to three times a month, 1 recalled nightmares about once a month, 7 recalled nightmares about two to four times a year, 2 recalled nightmares about once a year, and 1 never recalled nightmares. Ten participants recalled lucid dreams several times a week, 1 recalled lucid dreams about once a week, 4 recalled lucid dreams two to three times a month, 3 recalled lucid dreams about once a month, and 2 recalled lucid dreams about two to four times a year.

Lucid dream task

Participants were pseudo-randomly assigned to one of four tasks, each with a unique instruction of what to do during their next lucid dream. Three of the four lucid dream tasks (*visual wakeup*, *verbal wakeup*, *gaze wakeup*) included the intention to wake up from the dream, and the other task served as the control condition (*fist clench*). Verbatim task instructions are provided in Table 1. The participants received these task instructions, along with the layout of the study, on the last page of the initial questionnaire regarding

Table 1 Dream task instructions

Task	Instructions
Visual wakeup	As soon as you become lucid, try to wake up from the dream in this way: Close your eyes and think to yourself that when you open them, you will wake up.
Verbal wakeup	As soon as you become lucid, try to wake up from the dream in this way: Vocalize to your dream that you want to wake up and think to yourself that when you say it, you will wake up.
Gaze wakeup	As soon as you become lucid, try to wake up from the dream in this way: Focus your gaze on a single point in the dream and think to yourself that you will wake up.
Fist clench	As soon as you become lucid, clench your fists in the dream.

demographics and dream recall. Beyond the brief task instructions, participants were not provided any specific training as to how to wake up from a dream. Participants were also not provided with any instructions or guidance as to how they might induce lucid dreams.

Post-task survey

Shortly after awakening, participants completed a survey about their dream experience and subsequent awakening. This included a dream report, the first probe of the Dream Lucidity Questionnaire to measure lucidity level (Stumbrys et al., 2013), the Lucid Skills Questionnaire (LUSK) to measure lucid dream skills exercised during the dream (Schredl et al., 2018), and the Positive Affect and Negative Affect Scale (PANAS) to measure dream emotion (Watson et al., 1988). Participants reported lucidity level as their agreement with the statement “*I was aware that I was dreaming*” on a 5-point Likert scale (1 = *not at all*, 2 = *just a little*, 3 = *moderately*, 4 = *pretty much*, 5 = *very much*). The LUSK and PANAS were slightly reworded from their original versions to probe the events of the dream. For the PANAS, participants were asked to indicate the extent they felt a certain way (e.g., *excited* or *scared*) in their dream. For the LUSK, participants were asked to indicate the extent to which, while dreaming, they had various lucid dream skills-related experiences (e.g., *were aware that your physical body was asleep* or *chose deliberately a specific action*). Response options for both questionnaires followed a 5-point Likert scale (1 = *not at all*, 2 = *a little*, 3 = *moderately*, 4 = *quite a bit*, 5 = *extremely*). We also included two questions about the experience of awakening. The first question asked “*Do you think performing the task forced or helped you to wake up in any way?*” and response options were “*No, I would’ve woken up when I did anyways*” and “*Yes, I only woke up when I did because I performed the task.*” Because of the possible response bias and demand characteristics inherent to this question, the survey also asked participants: “*How soon after performing the task did you wake up?*” with response options on a 5-point Likert scale, (0 = *I woke up while performing the task*, 1 = *I woke up immediately [0–5 seconds] after performing the task*, 2 = *I woke up shortly [6–30 seconds] after performing the task*, 3 = *I woke up a long time [31–120 seconds] after performing the task*, 4 = *I woke up a very long time [more than 2 minutes] after performing the task*). The full materials, including direct copies of all questionnaires used, are available in the public OSF repository.

Analyses

A chi-squared test was used to test if participants in the *visual wakeup* condition reported that the task forced or helped them to wake up more than participants in the *clench*

condition. Regression was used to test if the time between task-execution and awakening (Likert response as dependent variable) was less in the *visual* condition than the *clench* condition (categorical independent variable). A Kendall rank correlation was used to test if lucidity level while dreaming was related to the time between task-execution and awakening, and also to test if reported lucid dream skills were related to negative dream emotion. All statistical analyses were completed in JASP (Love et al., 2019) and the Pingouin Python package (Vallat, 2018). Questionnaires were implemented with Qualtrics. Due to the low completion rate for the *verbal* and *gaze* tasks, sample sizes differed across analyses. When comparing the control condition against deliberate awakening, the *fist clench* condition ($n = 8$) was compared directly against the *visual wakeup* condition ($n = 6$). When correlating general dream features, all wakeup conditions were included ($n = 12$).

Results

Participants can intentionally wake themselves up with lucidity

As shown in Fig. 3A, participants in the *visual wakeup* condition woke up sooner after lucid dream task execution than participants in the *clench* condition ($\beta = -0.17$, $p = .033$). Four participants in the *visual wakeup* condition reported waking up during the dream task, one 0–5 seconds after, and one 31–120 seconds after. One participant in the *clench* condition reported waking up during the dream task, two 0–5 seconds after, one 31–120 seconds after, and four >120 seconds after. Furthermore, as shown in Fig. 3B, participants in the *visual wakeup* condition more often reported that they woke up as a direct result of performing the task ($\chi^2(1, N = 14) = 7.9$, $p = .005$). See Table 2 for example dream reports.

Prior work suggests that lucid dreams can vary significantly in the degree to which an individual is “lucid” or aware of the dream, and that this might relate to the amount of control they can exert over dream content (Mallett et al., 2021). When aggregating across the three conditions involving a wake-up task (*visual*, *verbal*, *gaze*; $N = 12$), lucidity level was negatively correlated with time-to-wake-up after dream task execution ($r = -0.59$, $p = .028$), suggesting that higher lucidity shortened wakeup time.

Lucid dream skills are associated with reduced negative dream mood

In addition to waking up directly from a dream, a proposed benefit of lucid dreaming therapy is a decreased emotional tone with higher lucid dream skills. As

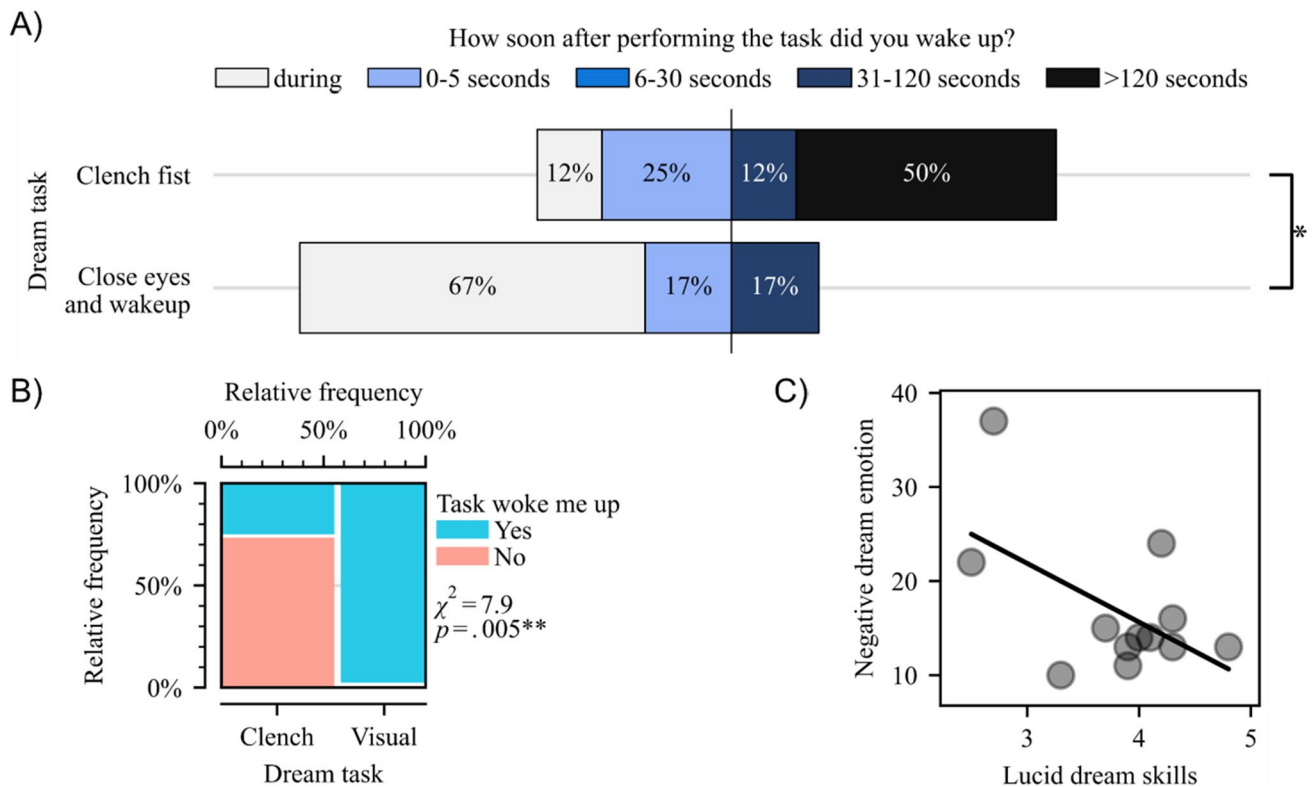


Fig. 3 Participants were able to wake up from sleep with deliberate intention. **A** Influence of dream task on time to wake up. Participants that were asked to try to wake up while dreaming by closing their eyes woke up sooner after completing the dream task than those that were asked to clench their fists while dreaming. **B** Subjective influ-

ence of dream task on awakening. Participants who tried to wake up from their lucid dream by closing their eyes reported that the task led to their awakening more than those who were asked to clench their fists while lucid dreaming. **C** Dreams that included higher lucid dream skills were associated with reduced negative emotions

Table 2 Example dream reports

Dream task	Did performing the task wake you up?	Dream report excerpt
Close your eyes and try to wake up	Yes	The shower was already off and he was just squatting so I scooped him up only to remember that I needed to do a ‘dream task’ [...] It took 3 attempts to open my eyes. I could hear the music I put on first on the second eye opening attempt and I knew I was close to the real world then try 3 it was a success.
	Yes	I became lucid. I remembered about the task and tried to complete it. [...] I managed to open my eyes, (for real, not simply in the dream) and to wake up partially, but I felt very tired and couldn’t really move.
Clench your fists	Yes	I dreamed that I was standing in my bedroom, staring at the closet. I was a bit annoyed because I kept putting off completing this task. My brain reminded me that I needed to clench my fist, so I raised my right hand up in front of my face and clenched my fist. Then the dream ended.
	No	I recall the dream task and look at my hand while attempting to make a fist. Looks odd as my hand is inside a sleeve and I can make the fist but it’s covered in material. [...] Dream goals over. I keep on wandering.

shown in Fig. 3C, the amount of reported lucid dream skills on the LUSK was negatively correlated with the reported amount of negative dream emotion on the PANAS ($n = 20, r = -0.54, p = 0.014$). All conditions

were included in this analysis because the relationship between lucid dream skills and mood was independent of our wake-up predictions.

Semantic task associations permeate into the dream narrative

To gain deeper insights into how the dream tasks influenced dream content, we explored the narrative content of dream reports. We identified a common theme that was present in the *fist clench* condition and might have a strong relationship to the fist-clenching task. An attempt to perform the *fist clench* dream task during a dream often elicited violent dream content, and in some cases an increase in confidence. A notable half of participants in the *clench* condition included violent content of their dream reports, mostly with an explicit connection between the fist and violence. One participant reported, “I clenched my fists. It felt real. After that I punched some comic characters but it didn’t really feel that real because it was a comic.” The presence of violence in *fist clench* dreams suggests that the act of forming a fist caused semantic associations to ripple throughout the context of the dream. Additional examples:

At one point the dream shifted when I was walking to the bathroom and some girl came out and looked like she was going to attack me. I remembered to clench my fist because I was repeating it a lot before bed and I purposefully clenched my fist into a ball to try to punch her.

I walk down a street. It is dark outside. I become lucid and remember my dream task to clench my fists. At the same time I see two guys approaching me. They look a bit unfriendly.

I was being chased by people who wanted to kill me. [...] I realized I had my robe on now. That made me think about how crazy this was and I realized it had to be a dream. I looked at my hand [...] then I remembered I was supposed to make a fist. So I did. I looked up and the people chasing me were there, so I ran.

Discussion

The goal of the current study was to determine if individuals can intentionally wake themselves up from sleep while dreaming. We observed that people were able to wake themselves up directly from sleep via lucid dreaming. This finding adds to mounting evidence that sleep is not an entirely uncontrollable off-state, as suggested by folk psychology (Carr et al., 2020a; Paller et al., 2021). The observed ability to wake up from a lucid dream is consistent with prior subjective reports of intentional awakening (Mallett et al., 2022; Stumbrys et al., 2014), and adds a quantitative success rate that can be used for the basis of future research and clinical trials. Because of the inclusion of an active control

condition in this experiment, we obtained convincing support that it is indeed the cognitive act of attempting to wake up from a lucid dream – as opposed to merely the lucid state or general effort to complete a task – that is operative for yielding awakening. In addition, the finding that lucidity level positively predicted successful deliberate awakenings from dreaming suggests further that the cognitive intention to awaken from a lucid dream drove the arousal.

These results not only advance understanding of dreaming, but they also have important practical ramifications. The evidence suggests that lucidity can free people from this entrapment by providing them a route for volitional escape. First, the high success rate of intentionally awakening suggests that this sort of strategy could be effective for LDT. One hundred percent of the small sample of participants in the *visual* condition felt that the dream task woke them up, and 75% of them woke up within 30 seconds or less of completing the task. Second, successful wakeups were generally very abrupt (i.e., less than 30 seconds after the attempt). Success rates are unknown for the different proposed tactics to resolve a nightmare with lucidity (Fig. 1). If a clinician wants to implement LDT, what should they advise the patient to do when they become lucid during a nightmare? The high success rate in our study of intentionally awakening suggests this eye-opening approach could be effective. Future work on the other tactics and their long-term outcomes will be valuable for comparison.

Although the current approach would only end a single nightmare, pilot LDT studies suggest that a single actively-ended nightmare with lucidity can reduce *repetitive* nightmares at a 6-month follow-up (Zadra & Pihl, 1997) or longer (Mallett et al., 2022). Patients might develop the skill to become lucid with the expectation that lucidity will occur during a nightmare and that they can deliberately choose to exit the dream. A major limitation that could impact the clinical usefulness of this strategy is identifying a method to consistently induce lucidity (Stumbrys et al., 2012; Tan & Fan, 2023).

Our finding that the level of lucidity predicted a quicker wakeup also has important implications for LDT. Lucidity, or insight into the dream state, falls along a continuum (Mallett et al., 2021; Stumbrys & Erlacher, 2017b; Voss et al., 2013; Windt & Voss, 2018), and our finding suggests that minimal levels of lucidity might not be enough to wake up intentionally. Importantly, prior work has also shown an association between low dream control and increased dysphoric content within lucid dreams (Mallett et al., 2022; Stumbrys, 2018). Most LDT proposals do not specify or emphasize levels of lucidity, but this should be considered in future studies of lucid-dream induction methods and therapies.

A similar concern in the literature is the importance of control in lucid dreams for LDT. Though lucid dreams are

defined only as dreams with a recognition of dreaming, they are often assumed to have dream control as well, which also falls along a continuum (Mallett et al., 2021; Stumbrys & Erlacher, 2017b; Voss et al., 2013; Windt & Voss, 2018). While many of the proposed benefits of LDT rely on dream control, other preliminary results suggest that simply the recognition of dreaming is enough for a reduction in nightmare symptomatology (Spormaker and van den Bout, 2006). In the current study, we observed that higher lucid dream skills were related to reduced negative emotions in dreams. This observation is consistent with accumulating evidence suggesting that “mastery” over dream content is a critical therapeutic mechanism in Image Rehearsal Therapy (Germain et al., 2004; Gill et al., 2023; Rousseau & Belleville, 2018). For example, an increase in dream control – but not awareness – was linked to a reduction in nightmare distress in a sample of military veterans with posttraumatic stress disorder (Harb et al., 2016). To-date, it is not clear whether lucidity or control is more valuable for reducing nightmares with LDT, and it is plausible that insight and control have differential benefits. Although dream control offers extra tools for dreamers to use, it might not be necessary for LDT to be effective.

A single approach to LDT is unlikely to work for all patients. Different circumstances might call for different approaches to solve the problem, so future research should delve into diverse approaches to ending a nightmare with LDT (Fig. 1). Even without any control, awareness of the dream might dispel a lot of the negativity from the nightmare. When the dreamer realizes the perceived distress in the dream is not real, the apparent realism and importance are removed. Even if the dreamer has very poor dream control, escaping the storyline by ending the dream and waking up, as was investigated here, might be possible. With high levels of dream control, the dreamer might use the control to manipulate the storyline to change it from negative to positive. This strategy has been reported on online discussion boards, such as “As soon as I knew I was dreaming, I looked them in the eyes and told them to go away” (Mallett et al., 2022, p. 5). However, when high levels of dream control are present, the dreamer might be able to implement more resolution-focused strategies (as opposed to avoidance strategies). An individual facing fear in a nightmare may benefit more from changing the storyline than by waking up, which might be analogous to confronting your fear rather than running away from it. For example, frequent nightmare sufferers reported more avoidance/escapism behavior when encountering threatening figures in their lucid dreams, whereas more frequent lucid dreamers often sought conflict resolution (Stumbrys & Erlacher, 2017a). Evidence from Image Rehearsal Therapy trials (Harb et al., 2012) and lucid dreaming studies (Stumbrys & Erlacher, 2017a) suggest that interacting with dream characters in a positive way might

be a better treatment option, but more work is needed in this area. Identifying the short- and long-term treatment outcomes of ending or interacting with a nightmare would be useful in determining which approach is most practical for LDT. Alternatively, it might be beneficial for some patients to have multiple strategies they can choose to implement according to the circumstances of the nightmare.

The present results have important implications beyond a clinical context. Researchers utilizing lucid dreams to answer scientific questions also require participants to wake up from their lucid dreams (Dresler et al., 2011; Konkoly et al., 2021; LaBerge et al., 2018a). A typical lucid dream study involves asking the participants to complete a task during their dream (e.g., jumping jacks) and then immediately wake up afterwards. Participants are asked to wake up immediately after the task so that researchers can collect a reliable report of what happened during their dream. It is common to forget dreams upon awakening (Nemeth, 2022), and if a participant continues to sleep after the task, their chance of dream recall likely declines. Indeed, there are reports of forgotten lucid dreams, indicated by signal-verification without recall (Carr et al., 2020b; Stumbrys & Erlacher, 2012). Thus, it is difficult to conclude how many times someone is failing to wake themselves up from lucidity in the lab, as reliable dream reports are only collected when participants wake themselves up successfully or are woken up by the experimenter. Currently, there is no standard procedure for how participants should be instructed to wake up (other than to simply “wake up”). The present results offer quantitative support for a best-practices approach to laboratory studies of lucid dreaming that includes providing participants with task instructions that conclude with attempting to close their eyes and then open them to wake up.

Beyond our findings about intentional awakening, we identified an interesting theme in dreams from the *fist clench* condition. When participants set the pre-sleep intention to clench their fists during a lucid dream, they frequently dreamt of violent scenarios. On multiple occasions they used their fist for violent behaviors. This finding is consistent with the notion of “embodied dreaming,” which highlights how dreams are not entirely random, but rather are influenced by sensory perceptions (Carr et al., 2020a). That is, the act of making a fist before or during the dream might have triggered a semantic memory association with violence and thus generated the context of the dream. Future work looking at how the performance of different dream tasks – independent of waking up – influence dream content would be valuable. In the current study, most of the tasks involved waking up, limiting the analysis of dream content after the task.

A major limitation of the current study is the small sample size. Despite wide recruitment and a large sample of initial volunteers, only a small subset of participants completed the full study. This limitation highlights the rarity of lucid

dreaming (Saunders et al., 2016). Future studies using a similar design might include a lucid-dreaming training component to increase the probability of a participant becoming lucid and performing the dream task. Another possible reason for low retention was the nature of the dream task. Lucid dreams are generally regarded as both rare (Saunders et al., 2016) and highly positive (LaBerge et al., 2018b; Mallett, 2020; Schredl et al., 2022; Stocks et al., 2020; Voss et al., 2013). Thus, people generally want to take advantage of their lucid dream for pleasure, not wake up and end it. Though this study involved healthy participants who likely have positive lucid dream experiences, the motivation was to understand a mechanism that can later be applied to those who have negative dream experiences. A further limitation is that our participants accomplished the task in a lucid dream that was not a nightmare, so whether the deliberate awakening approach transfers to the nightmare context remains to be determined.

Similarly, because no lucid dreaming training was included, the sample was biased towards frequent lucid dreamers and was perhaps not representative of the general population. Prior research suggests that lucid dreaming is a learnable skill, and recent laboratory methods show high efficacy of inducing lucid dreams in naive participants (Carr et al., 2020b; Tan & Fan, 2023). Thus, we might expect similar results in a group of novice lucid dreamers who went through induction training. Another limitation in this study was the reliance on self-report data (Rosen, 2013; Windt, 2013). Our measure of time-to-wake-up after task completion was reported by the participant, and thus might not be entirely accurate. In the future, a laboratory study that uses real-time dream reporting (Konkoly et al., 2021) to track when the dream task was completed and when the participant woke up would provide stronger evidence on the question of whether one can wake up from sleep.

As lucid dreaming therapy becomes viewed as a potentially effective clinical option, a quantified approach to lucid dream control and dream-exit strategies will be important. To-date, clinical approaches to LDT have not been well-specified, but our results suggest that waking up to end a nightmare is something clinicians could specifically instruct patients to try. This study showed that healthy participants had the ability to intentionally wake up from a dream. These results offer critical insight into the potential of LDT, a currently promising nightmare treatment that is understudied. Participants here were not asked to wake up from a nightmare, so attempting to wake up from nightmares through lucid dreaming to reduce the future frequency of such an event and the psychological impact it often leaves should be investigated further. Having more options available could also make therapy more effective. Future research could investigate whether certain LDT approaches result in fewer nightmares. It would also be interesting to investigate if a

specific form of the wake-up approach is more effective or would result in fewer nightmares.

Authors' contributions CS, TS, KP, and RM designed the study. CS and RM collected the data. CS and RM performed the analyses. CS, KAP, and RM wrote the manuscript. KP and RM supervised the project.

Funding RM was supported by the National Institutes of Health under award number T32-NS047987. We are also grateful for funding from the US National Science Foundation (BCS-1921678).

Data availability Data and code are available in a public OSF repository (<https://osf.io/s6a7r>).

Declarations

The study was approved by Northwestern University's Institutional Review Board. Informed consent was obtained from all the individual participants that were included in the study.

Conflict of interest The authors have no financial or non-financial interests to disclose.

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