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The clinical neuroscience of lucid dreaming

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ABSTRACT

During most dreams, the dreamer does not realize that they are in a dream. In contrast, lucid dreaming allows to become aware of the current state of mind, often accompanied by considerable control over the ongoing dream episode. Lucid dreams can happen spontaneously or be induced through diverse behavioural, cognitive or technological strategies. Such induction techniques have spurred research into the potential therapeutic aspects of lucid dreams. In this review, we gather evidence on the link between lucid dreams and conditions like nightmare disorder, depression, anxiety, psychosis, and dissociative states, and highlight the possible neurobiological basis of these associations. Furthermore, we explore contemplative sleep practices that train lucid states during sleep, such as Dream/Sleep Yoga and Yoga Nidrâ. The potential drawbacks of lucid dreaming interventions are outlined, accompanied by an examination of the impacts of lucid dreams on individuals without clinical conditions. By shedding light on these intricate relationships, the review contributes to a deeper understanding of the therapeutic possibilities and implications of lucid dreaming.

1. Introduction

Dream content varies considerably, from mundane to bizarre, depending on various factors including psychopathological symptoms (Noreika et al., 2010; Soffer-Dudek and Sadeh, 2013), cognitive style (Kunzendorf et al., 1997), memories of waking-life events (Picard-Deland et al., 2023), and media use (Gackenbach et al., 2009). During most dreams, the dreamer is presumably under the impression that the experienced images and emotions are real, and only upon awakening realizes their dream-like nature. However, in some cases, spontaneous awareness of the dream state may occur while the dream is taking place – an experience that has been described already by the classical Greek philosophers (Ferreira et al., 2021) as well as ancient Eastern traditions (Gillespie, 1988). The phenomenon was introduced to the modern scientific literature more than a century ago by the French sinologist Léon d'Hervey de Saint-Denys (1867) and the Dutch psychiatrist Frederik Willem van Eeden (1913) who also coined the now common term *lucid dreaming* (LD). Apart from becoming aware of the current state of mind, lucid dreamers may experience varying degrees of control and awareness of the dream state. They may have increased access to their daytime memory, experience the ability to wake themselves up or exit the dream, or the capacity to control their dream body, or to influence or change the dream environment and dream characters (Dresler et al., 2014; Holzinger, 2009; Stumbrys and Erlacher, 2017a; Voss et al., 2013; Watson, 2001). Based on the above, a lucid dream is typically defined as a dream in which the dreamer becomes aware of the fact that they are dreaming, which often allows them to consciously influence the dream content (LaBerge, 1986). While this awareness is generally considered the core criterion for LD, some scholars have debated whether it is sufficient. Tholey (1985), a pioneer of LD research, identifies seven facets of lucidity: (1) recognizing that one is dreaming; (2) having freedom of choice within the dream; (3) clarity of

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consciousness; (4) clarity about waking life; (5) clarity of perception; (6) clarity regarding the meaning of the dream; and (7) clarity of recollection (Tholey, 1985). According to this author, the first four aspects are essential for lucid dreaming. The seven criteria first proposed by Tholey (1985) have been revised to reflect more recent neurophysiological findings, emphasizing that LD is not an all-or-nothing phenomenon, but exists on a continuum; a dynamic process rather than a static moment of clarity (Holzinger and Mayer, 2020).

Dream lucidity may occur spontaneously, with dream awareness usually being triggered when the dreamer realizes anomalies or bizarre elements in the dream that seem incompatible with reality (Adams and Bourke, 2020; LaBerge and DeGracia, 2000). It can also appear when a dreamer recognizes elements that already appeared in previous dreams, or experiences strong emotions such as anxiety that trigger the insight into the current dream state (LaBerge and DeGracia, 2000). In addition, there are cases in which lucid dreamers can remain conscious while falling asleep, reaching the dream state directly from wakefulness—referred to as wake-initiated LD (Levitan et al., 1999).

The phenomenon of LD was validated electrophysiologically almost half a century ago with the development of a technique that lucid dreamers could use to communicate to the outside wake world while still being in the "dream world": thanks to their ability to reflect on waking intentions and to carry out deliberate actions agreed with the researcher before falling asleep, lucid dreamers can be instructed to use their dream gaze to perform a pre-arranged set of eye movements (typically Left-Right-Left-Right) upon achieving dream lucidity, which is objectively measurable via electrooculography (EOG) (LaBerge et al., 1981). Such eye-signal verification of dream lucidity has since then become the gold standard of LD research (Baird et al., 2019). More recently, the possibility of bidirectional communication with lucid dreamers has been demonstrated with similar strategies (Konkoly et al., 2021), transforming the notoriously elusive dream state into an increasingly tangible phenomenon.

Research into LD and its potential clinical applications has gained considerable momentum over the past decade (Zerr et al., 2024), however, it is still hampered by the relatively rare occurrence of LD in most people. A recent meta-analysis on the prevalence of spontaneous LD estimates that 53 % of people have experienced it once, while 23 % can be considered regular lucid dreamers—who experience at least one LD per month—(Saunders et al., 2016). While this is not so much an issue in simple survey-based studies (valuable among other things to detect correlations between LD and other parameters), experimental studies require investigations of participants in a sleep laboratory setting. As even frequent lucid dreamers often fail to achieve or reliably indicate dream lucidity in the sleep laboratory setting, respective studies are costly and time-consuming, and the final results are regularly based on just a handful of subjects or dream events (Oudiette et al., 2018).

Nevertheless, the relatively low frequency of spontaneous LD can be increased with various techniques (Schredl, 2013; Tholey, 1983) that have been thoroughly described in the scientific literature (Stumbrys et al., 2012). After proving that LD is a learnable ability (LaBerge, 1980; Tholey, 1983), interest in the phenomenon within the scientific community has increased and new methods to investigate LD in the laboratory setting have been developed. As research progresses, it is becoming increasingly clear that LD is not merely a fascinating curiosity but a phenomenon with significant implications for understanding the neural correlates of consciousness, dream control and body representation.

The overall conception of LD as a pleasurable and beneficial experience by pioneering authors (Gackenbach and Bosveld, 1989; LaBerge and Rheingold, 1990), together with the development of relatively easy-to-implement induction techniques, has contributed to the increasing popularity of lucid dreams also outside academia. Social media and various discussion forums offer a vast amount of personal LD experiences, tips, and extensive instructions on how to induce a state of lucidity, thereby reaching a large audience. In parallel, researchers have begun to question whether LD is something more than an interesting dream oddity or if it can have clinical implications and effects on well-being. Research indicates that LD can enhance emotional experiences (Schredl, Remedios, et al., 2022) and problem-solving abilities (Bonamino et al., 2023; Stumbrys and Erlacher, 2016), contributing to overall mental health and well-being (Mallett, Picard-Deland, et al., 2022). However, it also addresses potential risks associated with the phenomenon, and the training techniques used in order to induce it, particularly concerning sleep quality (Soffer-Dudek, 2019; Vallat and Ruby, 2019).

Beyond its cognitive and emotional benefits in non-clinical populations, evidence suggests that LD may have therapeutic applications, such as treating recurrent nightmares (Morgenthaler et al., 2018), post-traumatic stress disorder (PTSD) (Yount et al., 2023), and depression (Sackwild and Stumbrys, 2021). The possibility of integrating LD into clinical practice makes the topic even more relevant, as researchers seek to refine and develop methods that may alleviate distressing dream experiences or enhance overall well-being in clinical populations.

Nevertheless, despite its intriguing possibilities, the neuroscience of lucid dreaming remains underexplored compared to other states of consciousness, partly due to the aforementioned difficulties researchers face when studying it. A comprehensive review of the current literature is therefore timely, synthesizing findings from both neuroscience and clinical research to provide an updated overview of LD's potential and limitations. Such a review could address the implications of LD research for cognitive neuroscience, and critically examine the feasibility and risks of its therapeutic use. Alongside the scientific advancements, the intersection of lucid dreaming and spirituality adds another layer of significance. Contemplative practices like dream yoga naturally cultivate lucid dreaming, promoting spiritual growth and self-awareness while highlighting its historical and cultural relevance (Gillespie, 1988). This connection between LD and contemplative practices underscores the broader relevance of lucid dreaming in understanding altered states of consciousness. In modern psychology and therapeutic interventions, techniques like meditation and mindfulness—rooted in spiritual traditions—are often integrated to manage stress, anxiety, and trauma (Bonelli and Koenig, 2013; Gonçalves et al., 2015). This link between spiritual experiences and mental health suggests that lucid dreaming's clinical applications may benefit from a more holistic approach, encompassing both psychological and spiritual dimensions.

In this literature review, we compiled the known evidence on the clinical relevance of LD. We first describe the associated benefits and risks of LD in non-clinical populations and then highlight several disorders and conditions which have been associated with LD. We will describe the clinical relevance of LD on each of them before moving to the therapeutic potential of LD induction protocols. Then, we will elaborate on the known potential drawbacks of these proposed therapies, discuss the main findings on the topic and their implications. Finally, we will present and discuss the role that LD plays in eastern contemplative practices and dream yoga, as well as their therapeutic potential.

2. Methodology

This narrative review aims to provide a comprehensive overview of the clinical neuroscience of lucid dreaming (LD), synthesizing current research across various disciplines. Given the interdisciplinary nature of the topic, a flexible approach was employed to capture the wide range of available literature. The review process did not adhere strictly to a predefined protocol, allowing for the inclusion of a wide range of studies from different perspectives, including cognitive neuroscience, clinical psychology, and studies on spiritual practices associated with LD.

To gather relevant sources, a combination of initial database searches and subsequent snowballing techniques was used. Key databases such as PubMed, PsycINFO, and Google Scholar were consulted using combinations of search terms like "lucid dreaming", "lucid

dreaming therapy", "nightmares", "clinical", "narcolepsy", "PTSD", "depression", "anxiety", "psychosis", "dissociation", "sleep paralysis", "out-of-body experiences", "dream yoga", "mental health", "well-being", "sleep", "Covid-19". The core literature search was conducted from the end of 2019 till 2022, and additional relevant articles that were published afterwards were incorporated later. From these initial search results, further references were identified through backward and forward citation tracking. This approach facilitated the inclusion of both historical and recent contributions to the topic.

Articles were selected based on their relevance to the clinical and neuroscientific aspects of LD, with particular attention to studies involving therapeutic applications, behavioral, physiological, and experimental findings on the mechanisms of lucid dreaming. In order to provide a balanced perspective, research addressing both the benefits and limitations of LD induction techniques was included. While no strict inclusion or exclusion criteria were applied, an effort was made to prioritize peer-reviewed studies and key theoretical contributions to ensure the robustness of the review.

In addition to empirical studies, seminal theoretical works and reviews were included to offer a broader context for understanding the clinical significance of LD. Given the iterative nature of the review process, literature selection evolved organically as key themes emerged, helping to refine the focus on relevant clinical and neuroscientific aspects of LD.

3. Lucid dreaming and well-being in non-clinical populations

Regardless of spontaneous or induced LD, a number of studies have assessed the effects that it may have on different parameters in non-clinical populations. In this section, both the positive and negative effects that have been described in the context of LD will be recapitulated.

3.1. Effects of LD on general mental health and well-being

Lucid dreams are usually considered a pleasant experience for the dreamer. LD reports generally contain more positive emotions compared to non-lucid dreams as measured by questionnaires designed to query positive dream emotions (Voss et al., 2013) and analysis of dream reports (Schredl, Fuchs, et al., 2022). Whereas reports of the dominant emotion at the beginning of lucid dreams vary between positive and negative, emotions at the conclusion of an LD are predominantly positive (Aviram and Soffer-Dudek, 2018). Furthermore, a recent study with 459 lucid dreamers, found that around 64 % of all lucid dreams were subjectively rated as an emotionally positive experience (Stumbrys, 2023). This evaluation of lucid dreams is not surprising considering that wish fulfilment in dreams (e.g., flying, engaging in sexual activities) are especially popular among lucid dreamers (Stumbrys et al., 2014). In these cases, despite being perfectly aware of the unreal nature of their experiences, the dreamers report feeling as exhilarated as they would be in the physical world. Importantly, these positive feelings do not cease when the lucid dream ends and often persist long after awakening with corresponding improvements in happiness and satisfaction (Stocks et al., 2020; Stumbrys and Erlacher, 2016). A strong connection between dreaming and waking mood has been suggested: recalled negative dream content is associated with a more negative morning mood, while positive emotions in dreams are linked to less negative morning mood. This suggests that dream influence and control, such as the one displayed in LD, could have potential implications for improving overall well-being (Mallett et al., 2022).

LD has been used to solve waking life problems (e.g. find a solution for a daunting job task) and to reduce performance anxiety (e.g. practice a public presentation) (LaBerge and Rheingold, 1990). These anecdotal positive aspects of LD, largely based on subjective personal reports, have been partly backed by empirical evidence (Bonamino et al., 2023; Bourke and Shaw, 2014; Peters et al., 2023; Stumbrys et al., 2016). Similarly, studies using questionnaires found a positive correlation between LD frequency and better mental health, freedom of complaints, autonomy, self-confidence and lesser loneliness (Doll et al., 2009; Stumbrys, 2023). Furthermore, in an online survey of 386 lucid dreamers, 81 % of respondents agreed that their lucid dreams contributed to their mental well-being (Erlacher et al., 2021). Similarly, in a longitudinal study, high frequency of previous LD correlated with higher resilience to stress (smaller pre-to-post increases in psychological symptoms) after being exposed to terrorism (Soffer-Dudek et al., 2011). Resilience was also found to be related to dream lucidity, but not to dream intensity, suggesting that self-reflectiveness during dreaming may indicate a person's ability to recover from adversity (Yu and Wong, 2020). Other studies showed that LD induction provides aid in creative problem-solving tasks (Lacaux et al., 2019; Stumbrys and Daniels, 2010) and successful induction of LD was associated with life satisfaction, increased self-esteem, and reduced stress, compared to unsuccessful induction (Konkoly and Burke, 2019). However, these results should be interpreted with caution since, in the latter study, the improvements were only found when comparing successful and unsuccessful LD induction in 19 subjects, with no difference when compared to a non-LD group, indicating that the observed effects might be caused by the rewarding effect of learning and succeeding in a new skill. Moreover, other studies that will be discussed later in more detail did not find a correlation between LD frequency and mental health, especially when separating dream awareness from dream control (Aviram and Soffer-Dudek, 2018; Jones and Stumbrys, 2014).

Several mechanisms have been proposed to explain the observed relationship between LD and better mental health outcomes in non-clinical populations. One of these mechanisms hypothesises that the correlation between LD frequency and mental health is explained by a third factor that influences both: having an internal locus of control (Patrick and Durndell, 2004). The locus of control is a personality trait that indicates the individual's perceptions of the forces controlling their life. The locus of control can be internal—when believing that one controls their own—or external—if life is believed to be controlled by external uncontrollable forces. Individuals with an internal locus of control tend to feel more agency and confidence, qualities correlating with higher well-being (Rotter and Mulry, 1965). An internal locus of control may also affect the dream state through the so-called continuity hypothesis, postulating a continuity between the awake personality and the dream personality (i.e., the dream world is experienced similarly to the waking world) (Domhoff, 2017; Schredl, 2003, 2006, 2012). Under this assumption, individuals with an internal locus of control are confident in their capacity to control their own fate in both waking and dreaming (Patrick and Durndell, 2004). This would translate into improved well-being in the waking world and increased confidence in one's own power to influence the environment in the dream world, a skill that could trigger and maintain dream lucidity (Holzinger, 2009). This hypothesis of dream lucidity and mental health being independent of each other while dependent on a common trait is supported by studies showing that lucid dreamers score higher in internal locus of control measurements (Blagrove and Hartnell, 2000; Patrick and Durndell, 2004). However, other studies found no correlation between lucid dreaming variables, including dream control, and internal locus of control (Taitz, 2011; Yu and Wong, 2020).

An alternative (or complementary) hypothesis establishes a causal relationship between dream lucidity and positive mental health outcomes. This hypothesis postulates that the positive effects on waking mood observed after LD are a consequence of a spill-over effect of the feelings experienced in dreams which are carried over to the waking life (Konkoly and Burke, 2019; Stocks et al., 2020; Stumbrys and Erlacher, 2016). As LD is frequently associated with positive emotionality, the effects on well-being may be determined by the pleasurable content of the lucid dream rather than by lucidity itself. This is particularly significant considering recent findings suggesting that deepening techniques (i.e., techniques used during LDs to increase perception vividness, like imagining wakefulness or palpation within the dream)

can lead to more emotionally satisfying dream experiences by helping individuals to achieve enjoyable goals in the dream (Shashkov et al., 2024). However, it is important to highlight that lucid dreams may also be emotionally negative. In that case, the negative emotions experienced during the dream may also affect waking life through the same spill-over effect. Although these negative experiences affect only a minority of lucid dreamers, between 10 % and 12 %, (Aviram and Soffer-Dudek, 2018; Stumbrys, 2023), three major predictors have been found to associate with their incidence: 1) they are more likely to occur in women, 2) they are associated more with spontaneous than with induced lucidity, and 3) they are linked to increased nightmare frequency (Stumbrys, 2023). The latter is not surprising, since nightmares are assumed to trigger dream awareness (Adams and Bourke, 2020; Schredl and Erlacher, 2004; Stumbrys et al., 2014). Moreover, the link to spontaneous rather than induced lucidity indicates that lucid dreams with negative valence represent a naturally occurring phenomenon (Stumbrys, 2023). However, a strong association between the frequency of spontaneous and induced LD (Aviram and Soffer-Dudek, 2018) implies that such a natural phenomenon might be increased in individuals attempting LD induction. A specific type of negative lucid dreams, often referred to as lucid nightmares, will be further addressed later in this review.

Despite some evidence for a positive association between (spontaneous) lucid dreaming and mental health, it is not possible to discern whether they stem from a shared cause (e.g., locus of control), or causally affect each other. Even if there is a causal relation, we do not know whether better mental health increases the likelihood of lucid dreams or whether higher dream lucidity eventually leads to improved mental well-being (via de proposed spill-over effect, for example). Moreover, some studies do not find such a relationship at all. In one study, the frequency of LD was unrelated to lower or higher psychopathology, and associations of several lucid dream characteristics (such as control of dream events) with lower psychopathology scores were present only when compared to other lucid dreamers (e.g., those with little control), but were absent when compared to non-lucid dreamers (Aviram and Soffer-Dudek, 2018). That study and a few others have also presented evidence for certain risks of LD induction to poor mental health, which will be reviewed in Section 4 as they pertain to specific types of symptoms.

3.2. LD and physical health

It is important to highlight that the potentially beneficial effects of LD may go beyond mental health parameters. Several studies have tested the possibility of using LD for physical training (Bonamino et al., 2023) and others have found increased activity in the sensorimotor cortex during the performance of a motor task in a LD environment (Dresler et al., 2011). In an online study, participants were presented with a complex unfamiliar motor task; after performing it for the first time, they were asked to practice it again physically (repeat the same task on their own), mentally (imagine repeating the same tasks without executing it) or in a lucid dream. Upon performing the task for a second time, the improvement observed in the three groups was identical and significant when compared to a control group that did not show any improvements (Stumbrys et al., 2016). However, it must be noticed that of twenty-one participants in the LD group, only six were able to accomplish the task on their first trial. Similar results were reported in a previous study, in which only seven out of twenty participants succeeded at practicing a simple motor task on a single night of LD (Erlacher and Schredl, 2010). Another study also explored the effects of LD when practicing a dart-throwing task, showing that LD may lead to performance improvements in the laboratory setting, but only if the dream unfolds with few distractions (lucidity fading away or dream character interference, among others) (Schädlich et al., 2017). On the contrary, when the lucid dream was experienced with high frequency of distractions, the subsequent performance was diminished. This may indicate that only lucid dreamers who can be focused and control their dreams—mostly experienced and frequent lucid dreamers—could benefit from LD in the context of physical training.

It has been shown that almost a quarter of professional athletes in Germany already experience one or more lucid dreams per month (Erlacher et al., 2012). Furthermore, three quarters of those athletes using LD for sports practice (4 % of the total sample) have reported improved performance in the physical world (Erlacher et al., 2012). Although this still represents only a small percentage of athletes, further research may elucidate whether this proportion can be increased with LD training or not. A recent meta-analysis with seven studies (Bonamino et al., 2023) showed an overall medium positive effect of LD practice on subsequent performance (g =.483), yet statistically insignificant (p = 0.095). In specific, future studies should address whether the benefits of this practice could overshadow the potential risks associated with LD or LD techniques, and compare them with those that arise from only employing mental imagining tasks. If successful, these results may herald a new line of research in the fields of physical training and rehabilitation.

3.3. Effects of LD on sleep quality

Concerns have been raised about sleep quality potentially being diminished by either LD-associated arousal (Vallat and Ruby, 2019) or by the frequent implementation of deliberate LD-induction techniques, such as those involving initiated awakenings and a blurring of sleep-wake boundaries (Soffer-Dudek, 2019). These concerns have been empirically researched both in spontaneous and induced lucid dreams. For instance, when employing different induction techniques, a daily dream diary study of 149 students found that LD occurrence was associated with a higher feeling of being refreshed in the morning, compared to recall of a non-lucid dream (Schredl et al., 2020). However, that study also showed that the wake-back-to-bed (WBTB) technique, which involves planned awakenings during the night, was associated with feeling less refreshed in the morning when controlling for sleep duration. Together, these findings support the idea that sleep quality may possibly suffer from certain induction techniques rather than from LD per se (Soffer-Dudek, 2019).

Indeed, in a survey with 187 undergraduate students, poor sleep quality was not associated with spontaneous LD, but was significantly associated with LD attempt (frequency of attempts to deliberately induce LDs). The same study, when focusing on 64 students who reported using LD induction techniques, also found that a more intense use of LD techniques is strongly correlated with poor sleep (Aviram and Soffer-Dudek, 2018). Finally, a study with 19 students required participants to follow a specific set of instructions to induce LDs, finding that there were more sleep disruptions (in the form of awakenings) on nights in which LD was reported (Konkoly and Burke, 2019). Other studies have explored the association between general LD frequency and poor sleep quality without taking induction techniques into account. For example, a study analysed the relationship between LD frequency and sleep quality in both a sample of 444 students and compared to 1380 population-based sample. For both study groups, a positive correlation was found between higher LD frequency and poorer sleep quality, but the observed detrimental effects of LD disappeared when results were adjusted for nightmare frequency (Schadow et al., 2018). This does not necessarily mean that LD is not associated with poorer sleep quality, but that the shared variance between LD and poor sleep quality is also shared by nightmares. It could be hypothesized in this context that poor sleep quality causes nightmares, which in turn cause LD; but it could also be that nightmares cause both LD and poor sleep quality, or that LD cause both nightmares and poor sleep quality. There are indeed multiple possibilities that may explain these results. A recent online survey study (N = 259) found that the indirect effect of LD on sleep quality through nightmare distress depends on one's level of mindfulness. Lucid dreaming appears to benefit those with high mindfulness, but it may

worsen nightmare distress for individuals with low or average mindfulness (Barngrover et al., 2021). However, other studies on the topic suggest no correlation between LD frequency and sleep quality, specifically, in a large online sample (N = 1928) (Denis and Poerio, 2017), and in both a student sample (N = 274) and a general population sample (N = 681) (Ribeiro et al., 2020). Another study on 42 healthy participants found no association between trait sleep quality and LD, longitudinally assessed with morning questionnaires over several weeks (Gott et al., 2020).

A recent study on an online self-selected sample of lucid dreamers (N = 459) found that LD frequency was not associated with the overall sleep quality score (Stumbrys, 2023), however, a closer look into subscales revealed mixed results. LD was associated with greater subjective sleep quality and lower daytime dysfunction, despite it also being linked to more sleep disturbances. Two things are important to notice in this regard: Firstly, the sample consisted of relatively poor sleepers to begin with, as inferred from the average sleep quality scores. Secondly, the occurrence of more sleep disturbances in a sample with a large proportion of lucid dreamers is not surprising, given that deliberately waking-up during the night is part of a commonly-used LD induction technique (WBTB; see below) designed to increase lucid dreaming frequency. Thus, it could be speculated that naturally waking up during the night might have similar effects as this technique (Gott et al., 2020; Stumbrys, 2023). Importantly, only a little over 20 % of the sample reported self-perceived negative consequences of LD. Among those who did, tiredness and poor sleep quality were the most prominently mentioned side effects (reported on 34 occasions), with half of these reports being accounted for by the use of specific induction techniques (Stumbrys, 2023). This is in line with previous findings showing that sleep quality may be reduced by the use of certain LD induction strategies (Aviram and Soffer-Dudek, 2018; Konkoly and Burke, 2019), in particular when users become too preoccupied with LD induction or when LD induction attempts rely on a disruption of the sleep cycle. For instance, a popular technique requires the subject to wake up in the middle of the night (WBTB), intentionally fragmenting sleep and possibly reducing sleep length (Soffer-Dudek, 2019; Vallat and Ruby, 2019). In this regard, some of the studies described above do not report the specific LD induction tools employed.

In conclusion, the analysed literature indicates that LD per se appears to exert no significant effects on sleep quality (Ribeiro et al., 2020; Schadow et al., 2018; Schredl et al., 2020; Stumbrys, 2023; Stumbrys and Erlacher, 2016). However, sleep quality might be negatively affected by deliberate attempts to induce lucidity (Aviram and Soffer-Dudek, 2018; Konkoly and Burke, 2019). Together, these results highlight that the chosen induction technique plays an important role in the effects of LD on non-clinical populations. Future studies should therefore consider less aggressive LD induction protocols such as reality testing or dream diaries to minimize detrimental effects on sleep quality.

3.4. *Effects of LD on REM sleep function*

The potential effect of LD on the biological functions of REM sleep has been subject to considerable attention. Although there is some anecdotal evidence of EOG-verified lucid dreams emerging during non-REM sleep (Dane and Castle, 1984; Price and Cohen, 1988; Stumbrys and Erlacher, 2012), dream lucidity is considered to be typically associated with the REM phase (Baird et al., 2019; LaBerge et al., 1986). Importantly, despite emerging during REM sleep, some aspects of the physiology of dream lucidity seem distinct to that of non-lucid REM sleep: early research reported higher REM density, heart rate and respiration rate upon achieving dream lucidity, resembling the higher levels of physiological activation observed in wakefulness (LaBerge et al., 1986). An fMRI case study reported an LD-linked over activation of different cortical regions compared to non-lucid REM sleep (Dresler et al., 2012). In contrast to the desynchronized electrophysiological activity linked to the recall—and thus presumed experience—of non-lucid dreams (D'Atri et al., 2019; Scarpelli et al., 2020; Siclari et al., 2017), EEG studies have reported increases in the power of the gamma bands (especially in the frontal region) and the global coherence of the signals during lucid dreaming (Voss et al., 2009). Since these neurophysiological activity patterns are shifted towards those observed in wakefulness, it has been suggested that LD constitutes an intermediate or hybrid state between REM sleep and waking (Voss et al., 2009, 2018). However, more recent research has questioned these results, attributing increases in EEG gamma activity to artifacts stemming from eye movements (Baird et al., 2022; Demirel et al., 2024), and also other studies challenge the hybrid-state notion by demonstrating greater muscular atonia and greater reflex suppression during lucid vs. non-lucid REM (Brylowski et al., 1989; Dodet et al., 2015).

Despite the biological function of REM sleep not being unequivocally established (Peever and Fuller, 2017), this conception of LD as an alteration of normal REM has prompted some authors to hypothesise that LD could disrupt the function of REM sleep (Vallat and Ruby, 2019). REM sleep and associated mental activity can be considered a multifunctional process (Dresler, 2015), with roles such as aiding in problem solving or keeping the brain in a sentinel state that facilitates the detection of dangerous stimuli. Another prominent function that is ascribed to dreams is to serve as a simulation of the real world. In the context of this latter function, two prominent theories arose: The Threat Simulation Theory (TST) and the Social Simulation Theory (SST) (Revonsuo, 2000; Revonsuo et al., 2016). The TST postulates that dreams may serve to safely simulate threatening events to train the dreamer on how to react to them if presented in the real world. Similarly, the SST focuses on the simulation of social interactions outside of threat situations and hypothesizes that dreaming about social interactions aids in building stronger social bonds (Zink and Pietrowsky, 2015). Importantly, the effectiveness of this training for the real world relies on the dreamer being fully engaged with the environment presented to them (Dresler, 2015). In consideration of two characteristic features of LD—dream awareness and dream control (Dresler et al., 2014; Holzinger, 2009; Voss et al., 2013)—the realization that the current experience constitutes a dream state might render the simulation of certain actions, such as conflict resolution, less relevant. Moreover, the ability to modify the dream proceedings allows the dreamer to escape threat situations or transform social situations in the dreamer's favour, which cannot be meaningfully transferred to real-world situations during wakefulness. This does not occur in non-lucid dreams since, by definition, they are characterised by the failure to reflect on the state of consciousness. Thus, any disruption of the perceived immediacy may prevent the dreamer from fully engaging with the dream situation and thereby interfere with the preparatory role of dreams.

A further dominant theory that is worth considering in the context of LD assumes that REM sleep plays an important role in emotion regulation. By activating and recombining episodic memory elements and emotional expressions, REM sleep is theorized to regulate overall affective processing and support mechanisms like fear memory extinction. In line with that, REM sleep has been linked to activity in several brain networks that are implicated in emotion regulation. Specific relevance has been attributed to changes in amygdala-related networks, which are involved in modifying memory processes by strengthening or weakening negative affective information (Genzel et al., 2015; Levin and Nielsen, 2009). Since the neural activity underlying LD differs from normal REM sleep, it might interfere with the neurophysiological processes involved in emotion regulation and associated memory processes during REM sleep. Moreover, similar to its potential impact on simulating waking experiences, dream awareness might also prevent the overall engagement with and the expression of emotions during the dream state. As a consequence, LD might lessen the impact of re-experienced episodic memory elements and thereby further interfere with emotion regulation processes during REM sleep.

However, although the argument that lucid dreams may disrupt the function of non-lucid dreams and REM sleep is theoretically plausible

and deserves further investigation, it must be highlighted that dream lucidity rarely lasts longer than a few minutes or up to a quarter-hour even in experienced lucid dreamers (LaBerge et al., 1986; Stumbrys et al., 2014). Hence, since the majority of REM sleep time is still employed in non-lucid dreams even among regular lucid dreamers, it is unlikely that dramatic negative effects will arise because of sporadic dream awareness per se. Further below, we will review risks associated with the frequent implementation of LD induction techniques.

4. Lucid dreaming in the context of clinical populations or symptoms

LD has often been considered a rare oddity of sleep, subject merely to academic curiosity. Over recent years, however, ties between dream lucidity and different pathological states became increasingly apparent. In parallel, the therapeutic potential of LD induction and the associated risks have been pointed out. These connections between LD and different disorders or conditions will be compiled in this section.

4.1. Recurrent nightmares

4.1.1. Definition and connection between nightmares and lucid dreaming

Nightmares are defined as vivid and highly dysphoric dreams. During a nightmare, terror and fear are commonly experienced, although other unpleasant feelings such as sadness or anger may also occur. These negative feelings appearing during nightmares are of such an intensity that the dreamer may wake up (Levin and Nielsen, 2009). Posttraumatic nightmares, which closely resemble or share elements with a witnessed traumatic event and may be co-occurring with other post-traumatic stress disorder (PTSD) symptoms, can be distinguished from idiopathic nightmares, where the content of the nightmares is unrelated to any actual experiences (Gieselmann et al., 2019). Compared to LD, nightmares are a more prevalent alteration of normal dreams. Results differ among different studies but the proportion of individuals who never experience nightmares ranges from 17 % (Levin, 1994) to 42 % (Schredl, 2010). When nightmares occur sporadically, as is the case for most nightmare sufferers, the associated disruption of normal sleep is minimal. However, a small but relevant fraction of the population (3.5 %–8.3 %) reports suffering from frequent nightmares and, as such, can be diagnosed with nightmare disorder. Regardless of comorbidities or the aetiology, nightmare disorder is associated with a wide variety of symptoms including, among others, insomnia, daytime sleepiness, depression, poor academic performance and higher suicide risk (Gieselmann et al., 2019).

The connection between LD and nightmares has been studied repeatedly (reviewed in de Macêdo et al., 2019). While normal dreams frequently occur also during the NREM phase, nightmares—just like LD—typically arise during REM sleep (Levin and Nielsen, 2009). Relatedly, both nightmares and lucid dreams tend to be more common towards the end of the sleep cycle. This is explained by the fact that the length of the REM phase is increased in every subsequent sleep cycle thereby increasing the chances of a REM-related event (Fisher et al., 1970; LaBerge et al., 1986). Different studies also found an association between LD frequency and nightmare frequency. In a survey about dream behaviour, the proportion of responders reporting nightmare occurrences was higher among those who also reported occasional dream awareness, compared to those who never became self-aware while dreaming (9 % vs 4 %, N = 1000) (Stepansky et al., 1998). In addition, a different study showed that a factor constituting several specific dream experiences, including nightmares, was significantly associated with an LD factor in two large samples (Watson, 2001). Another investigation in both a student (N = 444) and a general population sample (N = 1380) similarly showed that lucid dreamers had a higher nightmare frequency and suggested that those nightmares may be behind the observed detrimental effects on sleep quality rather than lucidity itself (Schadow et al., 2018). In line with these findings, a survey-based study with N = 1332 indicated that while lucid dreaming initially appeared to be linked to poor sleep quality, this association disappeared after accounting for nightmare frequency, highlighting nightmares as the primary factor affecting sleep quality (Carr et al., 2024). Importantly, comparable results were also observed in a different study even when data were corrected for general dream recall frequency (Schredl and Erlacher, 2004). Interestingly, in another study, more than a third of war veterans suffering from nightmares reported having frequent lucid dreams, a figure significantly higher than that observed in non-clinical populations (Vona et al., 2015).

Several hypotheses have been suggested to explain this correlation between dream lucidity and nightmares. One of them explores how nightmares are often a lucidity trigger (i.e., the strong emotional content of nightmares serves as the cue that causes the dreamer to become self-aware of their dream state). For example, a study found that the first lucid dream experiences often originate from nightmares (Stumbrys et al., 2014). An alternative hypothesis postulates that the increased physiological arousal observed both during nightmares and lucid dreams may instead explain the co-occurrence of both REM-linked events (Schredl and Erlacher, 2004). However, the cross-sectional nature of these studies prevents from elucidating any potential causality between LD and nightmare frequency (Schadow et al., 2018; Schredl and Erlacher, 2004; Stepansky et al., 1998). On the one hand, this finding is in line with numerous subjective reports of nightmares being the trigger of dream awareness, pointing towards nightmares as being (partly) responsible for dream lucidity—although the apparent correlation may simply be the result of a higher dream recall that would increase reports of both nightmares and lucid dreams in selected individuals (Levin, 1994). Notably, however, dream recall and nightmares both loaded on a general sleep and dream experiences factor in one of the studies mentioned above, whereas LD constituted a separate factor, suggesting that lucidity has some unique features that cannot be explained by nightmares or dream recall alone (Watson, 2001). Finally, the evidence of a correlation between nightmares and LD was obtained using retrospective questionnaires vulnerable to recall bias (Schredl and Erlacher, 2004). Therefore, daily dream diaries or reports should be used in this context to minimize recall issues.

However, in a recent cross-sectional study comparing experienced lucid dreamers using LD training techniques and a naïve group, a correlation between lucid dream frequency and nightmare frequency was found only in the naïve sample (Tzioridou et al., 2022). Among experienced lucid dreamers, there was a negative correlation between lucid dream frequency and nightmare distress, suggesting less distress during nightmares for frequent lucid dreamers. Additionally, the practice of LD induction techniques was linked to lower nightmare frequency and distress in the experienced group. It is worth noting that the experienced group also practiced meditation and had higher mindfulness scores, potentially contributing to better emotional regulation during or after nightmares (Tzioridou et al., 2022).

4.1.2. Lucid dreaming as a therapy for nightmares

Shortly after the first scientific studies on lucid dreams, researchers began to hypothesize on the potential role of dream awareness in the treatment and management of recurrent nightmares. The rationale behind the potential therapeutic use of lucid dreams was that if an individual were to become self-aware of their dream state while in a nightmare, the associated strong negative feelings would likely cease as the dreamer would no longer be under the impression of being in immediate real danger. Additionally, if on top of achieving self-awareness, the dreamer would also gain dream control, they could alter the nightmarish elements of the dream into more pleasant ones or choose to wake up altogether (LaBerge and Rheingold, 1990; Spoormaker et al., 2006). Altering the end of a nightmare may be similar to beneficial exposure, whereas spontaneously waking up from a nightmare may resemble anxious avoidance of a feared situation (LaBerge, 1985; Tholey, 1988). Notably, the ability to intentionally wake up from a lucid dream has

shown promising results, with a recent study showing high success rates among healthy individuals (Sandell et al., 2024). This suggests that intentional waking could potentially serve as an effective tool in lucid dreaming therapy (LDT) for nightmares (Sandell et al., 2024). However, this approach does not eliminate the potential sleep disturbances associated with waking during the night. Moreover, the notion of enacting a different ending to the frightening scenario is similar to the non-dream based therapeutic intervention of Imagery Rehearsal Therapy (IRT), which is useful in chronic nightmare treatment (e.g. Kellner et al., 1992; Krakow and Zadra, 2010). Unsurprisingly, this use of dream lucidity as a tool to alleviate nightmares is considerably popular among lucid dreamers: an online survey reported that 63.8 % of responders have used dream lucidity to change a bad dream into a pleasant one (Schädlich and Erlacher, 2012). A study in narcoleptic patients obtained comparable results, with up to 70 % of narcoleptic patients with frequent LD reporting that dream awareness provided relief during nightmare episodes (Rak et al., 2015). Given the availability of techniques to induce dream lucidity in non-spontaneous lucid dreamers (Stumbrys et al., 2012), several studies have explored the use of LD induction therapy in clinical populations suffering from recurrent nightmares (reviewed in de Macêdo et al., 2019). Whereas some of them were performed only in the context of idiopathic nightmare disorder, other studies focused on nightmares triggered by PTSD, or both idiopathic and PTSD-induced cases.

Early studies to explore the use of LD induction techniques in the treatment of nightmares worked mostly with small samples. For instance, a case series published in 1997 described the results of using lucid dreaming therapy (LDT) for the treatment of post-traumatic or idiopathic frequent and recurrent nightmares in five unrelated individuals (Zadra and Pihl, 1997). All of them were instructed to employ a feature of their repetitive nightmares as a cue to trigger lucidity and, once achieved, use it to change the nature of the nightmare into a more pleasant one. In the follow-up, four of the test subjects reported that the repetitive nightmare had ceased completely and, while still occurring in one of them, it did so less frequently and was perceived as less frightening. Interestingly, in two of the cases, the content of the repetitive nightmare was altered despite lucidity not being achieved (Zadra and Pihl, 1997). A comparable study used the same paradigm in eight different nightmare sufferers (Spoormaker et al., 2003). In this case, two months after the introductory LDT session, the average number of nightmares per week had dropped, with what seemed to be a clinically meaningful effect size (baseline 2.31 $\pm$ 3.56, post-intervention 0.88 $\pm$ 1.13), however, given the small sample size, without being significant. Additionally, out of the six participants that reported fewer nightmares after the intervention, three of them reported having lucidly changed their nightmare. Similar to the first study (Zadra and Pihl, 1997), three of them reported that the nightmares had changed without the involvement of lucidity (Spoormaker et al., 2003).

Several case studies support these findings. The disrupted sleep of a psychiatric patient caused by recurrent disturbing dreams improved significantly after successful training of LD. However, it is unclear if this improvement was due to the LDT or to any of the other simultaneous therapeutic interventions (Been and Garg, 2010). In another case report, LDT strongly reduced nightmare frequency in a chronic nightmare disorder patient who had remained refractory to numerous other treatments (Tanner, 2004). Although it is not possible to objectively assess if LDT rather than another concomitant treatment was behind the observed positive effects, the patient reported her subjective belief that LDT was the key driver in her improvement. Additionally, a case series of war veterans suffering from nightmares and PTSD report the case of an individual who was able to overcome a recurrent nightmare after gaining lucidity during the dream and facing the disturbing character within it (Coalson, 1995). In another series of case reports (Halliday, 1988), it was described how several nightmare sufferers were not able to change the dream environment as a whole, but succeeded at making smaller changes (e.g., changing the colour of an object), which considerably improved their experiences. On the other hand, one subject reported lucidity without any control of the dream, which worsened her nightmare episodes.

In a cross-sectional pilot study (Spoormaker and van den Bout, 2006) 23 subjects suffering from nightmare disorder (with or without PTSD) were allocated to three intervention groups: group LDT , individual LDT, and waiting list (control). The intervention consisted of a two hour-long session in which test subjects—both group and individual LDT subjects—were introduced to the concept of dream lucidity, were taught about the capacity to influence the dream environment, and were given some tips on how to achieve dream awareness. Twelve weeks after the intervention, nightmare occurrence in the previous seven days was assessed. While nightmare frequency in the control group remained unchanged, both treatment groups reported a modest but significant reduction in nightmare frequency when compared to baseline. Notably, nightmares were reduced in subjects of both treatment groups even when LD did not occur, indicating once again that achieving lucidity is not critical for the effectiveness of LDT. It is worth mentioning that even when nightmares were reduced, no changes were observed in sleep quality or other PTSD symptoms, although this may be explained by the low PTSD symptoms presented at baseline. In a different controlled trial (Holzinger et al., 2015), frequent nightmare sufferers were recruited and allocated to two treatment groups: 1) Gestalt Therapy (GT; a holistic and present-centered approach) or 2) GT + LDT. Both interventions took place weekly over the course of 9 weeks. Nightmare frequency was assessed at the end of the intervention and again 3 months later (follow up). A modest but significant reduction in nightmare frequency and an improvement in sleep quality was observed in both groups. Despite the final results being comparable between the groups, subjects in the GT+LDT group were more engaged with the therapy and experienced the positive effects sooner, providing some advantage to GT+LDT over the GT alone. Nevertheless, the lack of an (untreated) control group casts some doubts on whether the observed reduction in nightmare frequency is indeed caused by the intervention (i.e., tested subjects were not blinded to the purpose of the project and the simple participation in an "experimental therapy" could be enough to ease anxiety and nightmare frequency). The same authors performed another study (Holzinger et al., 2020) in which they measured the effect of LDT in a variety of mental health parameters (including nightmare frequency) in a sample of PTSD patients. Volunteers were divided to an intervention (weekly group LDT for six weeks) and a control group. Compared to baseline levels, a reduction in anxiety and depression markers was observed in the LDT group, while the rest of the mental health markers did not change. Likewise, nightmare frequency remained constant. These results seem to indicate that while LDT may provide some relief for PTSD patients, it does not do so via a reduction in nightmare occurrence. However, this research should be analysed critically. Apart from limitations typically observed in studies exploring LDT (high drop-out, relatively short intervention and low LD success), the authors reported others that are specific to this study: the sample was identified as inhomogeneous, and most participants already presented low nightmare frequency at baseline and a comorbid substance disorder (Holzinger et al., 2020). A similar study (Lancee et al., 2010) with a sample before the intervention of N = 278, measured whether LDT in combination with IRT was more effective at reducing nightmare frequency than IRT alone. Participants were assigned to three self-help intervention groups (IRT, IRT in combination with sleep hygiene or IRT in combination with LDT) and a control group (waiting list). Outcomes were measured by using questionnaires and dream diaries. Although a reduction in nightmare frequency was observed across all three treatment regimes, the difference to the control group was significant only in the IRT group, showing that LDT added no benefits to IRT alone. These results should, however, be interpreted with caution due to the low statistical power of the study and a high dropout rate (questionnaires and diaries were only returned to the researchers by 26 % and 17 % of the initial study subjects, respectively). Additionally, regarding the effects of LDT, it should be noted that

participants were only provided a short written guideline on how to achieve lucidity (which may be challenging without face-to-face interaction with a professional) and the authors do not report if volunteers actually achieved dream awareness or improved dream control (Lancee et al., 2010).

In contrast, a recent pilot study used a more intensive approach to facilitate healing via LD in PTSD sufferers (Yount et al., 2023). A total of 49 adults experiencing PTSD, determined through self-report on the PTSD Checklist (PCL-5) for Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5, American Psychiatric Association, 2013) were recruited to participate in a 6-day online workshop, consisting of 22 hours of live instruction and group activities. The instruction included mindfulness practices, sleep hygiene principles, practices to increase dream recall and various lucid dream induction techniques. Activities included guided meditations, yoga nidrâ (see Section 5.1. below), dream sharing, lucid dream and dream planning exercises. A majority of the participants (n = 37) achieved at least one lucid dream over the course of the workshop and over a half of the participants (n = 25) enacted their intended lucid dream healing plan. At the end of the workshop, PCL-5 scores had decreased significantly compared to PCL-5 scores retrieved at the onset of the workshop (from 43.4 ± 12.2–23.9 ± 13.7). Moreover, the benefits were retained at a 1-month follow-up. The same significant effects were observed for nightmare experience scores: 9.3 ± 4.2 at the beginning, 6.7 ± 4.1 at the end, and 7.1 ± 4.4 at the follow-up. In exploratory analyses, some effects consistent with a pattern of stress reduction were observed in the salivary alpha-amylase biomarker (Yount et al., 2023). However, it is difficult to determine the extent to which lucidity specifically, rather than unspecific factors (e.g. mindfulness, sleep hygiene, group interactions) is the underlying root of improvement.

A series of studies carried out on military veterans with PTSD and frequent nightmares have also addressed the effects of LDT in a more indirect way. In this context, a study tested the efficacy of components of Cognitive-Behavioral Therapy for Insomnia protocol (cCBT-I) over the course of 6 weeks (1 hour per week) and compared this group to a combination of IRT and cCBT-I (Harb et al., 2016). After the treatment, self-report measurements from military veterans in the combined group showed increased dream control (but unchanged dream awareness) when compared to the cCBT-I group, which was significantly correlated to a decline in nightmare-induced distress (Harb et al., 2016). Despite presenting a small sample size (N = 33 with 7 dropouts), this study again suggests that dream control—rather than dream awareness—may underlie the positive effects of LDT observed in nightmare sufferers. This corresponds with findings from non-clinical samples suggesting that dream control, rather than awareness, is the factor associated with well-being (Aviram and Soffer-Dudek, 2018). Moreover, the researchers propose that IRT may help achieve this control during wakefulness and transferring it to the LD state (Harb et al., 2016). Interestingly, participants in this study showed higher LD frequency accompanied by low dream control already at baseline, a pattern that was also reported in another study (Harb et al., 2017). The latter found that more dream awareness during nightmares does not directly translate into more dream control, at least in this specific population (N = 32)—while 84 % of veterans with PTSD reported awareness during nightmares, only 24 % were able to achieve dream control (compared to 54 % and 22 % in non-nightmare dreams, respectively). These results have recently been confirmed in another study on military veterans with PTSD (Miller et al., 2021), in which 75 % of participants experienced frequent awareness during nightmares, compared to 26 % that reported frequent control (65 % and 35 % in non-nightmare lucid dreams, respectively). Notably, these findings again correspond with findings from non-clinical samples, attesting to the probable dissociation between dream awareness and dream control, which will be discussed below.

In summary, findings on the effectiveness of LDT as a treatment for nightmares are somewhat inconsistent. On one hand, all case reports and case series analysed indeed pointed towards a positive effect of LDT in terms of a reduction in nightmare frequency and intensity. A pilot uncontrolled study also showed significant reductions in nightmares and PTSD symptoms (Yount et al., 2023). On the other hand, these findings were only partly confirmed after the implementation of better powered and controlled trials. Out of the four analysed controlled trials for the treatment of nightmares, one of them reported a strong reduction in nightmare frequency after LDT implementation (Spoormaker and van den Bout, 2006), two reported that LDT offered mild to no benefits over a different behavioural therapy (Holzinger et al., 2015; Lancee et al., 2010) and one reported no effect in nightmare frequency (Holzinger et al., 2020). Importantly, results from both the case studies and controlled trials show that increasing dream control and not lucidity *per se*, seems to explain the (partial) effectiveness of LDT.

The most recent systematic review that focused on the use of LDT for nightmare treatment in adults (Ouchene et al., 2023) arrived at a similar conclusion; out of 11 included studies (some of which are mentioned above) 10 showed a positive effect of LDT in reducing nightmare frequency (up to 50 %) and severity, with long-lasting effects after just a few sessions. However, caution is advised when interpreting these results, as the authors suggest, due to the low level of evidence represented by case series and reports, as well as the low internal validity of the included randomized controlled trials. The lack of external validity assessment and the risk of publication bias from only including published reports are also potential limitations. Additionally, the clinical relevance of the results may be questioned as the studied populations excluded individuals with psychiatric comorbidities and sleep disorders, even though nightmares are more common in such patients. Overall, while LDT shows promise for nightmare treatment, more comprehensive and rigorous studies are required to assess its true therapeutic value (Ouchene et al., 2023).

4.1.3. *Proposed neural mechanisms of lucid dreaming therapy*

The (partial) success at using LDT to treat nightmares prompted researchers to further investigate the underlying mechanism behind the observed effects. Two concepts of behavioural psychology were applied in order to explain both the aetiology of nightmares and the role of LDT: fear conditioning and fear extinction. Fear conditioning refers to the observed strong association that arises between two seemingly independent stimuli (one innocuous and one aversive) after simultaneous exposure. This association is seen in the form of a fear response that arises upon subsequent exposure to the innocuous stimulus, even in the absence of the aversive one. Similarly, fear extinction refers to the gradual disappearance of said fear response after repetitive exposure to the innocuous stimulus in the absence of the aversive one (i.e., dissociation) (Myers and Davis, 2007). In humans, fear extinction is utilized to decrease the affective tone of traumatic memories, and disorders characterized by high levels of anxiety such as PTSD are believed to be caused by a disruption of this fear extinction process (Maren and Holmes, 2016). The same disruption of fear extinction is also theorised to be the cause of nightmares (Gieselmann et al., 2019; Nielsen and Levin, 2007).

At a neural level, structures such as the amygdala, the hippocampus and the prefrontal cortex are currently considered to play a key role in fear processing and extinction (Herry et al., 2010; Loos et al., 2020). Importantly, the changes observed in these brain areas during fear extinction are also observed during REM sleep, suggesting that this sleep stage may participate in fear extinction (Genzel et al., 2015). During nightmares, this activation pattern has been suggested to be disrupted in the form of a higher activation of the amygdala and the hippocampus coupled with a failure of the prefrontal cortex to counteract said hyperexcitability (Holzinger et al., 2020). Of note, patients with bilateral amygdala lesions experience more pleasant dreams than healthy controls (Blake et al., 2019). During LD, increased activation of the lateral prefrontal cortex can be observed, which in turn might modulate the nightmare-linked hyperexcitability of the amygdala, and it has therefore been hypothesised to drive the reduction in nightmare frequency and

intensity after LDT (Dresler et al., 2012).

4.1.4. Lack of control and lucid nightmares as limitations of lucid dreaming therapy

Besides its defining feature of dream insight, several different factors have been identified that can fluctuate within a lucid dream, of which dream control can be considered the second-most prototypical (Voss et al., 2013). Control can be further separated in two categories: content control (i.e., willingly altering the dream proceedings) and the capacity to wake up. Importantly, these lucidity factors are independent of each other, meaning that dream insight may exist without dream control (Harb et al., 2016), and vice versa (Purcell et al., 1986). The interplay between these factors highlights the complexity of lucid dreaming, as varying degrees of awareness and control can coexist or occur independently. Most authors describe a state in which individuals question whether they are dreaming as pre-lucid (Green, 1968; Schredl, 2013; Windt, 2018). Other researchers suggest that dreams in which there is awareness of the dream state, but not an understanding of the ability to make choices and act intentionally, should also be classified as pre-lucid (Ableidinger and Holzinger, 2023). Yet some scholars have suggested classifying as LDs only those cases that include a conceptualization of the dreaming state (e.g., thinking about being currently in a dream) (Noreika et al., 2010; Windt and Metzinger, 2007). From this perspective, dream awareness is considered the key element to define a lucid dream, whereas dream control is less essential and can therefore be considered subordinate to dream insight (Aviram and Soffer-Dudek, 2018; Noreika et al., 2010; Voss et al., 2013; Windt and Metzinger, 2007). In a Brazilian sample (N = 3427), the proportion of responders who reported being able to achieve dream control rarely, very rarely or never, accounted for 45.3 % of all lucid dreamers (Mota-Rolim et al., 2013). Another study in a German sample of frequent lucid dreamers (N = 528) reported that control of the dreamer's "dream body" was achieved in 65 % of the lucid dreams, whereas control of the dream environment (i.e., elements "external" to the dreamer) only occurred in 40 % of lucid dreams (Stumbrys and Erlacher, 2017b). According to another study (Aviram and Soffer-Dudek, 2018), there were about five times more students reporting that most of their lucid dreams were not controlled than there were students reporting that most of their lucid dreams were controlled (Aviram and Soffer-Dudek, 2018). In another study, only 37 % of children and adolescents were regularly able to change or control events in their LD (Voss et al., 2012). These findings, combined, point to the importance of assessing insight and control separately, both in non-clinical samples and in the context of the potential effects of LDT on clinical samples.

This combination of dream insight with limited dream control may lead to the emergence of the so-called lucid nightmares. Lucid nightmares are disturbing and emotionally negative dreams in which the dreamer is self-aware of the oneiric state but remains unable to change the unpleasant dream plot and/or to deliberately wake themselves up from it (Stumbrys, 2018). In contrast, findings from a study with a Chinese adult sample of N = 249 propose that lucid nightmares may not simply be the product of dream insight with limited control. Instead, they suggest that lucid nightmares could serve as a hybrid state that propels the transition from a nightmare to a lucid dream (Wong and Yu, 2022). Different estimates have been given regarding the prevalence of lucid nightmares among lucid dreamers, ranging from 7 % of all reported lucid dreams in a sample of frequent lucid dreamers (Stumbrys, 2018), to 16 % in a sample of spontaneous lucid dreamers not familiar with any LD induction technique (Schredl and Bulkeley, 2020b). Importantly, despite the dreamer awareness of the unreality of the situation, lucid nightmares are perceived as distressing as normal nightmares (Stumbrys, 2018) or even more distressing (Halliday, 1988), and they may also induce a carry-over effect of negative emotions to the waking life (Konkoly and Burke, 2019; Stumbrys and Erlacher, 2016).

While these limitations of LD are presented mainly based on findings from non-therapeutic contexts, it is important to note that LD as a self-initiated practice without the guidance of a trained professional (outside of the formal structure of LDT) can introduce additional challenges. To the best of the authors' knowledge, neither the phenomenon of LD without control nor lucid nightmares have been specifically examined in the context of LDT. This lack of research makes it challenging to determine whether these issues arise during LDT or if they would have any negative consequences within this therapeutic approach. However, patients with nightmares could be particularly vulnerable to experiencing lucid nightmares, and therefore, professional care is needed when initiating LDT. This limitation points to the need for more targeted studies focusing on the potential adverse effects of LD in therapeutic settings, particularly for nightmare disorders.

4.1.5. Other limitations of lucid dreaming therapy

Since LDT appears to work similarly to IRT (Harb et al., 2016), and larger controlled trials struggle to replicate the findings of case studies, it has been questioned whether LDT offers any advantage over already established therapies like IRT that have received stronger scientific support and are not linked to any detrimental effects on sleep quality (Aurora et al., 2010; Soffer-Dudek, 2019). Despite this, it must be highlighted that the rationale behind IRT makes it only suitable to treat recurrent nightmares or nightmares that share some key features. Therefore, in the case of non-repetitive recurrent nightmares, LDT, to the extent that its effectiveness would be established, has the potential to be a more appropriate treatment regimen since it can be induced regardless of the dream proceedings and provides a more versatile tool that requires less targeted training (Holzinger et al., 2015; Zadra and Pihl, 1997). LDT may additionally serve as a potential valuable tool when more classical nightmare-disorder therapies fail to reduce nightmare frequency (Tanner, 2004). Another benefit that arises from using LDT over IRT is the opportunity to fully engage within the dream imagery. One study found in this context that threatening dream figures are more prevalent in nightmare sufferers who also tend to perform more avoidance behaviours (escaping, flying away) when encountering them (Stumbrys and Erlacher, 2017a). On the other hand, threatening dream figures are less prevalent in more frequent lucid dreamers (who might have better dream control), as they present less avoidance but more confrontational and resolutive behaviour. The authors speculate that these threatening figures may represent some internal conflicts of the dreamer—when these conflicts are avoided, they tend to repeat (giving rise to more frequent threatening dream figures and nightmares); when they are resolved in the lucid dream (the dreamer confronts the situation and seeks resolution), they subside (Stumbrys and Erlacher, 2017a). In that aspect, being able to fully engage within the dream may provide LDT an advantage over IRT procedures, as it may help to resolve some inner conflicts and potentially decrease the frequency of nightmares. Nevertheless, LDT would need to be focused on achieving dream control (rather than insight) to benefit from this, given that in many cases, lucid dreamers cannot control their LDs (Aviram and Soffer-Dudek, 2018; Stumbrys and Erlacher, 2017b). The idea that LD induction techniques can also give rise to lucid dreams that lack dream control, which is critical for a successful LDT in nightmare disorders, is one of the reasons why some authors have questioned the expedience of this type of novel treatment for nightmares (Soffer-Dudek, 2019). Further, while one study found that a large proportion of narcoleptic patients with experience in LD felt relief when they achieved lucidity during nightmares (70 %) (Rak et al., 2015), another study reported that only 11 % of PTSD patients found relief after becoming lucid during the nightmare (Miller et al., 2021). The latter found no more self-reported distress when experiencing lucid vs. non-lucid nightmares, suggesting that dream insight does not worsen the experience of a dream with no control, yet one study reports the case of a woman in which dream insight alone, accompanied by lack of dream control, triggered even more panic as she worried about not being able to wake up (Halliday, 1988). A recent study has shed light on the link that seems to exist between dream control and emotionally negative dream experiences (Mallett et al., 2022). In this

study, researchers analysed user accounts from a lucid dream discussion forum and found that both insight and high control in a dream are associated with overall positive experiences. However, failed attempts to achieve LD or dream control can trigger distressing dysphoric dreams, sleep paralysis and, reality confusion and sleep disruption after false awakenings. These results support the idea that negative outcomes in the context of LDT may appear mainly as a result of failed induction or due to an inability to reach high levels of control within the lucid dream.

In summary, there is some preliminary support in favour of the usefulness of LDT for the treatment of chronic nightmares, but more systematic research is needed, and there is no convincing evidence suggesting that LDT is preferable to other established methods such as IRT (if applicable). The recent inclusion of LDT as a first-line treatment for nightmare disorder in a position paper by the American Academy of Sleep Medicine (Morgenthaler et al., 2018) might thus be seen as based more on the plausible working mechanism of LDT than on unequivocal empirical evidence. Of note, different studies (Spoormaker et al., 2003, 2006; Zadra and Pihl, 1997) suggest that therapeutic gains achieved through LDT do not necessarily rely on lucidity *per se*, as participants in these studies improved regardless of successfully achieving lucidity. Possibly, therapeutic gains were attributable to the imagined altered ending the participants may have envisioned during waking, when preparing for what they will do in their LD; this preparatory action would be quite comparable to IRT. Alternatively, it is possible that merely knowing that nightmares can be controlled and altered could reduce anxiety. Therefore, more research is needed to firmly establish the efficacy and expedience of LDT.

4.2. Depression and anxiety

4.2.1. Definition and connection with lucid dreaming

Depression and anxiety are two distinct but regularly co-occurring disorder groups that are escalating positions among the most prevalent mental disorders worldwide (Tiller, 2013). As stated by the DSM-5 (American Psychiatric Association, 2013), depressive disorders are characterized by the appearance of sadness, emptiness or irritable mood that are also coupled with somatic and cognitive changes. These symptoms act as a whole, significantly affecting the individual's capacity to function. On the other hand, anxiety disorders are mainly characterized by the presence of fear (individual's emotional response to imminent threats, either real or not) and anxiety (vigilance that anticipates a potential future danger). To the best of our knowledge, three scientific articles have been published to date addressing the relationship between anxiety/depression and LD, discussed below.

A study performed on 175 students showed that LD frequency was positively correlated with depressive symptoms. Since the causal direction of the correlation could not be determined, the author proposed two theories to explain the findings: firstly, the disturbed sleep patterns that characterize depressive individuals (e.g., hypersomnia, fragmented sleep) might facilitate dream awareness. Alternatively, it was proposed that frequent LD could exacerbate underlying depressive symptomatology (Taitz, 2011). This aligns with findings from a large survey study (N = 1332) suggesting that associations between LD and heightened stress, anxiety, and depressive symptoms may be attributed to the occurrence of nightmares (Carr et al., 2024). Additionally, in this study, an interaction effect was identified, where those with more frequent nightmares showed increased depressive symptoms in association with LD (Carr et al., 2024). These results are inconsistent with reports from a recent study in an online sample of 163 respondents (the majority of whom had experienced LD and depression), in which no association was found between LD frequency and depression severity (Sackwild and Stumbrys, 2021).

Lucid dreams can vary in different dimensions such as their level of control and dream insight—from vague notions to full awareness of the dream state (Noreika et al., 2010; Windt and Metzinger, 2007). To investigate the effects of different lucidity dimensions on mental health, a study of 187 students showed that although lucid dream frequency did not correlate with mental health parameters, LD intensity was inversely associated with negative outcomes (Aviram and Soffer-Dudek, 2018). Specifically, within the context of having lucid dreams, the experience of less dream control and less confidence in the lucidity state was linked to higher measures of depression, anxiety and stress. Therefore, the presence of dream awareness *per se* may not explain the previously reported correlation between LD frequency and well-being, emphasising the importance of analysing each dimension of LD independently. These findings are in line with those reported on LDT in nightmare disorders, indicating that dream control and not necessarily dream awareness may carry most of the therapeutic potential of LD.

4.2.2. Therapeutic potential of LD in depression and anxiety

The potential of LD induction to serve as a therapy for both anxiety and depression has also been studied. For example, in an online survey of 153 lucid dreamers, the majority agreed that LD helped them when they were depressed or feeling low (Sackwild and Stumbrys, 2021). Further, qualitative in-depth interviews were conducted with six lucid dreamers (who had previously been diagnosed with depression) to elucidate specific ways in which LD may have helped them to alleviate depression. The qualitative findings revealed that LD experiences have been utilized for self-exploration, creativity and empowerment, transpersonal and spiritual practices; in addition, LD empowered depressed individuals to redefine themselves, rewire negative thought patterns, integrate new life skills and creative techniques into their waking lives, and thus enabled them to develop a better relationship with their mental health (Sackwild and Stumbrys, 2021). The study, however, was retrospective. Therefore, more prospective research (e.g., controlled trial) is warranted to examine the feasibility of LDT in depressed individuals.

Furthermore, a study performed on subjects suffering from insomnia reported that LD induction caused a significant reduction in anxiety and depression parameters, on top of helping improve sleep (Ellis et al., 2020). Similarly, a study primarily targeting a reduction in nightmare frequency using LDT also reported an indirect reduction in anxiety and depression parameters in patients suffering from PTSD (Holzinger et al., 2020). Importantly, this improvement was measured even when nightmare frequency remained constant, which could be taken to mean that LDT was directly responsible for the beneficial effects. However, alternative explanations could account for the effect, such as the weekly group session provided to the LD group and not to the control group.

It has been proposed that LD induction could be employed to internalize the locus of control (see section 3.1.) and, consequently, to alleviate depression (Taitz, 2011). In order to investigate the aforementioned hypothesis as well as test whether subjects with an internal locus of control usually experience more agency and confidence, which is linked to more general well-being (Patrick and Durndell, 2004; Rotter and Mulry, 1965), Taitz recruited 175 students, divided into an intervention and control group, and asked about depressive symptomatology. A two-week-long intervention, which consisted of providing instructions about achieving lucidity using reality testing techniques, did not result in a reduction in depression scores compared to baseline. However, it must be noted that patients failed to achieve dream awareness, possibly due to a relatively short intervention. In summary, evidence for the efficacy of lucid dreaming as a treatment for anxiety and depression is somewhat mixed and should be investigated further. (Table 1)

Abbreviations: LD, lucid dreaming; PTSD, post-traumatic stress disorder

4.3. Psychosis and dissociative symptoms

4.3.1. Definition and connection with lucid dreaming

Disorders on the psychotic spectrum can be diagnosed with the presence of one or more of the following key hallmarks: hallucinations, delusions, disorganized thinking or motor behaviour, and specifically in

Table 1
Synthesis table of studies in relation to depression, anxiety and lucid dreaming.

Study	Topic	Sample/Method	Main Findings
Taitz (2011)	Depression	LD induction (n = 175)	LD frequency positively correlated with depressive symptoms. No reduction in depression after a 2-week intervention.
Sackwild and Stumbrys (2021)	Depression	Online survey (N = 163 mostly lucid dreamers), Interviews (n = 6)	No association found between LD frequency and depression severity. Lucid dream experiences can aid in self-exploration, creativity, and empowerment, helping depressed individuals reframe negative thoughts, adopt new skills, and improve their relationship with mental health.
Aviram and Soffer-Dudek (2018)	Depression and anxiety	Online study (N = 187 students) and Daily dream diary (n = 78)	No correlation between LD frequency and mental health. LD intensity, specifically dream control and confidence, inversely associated with depression, anxiety, and stress. Frequency of applying LD induction training techniques was positively correlated with depression.
Ellis et al. (2020)	Depression and anxiety in insomnia	LD induction in insomnia patients (n = 48)	LD induction led to significant reductions in anxiety and depression parameters. LD also improved sleep, suggesting broader mental health benefits.
Holzinger et al. (2020)	Depression and anxiety in PTSD	LDT for nightmares in PTSD patients (N = 31)	Reduction in anxiety and depression, even without a reduction in nightmare frequency.

schizophrenia, negative symptoms (American Psychiatric Association, 2013). Although included in a different chapter in the DSM-5, schizotypal personality disorder is also associated with this spectrum and these features. In this review, we will only focus on hallucinations and delusions given their resemblance to the dreaming state—although disorganized thinking may also be compared to the fragmentation, bizarreness, and hyper-associativity observed in the dreaming brain (Malinowski and Horton, 2015; Voss et al., 2013). Hallucinations are defined as sensory perceptions that arise in the absence of the corresponding external stimulus (e.g., hearing voices), while delusions are strong false beliefs that are maintained despite exposure to disproving unambiguous evidence (e.g., believing that someone is always observing you) (Arciniegas, 2015). Both hallucinations and delusions are believed to be the consequence of an underlying impairment in reality testing, rendering the subject unable to distinguish between what is real and what is internally generated. Relatedly, a further defining feature of psychosis that affects both hallucinations and delusions is the frequent partial or complete lack of insight into their mental state (Arciniegas, 2015; Drinkwater et al., 2020).

Similar to psychosis, during non-lucid dreams, we are also immersed in a bizarre world that is entirely internally generated, and the lack of insight into our own mental state prevents us from questioning what we perceive or feel. In fact, there is a long historical tradition of remarking the similarities between dreams and psychosis—the philosophical works of Kant, Schopenhauer and Jung are only a few examples that illustrate the close resemblance between these phenomena. In the neuroscientific field, several researchers have proposed that dreams could constitute a valuable model for the study of psychosis (Dresler, 2015; Mota et al., 2016), as they are both, essentially, altered mental states characterised by diminished insight.

While no differences could be found in the frequency of lucid dreams of psychotic patients, 67–73 % of them experienced dream control in their LD compared to just 23 % among healthy lucid dreamers (Mota et al., 2016). As a potential explanation for this observation, the authors suggested that the increased reliance on internally generated information that characterizes psychotic patients (i.e., deficits in reality testing) may, in turn, cause them to be in closer contact with their internal reality and, as such, allow them to control it more effectively. This assertion was backed by a different study on healthy volunteers, which found that deficits in reality testing correlated with higher dream control (Drinkwater et al., 2020). This can be interpreted that LD (or at least LD control) is associated with a potential blurring of sleep-wake and fantasy-reality boundaries (Soffer-Dudek, 2019).

Dissociative symptoms are another form of an altered connection to reality. Specifically, dissociative symptoms constitute a change in one's subjective experience of the world, either in the form of detachment—depersonalization (feeling oneself as strange or unfamiliar) or derealization (feeling one's surroundings as strange or unfamiliar)—or in the form of compartmentalization—the disconnection between different psychological functions resulting in dissociative amnesia and, in extreme cases, in experiencing oneself as if having distinct identities (Holmes et al., 2005). Additionally, a habitually assessed dissociative factor is the more common experience of becoming deeply and totally immersed in a stimulus or vivid daydreaming, to the point of obliviousness to surroundings, termed "absorption and imaginative involvement" (Carlson and Putnam, 1993; Soffer-Dudek et al., 2015). Dissociative symptoms are especially high in dissociative disorders, post-traumatic stress disorder, and borderline personality disorder (Lyssenko et al., 2018). There is also a close link between dissociation and the positive symptoms of psychosis, and it has been advocated that some features that are considered psychotic should be considered dissociative instead (Longden et al., 2020). Importantly, both dissociative symptoms and the trait of schizotypy (assessing schizotypal personality as a continuum) have been associated with LD using a measure conflating awareness with control (van der Kloet et al., 2012; Watson, 2001). This, alongside associations with additional dream and sleep experiences, led to the hypothesis that there exists a continuum of bizarre cognitions by day and by night (Koffel and Watson, 2009), in accordance with the continuity hypothesis of dreams (Domhoff, 2017; Schredl, 2003, 2012). A recent study (Stumbrys, 2023) looked into associations between dissociative symptoms (as measured by Multiscale Dissociation Inventory, MDI) and LD in a sample of N = 489 online respondents. The overall MDI score was neither associated with lucid dream frequency nor with more spontaneous or more deliberately induced LD. But once again, a closer look at subscales revealed a more complex picture. Specifically, LD frequency was associated with fewer memory disturbances but higher derealization. When asked about self-observed negative consequences of LD, a small proportion of lucid dreamers (about 4 %) mentioned blurring boundaries between dreaming and waking.

4.3.2. *LD as a hypothetical therapy for psychosis*

Psychotic patients typically have poor insight into the presence of their disease, often believing that there is nothing wrong with them and, as such, are more likely to show poor compliance or discontinue the prescribed treatments (Lincoln et al., 2007). Accordingly, insight has been shown to be a relevant component for disease trajectory and prognosis (Lincoln et al., 2007; Voss et al., 2018). Importantly, this seems to be the case just at the beginning of the procedure, as the

association between insight and patient's adherence to the treatment fades away over time. Similarly, instead of working toward rejecting their hallucinations and delusions, patients with poor insight may instead completely embrace them, creating a vicious cycle in which the individual becomes increasingly detached from reality (Lincoln et al., 2007).

Among the therapies designed to facilitate insight into their disease state, LD therapy has been proposed as a promising new tool (Dresler, 2015). LD, just like regular dreams, may still contain bizarre elements resembling psychosis, with the important difference of preserved awareness of the mental state during a lucid dream (Voss et al., 2013). Therefore, reaching lucidity despite of a bizarre dream environment might be equated to achieving insight in psychosis. At the neural level, a review of several EEG and fMRI studies found that some cortical areas that are hyperactive during LD (compared to non-lucid dreams) overlap significantly with those regions whose activation is disrupted in psychotic patients with lack of insight. As such, the activity of these areas (primarily in the prefrontal and parietal cortex) has been hypothesised to be important for insight during both dream lucidity and psychosis (Dresler, 2015; Voss et al., 2018). Since LDT essentially attempts to increase insight, presumably through the induction and activation of frontal and parietal cortical regions, it has been proposed that it may as well increase insight during psychosis, serving as a novel approach for disease management. While interventions targeting insight deficits in psychotic patients have successfully been implemented through other means, the specific use of LDT as a treatment for psychosis remains to be tested in future scientific and clinical studies.

4.3.3. Limitations, counterindications, and proposed risk of LD as therapy for psychosis

Apart from these hypothetical uses of LDT for the treatment of psychosis, several studies have casted some doubt on the idea that increasing dream lucidity would also increase lucidity into the psychotic state. If that were to be the case, psychotic patients, being generally characterized by a lack of insight into their disease (Arciniegas, 2015), would be expected to experience dream awareness less frequently than healthy subjects. Similarly, psychotic patients who experience LD more frequently would be expected to have fewer psychotic symptoms since their more prominent dream insight should be translated into better insight into the psychotic state. A study measuring the spontaneous LD frequency and other parameters in both psychotic patients (schizophrenia, N = 25 and bipolar disorder, N = 20) and healthy controls (N = 28) disproved both hypotheses (Mota et al., 2016). It was found that the proportion of lucid dreamers was similar among psychotic patients (schizophrenia 48 %, bipolar disorder 55 %) and healthy subjects (46 %). Importantly, it was also found that psychotic patients who experienced dream awareness more frequently did not have fewer psychotic symptoms and even performed worse than non-lucid psychotic dreamers in some parameters. These results led to the suggestion that induction of dream lucidity in psychotic patients could reinforce deliria (Mota et al., 2016). A different study demonstrated that N = 18 frequent lucid dreamers showed more reality testing deficits in a memory task than N = 13 participants reporting fewer LD episodes (Corlett et al., 2014). This links with the aforementioned association between LD frequency and derealization, in which a small proportion of lucid dreamers reported a blurring of boundaries between dreams and reality as a negative side effect of LD (Stumbrys, 2023).

Moreover, a recent study carried out in 220 young adults found a positive correlation between LD and psychosis proneness (Farooqi et al., 2022), and identified LD as a factor mediating the link between nightmares and psychosis occurrence. Although these studies were conducted in healthy participants and the correlational nature of these results does not allow to infer causality, they serve as a further warning that induction of LD may increase deliria in psychotic patients. Another study, also in a non-clinical population, showed that deliberate induction of LD was longitudinally predictive of an increase in schizotypy and dissociation symptoms (Aviram and Soffer-Dudek, 2018). Specifically, that study went beyond cross-sectional correlations by predicting within-subjects change using a longitudinal design, controlling for between-subjects baseline tendencies of the investigated symptoms. The authors showed that across a 3-month time span, those who were more intensively employing LD techniques at Time 1, had a significant Time-1-to-Time-2 increase in schizotypy, general dissociation scores, and all three dissociative subscales: depersonalization/derealization, dissociative amnesia, and "absorption and imaginative involvement", with none of these effects being explained by pre-existing symptom levels (Aviram and Soffer-Dudek, 2018). Notably, these longitudinal effects were specific to the use of induction techniques rather than LD frequency per se (cf. Stumbrys, 2023). Additionally, the latter study (Aviram and Soffer-Dudek, 2018) found that the longitudinal effect of LD induction on increases in psychopathology was specific to dissociation and schizotypy, rather than depression, anxiety, and obsessive-compulsive symptoms, which were also assessed. This led the authors to suggest that caution should be exerted before recommending using LD as a therapeutic approach, as lucid dream training techniques may possibly blur reality-fantasy boundaries (see Aviram and Soffer-Dudek, 2018, and Soffer-Dudek, 2019). For example, frequent reality testing during various waking or semi-waking states is meant to facilitate reality testing within the dream state. Such a technique promotes excessive preoccupation with one's state, which may cause confusion, similar to the well-known effect of increased obsessive-compulsive checking on uncertainty regarding reality versus imagination (van den Hout and Kindt, 2003). When considering this technique in the context of psychosis as discussed above, it raises even further questions as to the appropriateness of LDT. A person who is unsure of what is real versus unreal to begin with, may not necessarily benefit from being taught to question this several times a day.

Uncertainty following increased doubting of reality may stem primarily from the intensity of using the technique rather than from its success rate. Possibly, the success rate may be associated with positive outcomes. For example, a study conducted in a sample of lucid dreamers (Stumbrys, 2023) found that more deliberately induced rather than spontaneously occurring dream lucidity is linked with better mental well-being. So how much training is too much? A recommended threshold for LD training intensity is yet to be determined, and if such a threshold exists, it probably interacts with individual differences in traits. Another study (Soffer-Dudek, 2019) suggested that perhaps individuals with pre-existing psychopathological tendencies (e.g., psychosis-proneness) may be more susceptible to detrimental effects stemming from induction technique implementation; this may explain why the blurring of reality-fantasy boundaries was spontaneously described by a small percentage of lucid dreamers when asked about possible negative effects of LD (Stumbrys, 2023). However, to the best of our knowledge, this idea of an interaction between pre-existing psychopathological tendencies and LDT adverse effects has yet to be empirically investigated.

In a different vein of research, it has been shown that increased insight into the psychotic state, whether occurring naturally or after intervention, may in itself carry negative effects on the well-being of the patient. While increased awareness of the disease state may encourage abidance to treatment, it could also produce feelings of worthlessness and despair (Lincoln et al., 2007). Thus, although our focus here is raising a call for caution on LD induction in particular, these findings question whether increasing psychotic insight, in general, is a safe approach for the management of psychosis.

As a final remark, no specific studies have been performed to date using LDT in the context of psychosis, so it remains unknown whether this method can improve insight in psychotic patients and, importantly, if the potential benefits outweigh the potential negative side effects (e.g., increased confusion). More research on the potential risks of LDT should be conducted on healthy participants, perhaps exploring interactions with baseline schizotypy levels, to promote knowledge on the

ethical considerations of attempting to treat psychosis with LDT. Then, perhaps controlled trials on psychotic samples could be conducted to answer these questions, as they may potentially provide a novel way to improve psychosis management.(Table 2)

4.4. Sleep-wake dissociative states: the case of narcolepsy, sleep paralysis, and out-of-body experiences

4.4.1. Definition and connection with lucid dreaming

Wakefulness, NREM sleep and REM sleep are characterized by a cluster of defining neurological, physiological, and behavioural parameters. However, in some cases, some of the defining markers of one state may penetrate another, resulting in a hybrid dissociative state (Mahowald and Schenck, 1991). In other words, a dissociative state may be defined as occurring when a given state of being incorporates features from another one (e.g., a state of wakefulness that incorporates features typically observed during REM sleep). There are three different groups of such dissociative states depending on the nature of the parent state (i.e.: the state from which most features are present). Only two of them are relevant for the purpose of this review: dissociations of wakefulness and dissociations of REM (Antelmi et al., 2016; Mahowald and Schenck, 1991).

Dissociations of wakefulness are characterised by the penetration of REM or NREM sleep features into the awake state. The phenomenon of sleep paralysis is included in this category (Antelmi et al., 2016). During a sleep paralysis episode, the muscle atonia that is normally observed during REM sleep—which prevents the dreamer from acting out their dreams—arises during an apparent state of wakefulness, either just before REM sleep onset or right after REM sleep offset. Although it was thought at first that muscle atonia intruded behavioural wakefulness in sleep paralysis episodes, there is now growing evidence suggesting the presence of mixed waking-REM features in the EEG during these periods (Mainieri et al., 2021; Takeuchi et al., 1992; Terzaghi et al., 2012). As a result, the subject feels paralysed while retaining (partial) awareness of this state (Terzaghi et al., 2012). Sleep paralysis episodes are often accompanied by one of these three types of hallucinations: hallucinations involving the company of a menacing presence (intruder); hallucinations involving feelings of chest pressure, suffocation and pain (incubus) and unusual bodily experiences such as out-of-body experiences (Cheyne et al., 1999; Denis and Poerio, 2017). Another dissociation of wakefulness is cataplexy. Cataplexy also involves penetration of REM sleep-linked muscle atonia in the waking state, but in this case not necessarily around sleeping time, as it may happen at any moment of the day (usually during excitation or arousal) and leads to loss of voluntary muscle control. Cataplexy is one of the defining features of narcolepsy type 1, a broader disorder that is also characterised by daytime sleepiness, irresistible sleep attacks and faster transition to REM sleep upon falling asleep (Antelmi et al., 2016; Kornum et al., 2017; Rak et al., 2015).

On the other hand, dissociations of REM are characterized by the penetration of NREM or wakefulness features into REM sleep (Antelmi et al., 2016). LD is one of them as it is essentially a penetration of wake features (e.g., self-awareness, memory access) into a REM sleep state. Some out-of-body experiences, which can occur independently of sleep paralysis, are also considered to be REM sleep dissociations by some authors (Nelson et al., 2007; Raduga et al., 2020). During out-of-body experiences, people report the subjective experience of being located outside their physical body, either during wakefulness (e.g., during trauma, stress or other situations) and near-death experiences, or in periods close to sleep and dreaming (Blanke et al., 2002; Levitan et al., 1999; Nelson et al., 2007).

4.4.2. Lucid dreaming and narcolepsy

Different sleep-wake dissociative states tend to be associated with each other: for example, while sleep paralysis can occur in isolation, it is also relatively common in narcoleptic patients (Dauvilliers et al., 2007; Dodet et al., 2015; Kornum et al., 2017). Similarly, LD frequency has been associated with the occurrence of false awakenings, sleep paralysis, and out-of-body experiences, indicating that all these phenomena share a common core (Ableidinger and Holzinger, 2023; Cheyne and Girard, 2009; Levitan et al., 1999; Raduga et al., 2020; Stumbrys, 2023). Another association of this type found more recently is the one existing between LD and narcolepsy. A case-control study assessed the frequency of different dream-related events in two groups of both narcoleptic and healthy controls (n = 106). The authors found a higher proportion of subjects classified as frequent lucid dreamers among the narcoleptic group (58.5 % vs 17 %). Similarly, narcoleptic patients reported on average more LD events than matched controls (7.6 ± 11 vs. 0.3 ± 0.8 LD events/month) (Dodet et al., 2015). A comparable study in both narcoleptic (N = 60) and control subjects (N = 919) reached similar results: in this case, narcoleptic patients reported on average 6.9 ± 1.0

Table 2
Synthesis table of studies in relation to dissociation, psychosis and lucid dreaming.

Study	Topic	Sample/Method	Main Findings
Mota et al., (2016)	Psychosis	Psychotic patients (n = 45) and healthy controls (n = 28)	No differences in LD frequency, but psychotic patients had higher dream control (67–73 % vs. 23 %).
Drinkwater et al., (2020)	Dissociation	Online study (N = 455)	Deficits in reality testing linked to higher dream control.
Watson, (2001)	Dissociation/ schizotypy	Questionnaire study with two samples of psychology students (n1 = 471; n2 = 457)	Moderate correlations between LD, dissociation and schizotypy.
van der Kloet et al., (2012)	Dissociation	Review	Association of LD and dissociative symptoms.
Stumbrys, (2023)	Dissociation	Online survey, mostly lucid dreamers (n = 489)	LD was not associated with greater dissociation. LD frequency associated with fewer memory disturbances but higher derealization. 4 % reported blurred boundaries between dreaming and waking.
Farooqi et al., (2022)	Psychosis	Questionnaire study (n = 220)	Positive correlation between LD and psychosis-proneness, LD mediated the link between nightmares and psychosis.
Aviram and Soffer-Dudek, (2018)	Dissociation/ schizotypy	Online study (N = 187 students) and Daily dream diary (n = 78), prospective-longitudinal design	LD induction predicted increases in schizotypy and dissociation across 2 months.
Corlett et al., (2014)	Reality monitoring and psychosis	Memory task on frequent lucid dreamers (n = 18) and controls (n = 13)	Frequent lucid dreamers showed more reality testing deficits than controls.
Soffer-Dudek, (2019)	Dissociation/ schizotypy	Review	Individuals with psychosis-proneness more vulnerable to negative effects of LD induction techniques.

Abbreviations: LD, lucid dreaming;

monthly lucid dreams while healthy subjects only experienced dream lucidity 0.7 ± 0.1 times per month (Rak et al., 2015).

Different hypotheses can be formulated to explain the observed higher LD frequency among narcoleptic patients. The simplest of them points to the notion that narcoleptic patients are characterised by longer periods of REM sleep. Since LD occurs mostly during REM sleep (LaBerge et al., 1986), increasing the duration of this sleep phase would increase the corresponding REM-related events. Although this on its own cannot explain the dramatic increase in LD frequency in narcoleptic patients, it may be partly responsible in combination with other mechanisms. Another possible explanation relates to the higher prevalence of nightmares among narcoleptic patients (Dodet et al., 2015; Pisko et al., 2014; Rak et al., 2015). Since nightmares often serve as a lucidity trigger (Schredl and Erlacher, 2004), narcoleptic patients may have a dream landscape more inclined to result in dream awareness. Finally, it has also been postulated that the fragmented and disrupted sleep that characterises narcoleptic patients may produce the same effects as some LD induction techniques and, as such, be responsible for the higher LD frequency (Rak et al., 2015). A recent multi-centre study used four volunteer groups to evaluate this proposed correlation (Gott et al., 2020). The authors found that parameters such as the number of awakenings per night or having a polyphasic sleep schedule, both indicative of having fragmented sleep patterns, correlated with higher likelihood of experiencing dream lucidity. To explain these results, they proposed that a rapid wake-REM transition, as often occurs in both circumstances, may cause wake-like cortical activations to persist into REM sleep and explain the occurrence of LD. Since narcolepsy also features this sort of rapid re-entry into REM phase—also called sleep-onset REM periods, used as one of the main criteria to diagnose narcolepsy (Kornum et al., 2017; Singh et al., 2006)—, this may be the underlying physiological explanation of the observed higher frequency of LD among narcoleptic individuals. Sleep-onset REM periods may also lead to wake-initiated lucid dreams (WILDs)—a type of lucid dream that consists of retaining conscious awareness when falling asleep (either spontaneously or induced) and directly entering the dream state (Levitan et al., 1999; Stumbrys et al., 2012). To our knowledge, it has not yet been tested whether WILDs correlate with narcolepsy more than regular lucid dreams (dream-initiated lucid dreams, which arise while already dreaming); but they have been linked to sleep paralysis and out-of-body experiences (Levitan et al., 1999).

Narcoleptic patients seem to be characterized by more hybrid sleep-wake dissociative states, both those involving sleep penetrating wakefulness (as in cataplexy and daytime sleep initiation) and those involving wakefulness penetrating sleep (as in LD or nightmares). Better understanding the mechanisms behind such general obfuscating of sleep-wake boundaries is a challenge for future research. Considering the above-discussed potential usefulness of LD to deal with frequent nightmares, LD may also offer some relief for nightmares that are a frequent hallmark of narcolepsy. Given that disrupted night-time sleep (as often induced by nightmares) is positively correlated with worsening of other narcolepsy symptoms such as day-time drowsiness (Kornum et al., 2017; Pisko et al., 2014), the overall wellbeing of narcoleptic patients may also be indirectly increased by reducing nightmares (Kornum et al., 2017). Before initiating any attempts to use LD as a therapeutic approach for narcolepsy, however, it should be emphasized again that the evidence for the efficacy of LDT for nightmares in general is mixed, and in particular the efficacy (and, most importantly, safety) of this method has not yet been tested in the context of narcolepsy. The papers discussed in this review were performed in subjects suffering from isolated nightmare disorders or nightmare disorder in the context of PTSD and, to this date, we are not aware of any attempts to implement LDT for nightmare-management in narcoleptic patients. Despite this fact, the use of LD to escape from nightmare dreams has intuitively been performed by some untrained narcoleptic patients (Dodet et al., 2015; Rak et al., 2015). In one study investigating N = 53 narcoleptic patients and N = 53 healthy subjects, half of the narcoleptic patients experiencing LD were able to control their dreams, while 78 % of those subjects with dream control used LD to reduce their nightmares (Dodet et al., 2015). Similarly, another study found that a large proportion of narcoleptic lucid-dreamer patients felt relief from experiencing LD always (43 %) or at least sometimes (70 %) (Rak et al., 2015). However, these studies did not control whether participants had the spontaneous ability to achieve lucidity in their nightmares or if they purposedly followed any LD induction method to overcome these episodes. Thus, no specific studies have investigated the potential negative effects of LD techniques over narcolepsy. The implementation of LDT in narcoleptic patients may pose a risk for a population that already suffers from fragmented sleep-wake boundaries, as it might strengthen their tendency towards hybrid sleep states (Wamsley et al., 2014). This is of special importance since some lucid dreamers have reported blurring of dream-wake boundaries as a negative side effect of LD (4 % in Stumbrys, 2023), and evidence supports this, as frequent LD induction predicts a temporal increase in such blurring of boundaries (Soffer-Dudek, 2019). Additionally, LD induction may lead to poorer sleep quality, possibly exacerbating other characteristic symptoms of narcolepsy such as daytime sleepiness (Aviram and Soffer-Dudek, 2018; Konkoly and Burke, 2019; Stumbrys, 2023). Therefore, more research would be needed to determine the potential side effects of LDT in the context of narcolepsy.

Besides LDT and given the increased lucid dreaming capacity of patients with narcolepsy, a recent pilot study (Mundt et al., 2024) investigated the efficacy of Cognitive Behavioural Therapy for Nightmares (CBT-N), adapted specifically for narcolepsy, with and without the additional component of Targeted Lucidity Reactivation (TLR). TLR involves pairing sensory cues with mental reflection during wake and playing these cues during REM sleep, aiming to induce lucidity and enhance dream control. The study involved N=6 adult women with narcolepsy and frequent nightmares and found significant reductions in nightmare frequency and severity for both groups, as well as, reductions in sleep paralysis, sleep-related hallucinations and dream enactment for some participants. However, it should be noted that this is a pilot study with a small sample size, lacking a control group, along with several other limitations outlined by the authors. All these limitations underscore the necessity of further research before even contemplating suggesting TLR as an effective complementary approach for reducing nightmares and parasomnia symptoms in narcolepsy (Mundt et al., 2024).

Finally, the exceptionally high frequency of dream lucidity in narcoleptic patients has some interesting implications for the field of LD research. Narcoleptic patients, unlike healthy subjects, regularly reach REM sleep during short day time naps. Additionally, they have been shown to achieve dream awareness in these naps, among which about half of the events were signal-verified (Dodet et al., 2015). Therefore, diagnosed narcoleptic patients may serve as a pool of frequent lucid dreamers that could be recruited for further studies of dream awareness. To this day, two studies have already exploited this high frequency of dream lucidity among narcoleptics. One study demonstrated that dream mentation exerted some control over respiratory patterns during REM sleep. This research was carried out in 21 narcoleptic patients with an exceptionally high capacity for dream awareness (Oudiette et al., 2018). Similarly, another study proving that bi-directional communication during dream lucidity was possible obtained its results from, among others, a narcoleptic patient (Konkoly et al., 2021).

4.4.3. Lucid dreaming and sleep paralysis

Studies have also explored the co-occurrence of sleep paralysis and LD. An online survey on 1928 participants addressed the prevalence of sleep paralysis and LD, and its relationship with multiple sleep and well-being parameters (Denis and Poerio, 2017). The results showed a strong correlation between LD and sleep paralysis frequency. The correlation was particularly prominent in the case of sleep paralysis episodes featuring unusual bodily experiences, compared to those containing other types of hallucinations (Denis and Poerio, 2017). This could be

because out-of-body experiences during sleep—classified as unusual bodily experiences (Cheyne et al., 1999)—may often be mistaken as LD episodes (for discussion see Campillo-Ferrer et al., 2024). In addition, other unusual bodily hallucinations and sleep paralysis episodes are commonly reported at the onset of out-of-body experiences (Irwin, 1988), which may lead to overestimate the correlation between LD and sleep paralysis (and especially with unusual bodily experiences). In another outstanding endeavour, a single researcher suffering from regular isolated sleep paralysis self-recorded a total of 5761 dream events over the course of ten years. Statistical analyses performed upon completion of data collection showed a strong correlation between LD and sleep paralysis frequencies (Conesa-Sevilla, 2002). However, these results are based on a single case study, thus making generalization difficult. Recently, a street survey (N = 974) also showed that those subjects reporting frequent dream awareness were more likely to also suffer from isolated sleep paralysis episodes (Raduga et al., 2020), and another survey in N = 489 online respondents (primarily lucid dreamers), showed a significant correlation between the frequencies of sleep paralysis and LD (Stumbrys, 2023).

The possible hypotheses to explain this relation are similar to those for the link between narcolepsy and LD. First of all, sleep paralysis appears as a symptom of narcolepsy in 50 % of the cases, which indicates that both phenomena probably occur under similar conditions and share at least some features that could explain their common link with LD (Dauvilliers et al., 2007). In addition, many sleep paralysis episodes are characterized by intense fear, including intruder and incubus hallucinations—which has been considered the origin of the term “nightmare” (Cheyne, 2003; Cheyne et al., 1999; Kliková et al., 2020). Negative and terrifying experiences in the context of sleep paralysis may also act as a lucidity trigger, leading to more LD reports within this population. Although no alterations in REM sleep macrostructure and fragmentation have been found in patients with recurrent isolated sleep paralysis (Kliková et al., 2021), different studies have confirmed the prevalence of this phenomenon during sleep-onset REM periods (Mainieri et al., 2021; Takeuchi et al., 1992, 2002). Consequently, some authors have remarked that, similar to the case of narcolepsy, the presence of sleep-onset REM periods could also partly account for the correlation observed between LDs and sleep paralysis episodes (Campillo-Ferrer, Alcaraz-Sánchez, et al., 2024).

LD has been used to escape from the highly distressing experience of sleep paralysis episodes. However, it should be kept in mind that not all sleep paralysis episodes are negative: in a recent study, 23 % of participants reported having positive emotions during a sleep paralysis episode (Kliková et al., 2020). Additionally, 76.9 % of those subjects with pleasant sleep paralysis also mentioned the ability to control their hallucinations while still paralysed, suggesting that dream control might also play an essential role in the treatment of fearful episodes of sleep paralysis. In line with this, a researcher developed a technique that allowed himself to use frequent sleep paralysis episodes as a starting point to achieve dream lucidity during a ten-year long study (Conesa-Sevilla, 2002). This technique, for which he coined the term Sleep Paralysis Signalling, was composed of several steps that ultimately allowed him to transition from a distressing sleep paralysis episode to a more pleasant lucid dream. The same technique was used by another subject suffering from frequent sleep paralysis, equally allowing her to jump from threatening sleep paralysis episodes to blissful lucid dreams and out-of-body experiences (Emslie, 2014). It is important to note, different studies have shown that sleep paralysis episodes are more likely to contain positive emotions when unusual bodily experiences are experienced (Cheyne, 2003; Cheyne et al., 1999; Kliková et al., 2020). In that aspect, dream awareness and control could be used in the context of sleep paralysis in order to turn incubus and intruder hallucinations into unusual bodily and out-of-body experiences, therefore reducing the negative impact of this experience. These case reports are promising, but due to their small-scale nature, they provide only limited evidence that LD could be employed to escape from negative sleep paralysis. We call for further studies on the matter to reach solid conclusions. Importantly, concerns that have been conveyed in the literature regarding the risks of implementing induction techniques (Soffer-Dudek, 2019) may be less relevant in the case of treating sleep paralysis, because awareness may already be partially or fully present in the paralyzed state, to begin with (for discussion see Campillo-Ferrer et al., 2024). Thus, instead of teaching them techniques that may confuse sleep-wake boundaries (e.g., wake-back-to-bed, constant reality testing), the intervention could focus only on educating the patient that they can achieve dream control (by, for example, detecting cues to solidify that this is a dream).

4.4.4. *Lucid dreaming and out-of-body experiences*

LD and out-of-body experiences share many commonalities: healthy subjects who have gone through out-of-body experiences describe that they emerge during sleep paralysis, falling asleep, waking up, or while already asleep, with the additional feature that individuals have awareness of this fact (Cheyne and Girard, 2009; Levitan et al., 1999; Rabeyron and Caussie, 2016; Twemlow et al., 1982). Besides state awareness, both lucid dreamers and out-of-body practitioners are able to control their behaviour, change the ongoing plot, or have memories of waking life while in this state. Some authors suggest that out-of-body experiences arise from the same physiological conditions as LDs and are, therefore, closely related to wake-initiated LDs, but they differ mainly in how the individual interprets the experience; in OBEs, individuals tend to believe they are experiencing real, physical events, while lucid dreamers recognize that their experience is a dream (Levitan et al., 1999). In support of this notion, a recent review has pointed out the essential difference between these two phenomena: the sense of reality reported during out-of-body experiences tends to be higher when compared to LDs (Campillo-Ferrer, Alcaraz-Sánchez, et al., 2024). Thus, individuals during out-of-body experiences may become aware of the fact that they are currently sleeping, but at the same time believe that the experience of being located outside of their physical body is actually occurring – for example, by describing how their “astral body” has visited a physical space while their physical body remained asleep. Additionally, this belief may still be maintained upon waking up from this experience. In contrast, lucid dreamers are more likely to qualify this episode as only a dream (Campillo-Ferrer, Alcaraz-Sánchez, et al., 2024).

Similar to the mechanisms involved in narcolepsy and sleep paralysis, sleep disruptions might also underlie the observed link between LD and out-of-body experiences. More specifically, both REM intrusions (appearance of cataplexy or hallucinations during wakefulness, assessed by structured interviews) and sleep-onset REM periods have been found to be associated with out-of-body experiences (Levitan et al., 1999; Nelson et al., 2007). This led some authors to speculate that the sense of reality experienced during out-of-body experiences compared to LDs could be a consequence of maintaining a heightened awareness of the physical body during sleep-onset REM periods – in contrast to the heightened dream awareness experienced during wake-initiated LDs (Campillo-Ferrer, Alcaraz-Sánchez, et al., 2024).

4.4.5. *Different sleep-wake dissociative states probably share a driving mechanism*

To summarize, LD is more common in patients with narcolepsy, isolated sleep paralysis episodes, and out-of-body experiences. In some cases, one dissociative state can give rise to another (e.g.: sleep paralysis transitions to dream awareness) and in others it can be challenging to differentiate between dissociative states. An example of the latter is the case of out-of-body experiences, which can sometimes be indistinguishable from LD reports when reported in a dream state (Emslie, 2014; Levitan et al., 1999). On top of that, all these phenomena have directly been linked to sleep-onset REM periods (Kornum et al., 2017; Levitan et al., 1999; Mainieri et al., 2021; Singh et al., 2006; Takeuchi et al., 1992). Given the co-morbidities and similarities between sleep-wake dissociative states, it is probable that they all share some underlying

neural mechanism (Campillo-Ferrer, Alcaraz-Sánchez, et al., 2024; Oudiette et al., 2018; Raduga et al., 2020). One study focused on the relationship between these hybrid sleep-wake states (or a labile sleep-wake cycle) with traditional dissociative symptoms (e.g., depersonalization/derealization, memory failures), as dissociative symptoms may also be viewed as sleep elements penetrating wakefulness (van der Kloet et al., 2012). Moreover, the blurring of sleep-wake boundaries or the tendency to linger within mixed sleep-wake states is increased under stress, trauma, or psychological distress, and has been suggested as a psychopathological marker that should be screened for in clinical settings (Soffer-Dudek, 2017). Importantly, sleep paralysis is strongly associated with post-trauma (Denis et al., 2018; Mellman et al., 2008); to the extent that LD may co-occur in such cases, it may be characterized by low control, helplessness, and distress. Moreover, out-of-body experiences can also be triggered by traumatic or stressful events (Herman, 1992; Rabeyron and Caussie, 2016).(Table 3)

Abbreviations: LD, lucid dreaming; SP, sleep paralysis; OBE, out-of-body experiences.

4.5. Lucid dreaming and the Covid-19 pandemic

The COVID-19 pandemic had a profound effect on mental health, with many studies documenting an increase in anxiety, stress, and depression during this period (Lakhan et al., 2020; Salari et al., 2020). Notable findings related to our topic were a rise in lucid dream recall frequency during the pandemic (Kelly et al., 2022) and a positive correlation between lucid dreaming and depression, anxiety and covid-related anxiety assessed through an online survey (Schredl et al., 2022). These findings are likely linked to the broader impact of the pandemic on sleep behaviour and emotional states (Gorgoni et al., 2021; Kelly et al., 2022; Scarpelli et al., 2022). Social isolation, fear of illness or death, and heightened anxiety were common during the pandemic, and these factors contributed to a surge in stress levels (Canet-Juric et al., 2020; Lakhan et al., 2020), which in turn affected sleep, dream patterns and dream recall frequency (Iorio et al., 2020; MacKay and DeCicco, 2020; Mota et al., 2020; Schredl and Bulkeley, 2020a).

Research indicates that stress, combined with changes in sleep behavior during the pandemic, such as more time spent at home and increased sleep duration (Cellini et al., 2020; Wright et al., 2020), may have contributed to longer periods of REM sleep—the stage most closely associated with lucid dreaming (Kelly et al., 2022). Frequent awakenings from REM sleep, often linked to heightened stress (Kim and Dimsdale, 2007), could also increase the likelihood of dream recall and lucidity (Kelly et al., 2022). Although the specific role of stress in lucid dream frequency during the pandemic was not statistically significant, the indirect effects of stress on other sleep variables like dream and nightmare recall frequency, and overall sleep quality, cannot be overlooked (Kelly et al., 2022).

Moreover, a notable connection between nightmare recall frequency and lucid dreaming emerged during the pandemic (Kelly et al., 2022). Nightmares, which often intensified due to the collective trauma experienced during this time (Gupta, 2020), may have acted as triggers for lucidity within dreams (Adams and Bourke, 2020; Schredl and Erlacher, 2004; Stumbrys et al., 2014). The authors who found the connection, theorize that the increase of nightmares and lucid dreams during the Covid-19 pandemic may represent a potential emotional regulation mechanism, possibly aiding individuals in coping with heightened stress and anxiety (Kelly et al., 2022).

While the pandemic exacerbated mental health challenges, including anxiety and depression, the accompanying rise in lucid dreaming has been speculatively interpreted as an adaptive response (Kelly et al., 2022). However, it is plausible that the heightened stress during the COVID-19 pandemic may have led to more vigilant sleep, potentially increasing the occurrence of hybrid sleep-wake states (Soffer-Dudek, 2017). In turn, it can be conjectured that this might have increased dream awareness without necessarily improving dream control, which,

Table 3
Synthesis table of studies in relation to sleep-wake dissociative states and lucid dreaming.

Study	Topic	Sample/Method	Main Findings
Dodet et al., (2015)	Narcolepsy	Narcoleptic (n = 53) vs healthy controls (n = 53)	Higher proportion of frequent lucid dreamers among narcoleptics (58.5 % vs 17 %); narcoleptics reported 7.6 ± 11 LD events/month, controls 0.3 ± 0.8 LD events/month. 50 % of the narcoleptic patients experiencing LD were able to control their dreams, while 78 % of those subjects with dream control used LD to reduce their nightmares.
Rak et al., (2015)	Narcolepsy	Narcoleptic (n = 60) vs control subjects (n = 919)	Narcoleptic patients reported 6.9 ± 1.0 monthly lucid dreams; controls 0.7 ± 0.1 lucid dreams/month. Narcoleptic lucid-dreamer patients felt relief from experiencing LD always (43 %) or at least sometimes (70 %).
Denis and Poerio, (2017)	Sleep paralysis	Online survey (N = 1928)	Strong correlation between LD and sleep paralysis (SP) frequency, particularly with unusual bodily experiences.
Conesa-Sevilla, (2002)	Sleep paralysis	Single case study (5761 dream events over 10 years)	Strong correlation between LD and SP frequencies.
Raduga et al., (2020)	Sleep paralysis	Street survey (N = 974)	Participants reporting frequent dream awareness were more likely to experience isolated SP episodes. Using frequent SP episodes as a starting point to achieve dream lucidity.
Stumbrys, (2023)	Sleep paralysis	Online survey (n = 489, primarily lucid dreamers)	Significant correlation between the frequencies of LD and SP.
Emslie, (2014);	Sleep paralysis	Single case reports	Use of SP as a starting point to achieve dream lucidity; positive transitions to LDs and out-of-body experiences.
Kliková et al., (2020)	Sleep paralysis	Questionnaire study. Participants with recurrent episodes of SP (N = 172)	23 % of participants reported positive emotions during SP episodes, often associated with unusual bodily experiences. 76.9 % of those subjects with pleasant SP also mentioned the ability to control their hallucinations while still paralysed.

(continued on next page)

Table 3 (*continued*)

Study	Topic	Sample/Method	Main Findings
Levitan et al., (1999)	OBE	Study 1: scored content analysis of 107 LD reports Study 2: Survey (N = 604)	LDs initiated from brief REM awakenings were significantly more likely (4.4 times, $p < .02$) to be judged as OBEs than LDs initiated during uninterrupted REM sleep. Subjects who reported lucid dreams were 158 % more likely to report OBEs than subjects who did not report lucid dreams. OBEs tend to feel more real than LDs.
Campillo-Ferrer et al., (2024)	OBE	Review	It is speculated that awareness of the physical body during sleep is higher during OBEs and SP compared to LDs, which may amplify the sense of realism in these experiences.

as discussed, is the aspect more closely linked to well-being (Aviram and Soffer-Dudek, 2018). Furthermore, it is worth noting that not all studies found an increase in lucid dreaming frequency during the pandemic, and therefore the aforementioned interpretations, are not consistently supported by all findings (Koppehele-Gossel et al., 2023).

During the pandemic, higher lucid dream frequency was observed in individuals with narcolepsy type 1, with patients showing more frequent and vivid lucid dreams than healthy controls (Scarpelli, Alfonsi, D'Anselmo, et al., 2021), a finding that is similar to findings on narcolepsy and lucid dreaming in non-pandemic periods (Dodet et al., 2015; Rak et al., 2015). This increased dream activity, including lucid dreams, was linked to daytime sleepiness, possibly due to fragmented sleep, which intensified oneiric activity and impacted wakefulness (Scarpelli, Alfonsi, D'Anselmo, et al., 2021).

As lockdowns ended and restrictions were eased, the frequency of lucid dreams decreased (Alfonsi et al., 2022; Gorgoni, Scarpelli, Alfonsi, Annarumma, et al., 2022; Scarpelli, Alfonsi, Gorgoni, et al., 2021; Scarpelli et al., 2022). A study comparing periods of lockdown and post-lockdown revealed that lucid dreaming frequency, as well as overall dream intensity and emotional vividness, dropped significantly after restrictions were lifted (Gorgoni, Scarpelli, Alfonsi, Annarumma, et al., 2022). This decline in lucid dreaming likely reflects both a reduction in stress-related dream content and changes in sleep behavior as people returned to more normal routines. The high rates of poor sleep quality, anxiety, and depressive symptoms that persisted after lockdown suggest that while lucid dreaming frequency decreased, the psychological impact of the pandemic remained significant (Gorgoni, Scarpelli, Alfonsi, Annarumma, et al., 2022). This reduction in dreaming activity, including lucid dreams, highlights how oneiric content and sleep patterns are closely linked to environmental and psychological factors, particularly during times of collective trauma.

Interestingly, despite the reduction in lucid dreaming and dream intensity post-lockdown, the emotional tone of dreams remained largely negative, dominated by fear (Gorgoni, Scarpelli, Alfonsi, Annarumma, et al., 2022). According to the authors, this finding aligns with the continuity hypothesis of dreaming, which posits that waking experiences and emotions influence dream content. The persistence of negative emotions in dreams, despite improved sleep patterns, underscores the lasting psychological effects of the pandemic. While lucid dreaming frequency may have diminished as restrictions eased, the long-term impact of the pandemic on mental health remained, reflected in both waking and dream experiences (Gorgoni, Scarpelli, Alfonsi, Annarumma, et al., 2022).

In conclusion, the COVID-19 pandemic influenced mental health and sleep, leading to a rise in lucid dreaming, possibly triggered by nightmares and the changes in the sleep routine. While lucid dreaming decreased post-lockdown, the psychological effects of the pandemic persisted. For a more comprehensive discussion of these findings and their implications, refer to the narrative review that delves deeper into the relationship between dreaming in general, including lucid dreaming, and the pandemic's psychological impact (Gorgoni, Scarpelli, Alfonsi, and De Gennaro, 2022).

5. Lucid dreaming and contemplative practices

The benefits of mindfulness on health and well-being have received increasing research attention over the last two decades (Galante et al., 2021; Gu et al., 2015; Keng et al., 2011; Tomlinson et al., 2018). Different contemplative cultures and religions including Tibetan Buddhism, Taoism, Shamanism or Hinduism have extended mindfulness practices to sleep and dream states, with the objective of increasing daily awareness and well-being (Mota-Rolim et al., 2020; Norbu, 1983; Wangyal, 1998). These practices—e.g., Sleep and Dream Yoga, Yoga Nidrâ and Nahualism—are exercises usually performed during the day that help to develop lucidity during the night and perform predetermined contemplative practices. Although attaining lucid dreams is often not the main objective, it is a natural consequence of the practice (Wangyal, 1998). Given the increasingly demonstrated value of meditation-based interventions for clinical applications (Chiesa and Serretti, 2011), it is worthwhile to also explore the clinical value of such sleep contemplative practices.

5.1. Definition and connection with lucid dreaming

Sleep and Dream Yoga use LD as a tool to attain liberation from conditioned patterns, emotions and behaviours that practitioners might suffer from in their daily lives (Wangyal, 1998). In specific, Dream Yoga uses LD as a virtual scenario to perform spiritual practices and trainings. The insights obtained during the dream are intended to be transferred to the waking life. Thus, providing the mind with flexibility and awareness during both night and day, with the final purpose of eliminating heavily conditioned reactions. Sleep Yoga, on the other hand, trains and prepares practitioners to be aware of the transitions between different stages of sleep (REM and non-REM) in order to experience a state known as "clear light sleep" and purportedly prepare for the transition between life and death (Norbu, 1983; Wangyal, 1998). In the Tibetan Buddhist tradition, three different types of dream-like experiences are recognized: 1) *samsaric dreams*, which are considered to be a reflection of our waking life, and therefore subjected to our conditioned patterns, identifications and instinctive reactions; 2) *dreams of clarity*, which appear when the individual is able to achieve and remain in a state of non-personal presence while still keeping increased awareness; and 3) *clear light sleep*, which is not a dream itself, appears, often, after many years of practice and refers to periods of lucidity during sleep with neither dreams nor any other content—also referred to as periods of objectless (non-dual) awareness (Alcaraz-Sánchez et al., 2022; Wangyal, 1998). The latter type has an exceptional value within these cultures, given that the subject abides in emptiness (clear) and pure awareness (light), which is purportedly needed for attaining the state of liberation (Norbu, 1983; Wangyal, 1998).

Yoga Nidrâ ("yogic sleep") is a systematic method that seeks to induce complete physical and emotional relaxation, leading practitioners to access altered states of consciousness in between waking and sleep. It is practised in a hypnagogic state, where consciousness is suspended for a few moments periodically, and thus, it alternates between unconsciousness and consciousness. In this state, awareness is thought

to be increased and receptivity and learning abilities enhanced (Pandi-Perumal et al., 2022). It has been speculated that an experienced Yoga Nidra practitioner can be considered a 'lucid sleeper' that is able to consciously enter sleep and maintain tonic alertness throughout the sleep stages (Kavi, 2023). However, this notion remains largely speculative, with empirical support being limited and primarily anecdotal.

5.2. Use of sleep/dream yogas and yoga Nidrâ for clinical application

Given the strong meditative component of these practices and their objective to relinquish conditioned and unconscious reactions, it has been suggested that these practices can increase cognitive insight and attention regulation, areas that are also improved by other meditative practices such as mindfulness training. Further, spirituality and spiritual practices have been linked to better mental health outcomes (Bonelli and Koenig, 2013; Gonçalves et al., 2015), possibly buffering stress-related mental disorders (McClintock et al., 2019). For example, a recent study (Stumbrys, 2021) found a positive relationship between LD frequency and more expressed spirituality (higher spiritual transcendence), and in another study (Erlacher et al., 2021) spirituality was a predictor of self-reported effects of LD on mental and physical well-being. As both studies were correlational, no causality can be implied. However, further longitudinal research, exploring whether engaging in LD can foster spirituality, is warranted. This, in turn, may serve as a coping mechanism for stress-related mental health issues.

Experimental evidence for the efficacy of Dream and Sleep Yogas is scarce, limited to a single pilot study with 12 participants who took part in weekly 2.5 hours Dream Yoga group sessions over 8 weeks period (Stefik, 2000). Several positive outcomes were observed as a result of practice, including less identification with thoughts and emotions, greater present centredness, improved skills for working with life challenges, etc. In contrast, there is an increasing number of studies exploring Yoga Nidrâ that have uncovered the potential benefits of this practice in clinical and non-clinical populations (Pandi-Perumal et al., 2022). Although research on Yoga Nidra is still in its early stages, positive effects on sleep (di Fronso and Bertollo, 2021), insomnia (Datta et al., 2021), stress (Anderson et al., 2017; D'souza et al., 2021) and the potential for an adjunct treatment for mood (Eastman-Mueller et al., 2013; Wahbeh and Fry, 2019) and neuropsychiatric disorders (Stankovic, 2011) have been reported (reviewed in Musto and Hazard Vallerand, 2023).

In summary, some of the results show promising outcomes for the treatment of insomnia, stress and for the potential adjunct treatment of mood and neurological disorders. However, the current state of the research on Yoga Nidrâ is still in early stages: most studies exploring Yoga Nidrâ do not include control groups – and for those including them, either they follow a within-subject design (i.e., pre/post-intervention comparison) or the control group is not properly designed. Therefore, future research is needed with the appropriate active control group accounting for non-specific intervention effects, such as attention, time, expectation, and social support or interaction (Kinser and Robins, 2013; Musto and Hazard Vallerand, 2023). Additionally, there is also a need to isolate the different components of the existing interventions to identify the essential mechanisms of action underlying them (Kinser and Robins, 2013). For instance, more than a decade of research on mindfulness and other meditative practices has shown that it can be a feasible and effective way to treat different clinical conditions (Phan-Le et al., 2022). Yoga Nidrâ and Sleep and Dream Yogas are still largely based on meditation, relaxation and the development of awareness. Therefore, in order to understand how these practices could induce changes in the sleep architecture and increase dreaming/sleep lucidity, research studies need to take into account the different components associated to each of them, similarities and differences with other mind-body interventions and behavioural and cognitive components that each practice may incorporate.

5.3. Use of sleep/dream Yogas and Yoga Nidrâ to induce lucid dreaming

Beyond their clinical application, Sleep and Dream Yoga practices and Yoga Nidrâ may potentially provide researchers with an effective tool to induce LD (Norbu, 1983; Wangyal, 1998). Contemporary lucid dreaming induction techniques seem to closely resemble these practices, but without incorporating the ritualistic and metaphysical aspects found in Dream Yoga teachings (Campillo-Ferrer, Alcaraz, et al., 2024; Kavi, 2023). Moreover, control over one's thoughts and observation of mental events, a feature present in many mindfulness approaches (see Millière et al., 2018 for a comparison), may help individuals to achieve control in a lucid dream, reducing even more the probability to suffer any negative outcomes (Mallett et al., 2022). One study indeed showed that dispositional mindfulness was a significant predictor of dream control in LD (Stumbrys and Erlacher, 2017b). However, evidence for the effect of mindfulness training on LD is mixed (Baird et al., 2019). Thus, future studies should assess whether sleep-focused mindfulness-based methods can induce LD and whether they are completely safe to be employed in healthy individuals and different clinical populations.

6. Conclusions

Lucid dreaming (LD) emerges as a phenomenon with diverse connections to different pathological conditions, while also showing potential therapeutic applications. The use of LD induction techniques has been primarily explored in the context of recurrent nightmares, showing some promising initial results. However, it is worth noting that not all positive outcomes were achieved through lucidity, and there is currently no conclusive evidence supporting LD's superiority over established interventions. Thus, LDT may possibly be useful in those cases in which other behavioural treatments fail, or when more conservative approaches are not suitable (e.g., frequent nightmares without recurrent features). Additionally, there is some evidence that LD induction therapies could provide some relief for depression and anxiety symptoms. Nevertheless, mixed results in this area call for further research, and as of now, there is no conclusive evidence of LD therapy outperforming other treatments. Preliminary, case-report evidence also exists regarding the potential treatment of sleep paralysis episodes with dream awareness and control, although larger studies are necessary to make any solid conclusions. Additionally, LDT has also been hypothesised as suitable therapy to improve insights in psychotic patients, but this area remains insufficiently investigated, and some potential risks associated with this approach have been identified. Interestingly, in the case of nightmares, sleep paralysis and depression, dream control emerges as a factor more important than dream awareness itself, both for the potential therapeutic applications and for its role in the disorder. Further investigation of the factors modulating dream control could help mitigate the risks associated with LDT while deepening our understanding of the pathophysiology of mood and sleep disorders. Moreover, during the pandemic and the lockdowns, the impact on mental health and sleep likely increased LD frequency, possibly triggered by nightmares and extended sleep routines. However, research from this period was limited, and the role of LD during collective trauma remains unclear.

Despite notable progress in the field, evidence about the role of LD in psychopathology is still scarce. Disorders for which only a very limited amount of evidence of their connection with LD was found were not covered in this review (e.g., LD as an adjuvant therapy in Alzheimer's disease, Smalheiser, 2019). Many published articles on this topic consist of case studies or studies with small sample sizes. While such studies provide valuable initial evidence about unknown phenomena (Bennett, 2002), their conclusions should be considered preliminary until subsequent studies with larger sample sizes and higher statistical power are conducted. Of note, the value of lucid dreaming for several neurodegenerative diseases has recently been pointed out on theoretical grounds (Foffani, 2023).

Regardless of the application or the target population (clinical or

non-clinical), LD induction is not entirely without risks. The most notable risk is a potential disruption of the sleep cycle or sleep-wake state boundaries. These potential negative side effects, however, probably depend on the induction technique of choice and the frequency of their application. For instance, reality testing may lead to excessive preoccupation with achieving lucidity throughout the day, and thereby impact sleep quality. Additionally, it may also lead to blur the boundaries between the waking and dreaming life, especially in subjects who have a tendency towards this behaviour (for example, asking themselves if a non-bizarre situation in their life is actually real or not, possibly exacerbating derealization and depersonalization symptoms). Naturally, LD induction methods that intentionally interrupt the sleep cycle (e.g.: WBTB), might more directly interfere with normal sleep function. Consequently, future studies should not only assess the efficacy of LD techniques but also consider potential side effects to determine which methods are safest and most effective for each population. By discarding the most disruptive induction techniques or limiting their use, the potentially beneficial effects of LD induction could be optimized. Furthermore, focusing on training dream control rather than dream awareness might help minimize possible negative side effects of LD therapy, especially as dream control appears crucial for the positive effects associated with LD. Finally, future studies should explore the effectiveness of LD mindfulness practices such as Sleep and Dream Yogas or Yoga Nidrâ, which may offer alternative paths to explore in this regard.

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