

Lucid dreaming during NREM sleep: Two case reports

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Summary. Lucid dreams – dreams in which the dreamer is aware that is dreaming – most frequently occur during REM sleep, yet there is some evidence suggesting that lucid dreaming can occur during NREM sleep as well. By conducting a sleep laboratory study on lucid dreams, we found two possible instances of lucidity during NREM sleep which are reported here. While lucid dreaming during NREM sleep seems to be much rarer and more difficult to achieve, it appears to be possible and is most likely to occur during N1 sleep, somewhat less likely during N2 sleep and yet to be observed during N3 sleep. Future studies should explore induction methods, underlying neural mechanisms and perceptual/dream content differences between REM and NREM lucid dreams. Furthermore, a consensus agreement is needed to define what is meant by lucid dreaming and create a vocabulary that is helpful in clarifying variable psychophysiological states that can support self-reflective awareness.

Keywords: lucid dreaming, NREM sleep, sleep stages

1. Introduction

Since the discovery of rapid eye movements (REM) sleep, it was strongly associated with dreaming: Initial experiments showed that upon awakenings from REM sleep dreams are recalled in 74-80% of cases, whereas only 7-9% of awakenings from non-REM (NREM) sleep resulted in dream recall, leading to a suggestion that a dream recalled during NREM sleep might be only a persisted memory from a previous REM period (Aserinsky & Kleitman, 1953; Dement & Kleitman, 1957). This view “dreaming = REM sleep” prevailed for a while, however Foulkes (1962) showed that when a person is asked to report any mental content which “was going through the mind”, the recall rate from NREM sleep was much higher and not that much different in comparison with REM (in his study: NREM .74 vs. REM .87). Despite this, differences between REM and NREM sleep mentation do exist: In a meta-analysis of 34 studies Nielsen (1999) found the average recall rate $81.7 \pm 8.7\%$ for REM sleep and $42.5 \pm 21.0\%$ for NREM. REM dream reports are typically longer, more bizarre, more perceptually vivid, more emotionally charged and more motorically animated, whereas NREM dream reports contain more thought-like mentation and representation of current concerns (Hobson, Pace-Schott, & Stickgold, 2000).

To explain the ambiguity between dreaming and REM vs. NREM sleep several models have been proposed. For ex-

ample, Hobson with colleagues (2000) suggest that wakefulness, REM sleep and NREM sleep are distinct mental states with different levels of cortical activation, input source and aminergic-cholinergic neuromodulation. A different view is proposed by Solms (2000), who on the evidence from brain lesions suggest that REM sleep and dreaming are controlled by different brain mechanisms and while there is a substantial correlation between the two, in fact they are dissociable states. Nielsen (2000) puts forward another hypothesis, proposing that there might be externally unnoticeable “covert” REM processes during NREM sleep, which might be responsible for dreamlike cognitive activity in NREM sleep.

Lucid dreaming - a state in which the dreamer is aware of the dream while dreaming – since its discovery was also considered as mainly a REM sleep phenomenon (LaBerge, Levitan, & Dement, 1986; LaBerge, Nagel, Dement, & Zarcone, 1981). In the initial sleep laboratory study (LaBerge et al., 1981) of 35 reported lucid dreams 32 (91.4%) occurred during REM sleep, two (5.7%) during NREM Stage 1 (N1) and one (2.9%) during the transition from NREM Stage 2 (N2) to REM, however of those 24 lucid dreams that were verified with volitional eye movements, all occurred during REM sleep. In a larger sample of 88 lucid dreams collected in the sleep laboratory (LaBerge et al., 1986), 83 cases (94.3%) were during REM, four cases (4.5%) during N1 and one case (1.1%) at the transition from N2 to REM. Seventy-six of these dream reports were verified with eye-signalling. Out of those, unequivocal REM was in 70 cases (92%), while the remaining six were less than one epoch (30 s) and therefore technically unscorable (LaBerge et al., 1986). This view “lucid dreaming = REM sleep” is still very persistent and the whole bunch of lucid dream induction techniques are developed on different methods of how to trigger lucid dreaming during REM sleep (Stumbrys, Erlacher, Schädlich, & Schredl, 2012).

Yet one lucid dream induction study (Dane, 1984), which used post-hypnotic suggestion as a means to induce lucidity, found an unusually high number of NREM lucid dreams.

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In this study, where 30 hypnotically susceptible women (aged 18-32) spent a single night in a sleep laboratory, three types of lucid dreams were differentiated: unambiguous REM lucid dreams (UREMLD, eye signalling occurred during unambiguous REM sleep), ambiguous REM lucid dreams (AREMLD, eye signalling occurred immediately after arousal from REM) and NREM lucid dreams (NREMLD, eye signalling and lucidity occurred during NREM sleep). In total, 48 signal-verified lucid dreams were recorded: 8 (from 8 different participants) were UREMLD (16.7%), 10 (8) were AREMLD (20.8%) and 30 (17) were NREMLD (62.5%). While due to inaccurate reporting, the exact distribution of those 30 NREMLD dream reports across the different sleep stages is not completely clear, 8-13 of those NREMLD seemed to occur in wakefulness or in a mixture of wakefulness and N1, 11-14 during N1 (22.9-29.2% in respect to the total sample) and five (10.4%) during N2. Of those five N2 stage lucid dreams, four occurred during ascending N2 (i.e. towards transition to REM sleep) and in all those cases eye-signalling occurred subsequent to movement arousals. One other instance of lucid dream was observed in descending N2, without an increase in EMG activity but with increased alpha EEG before the signal (which might also indicate some arousal). Notably, there was also one case of eye-signalling reported from N2 immediately after transition from NREM Stage 4 (or N3, according to the new classification, see Iber, Ancoli-Israel, Chesson, & Quan, 2007) and without any signs of arousal, however there was no any dream recall in this case. N1 and N2 lucid dreams were predominantly brief.

Dane (1984) study indicates that lucid dreaming can occur during NREM sleep and we found some possible further evidence for this while conducting a study on lucid dreams in a sleep laboratory. Two such cases are presented below. Before sleep, the participants were instructed to produce a sequence of left-right-left-right-left-right (LRLRLR) eye movements, whenever they will realise that they are dreaming and repeat the sequence about once a minute until the lucidity is retained. Unfortunately, due to the strict study protocol no NREM awakenings could be made and the participants could be asked to confirm the signal only upon a subsequent REM awakening or in the morning.

2. Case 1

The participant was female, 26 years old, frequent lucid dreamer (one lucid dream a week) and a good dream recaller (a few dreams a week). Eye-signalling during NREM Stage 2 sleep occurred on a second consecutive night in the sleep laboratory, during the second sleep cycle, 105 min after falling asleep. There was a descending N2 (starting 4 epochs before the signal), which was preceded by wakefulness and N1 sleep. The sleep recording with two epochs preceding the signal is presented in Figure 1. When asked in the morning, the participant confirmed eye-signalling in the beginning of the night. She reported that there was no any visual imagery present, but there was a floating sensation without feeling her body, therefore she realised that it has to be a dream and gave the eye-signal.

3. Case 2

Also a female participant, 26 years old, infrequent lucid dreamer (2-4 lucid dreams a year) and a good dream recaller (a few dreams a week). Eye-signalling during N2 sleep occurred on a third consecutive night in the sleep labora-

tory, during the first sleep cycle, 95 min after falling asleep. Five eye-signals were made within 5 min 30 s of ascending N2 sleep, preceded by N3 sleep and arousal. During eye-signalling there were some signs of arousal, yet such N2 sleep stage pattern was quite characteristic for this participant. Two instances of such eye signalling are presented in Figure 2. Upon awakening two and half hours later, when asked about the earlier recurrent eye signalling, the participant however, was not able to recall anything.

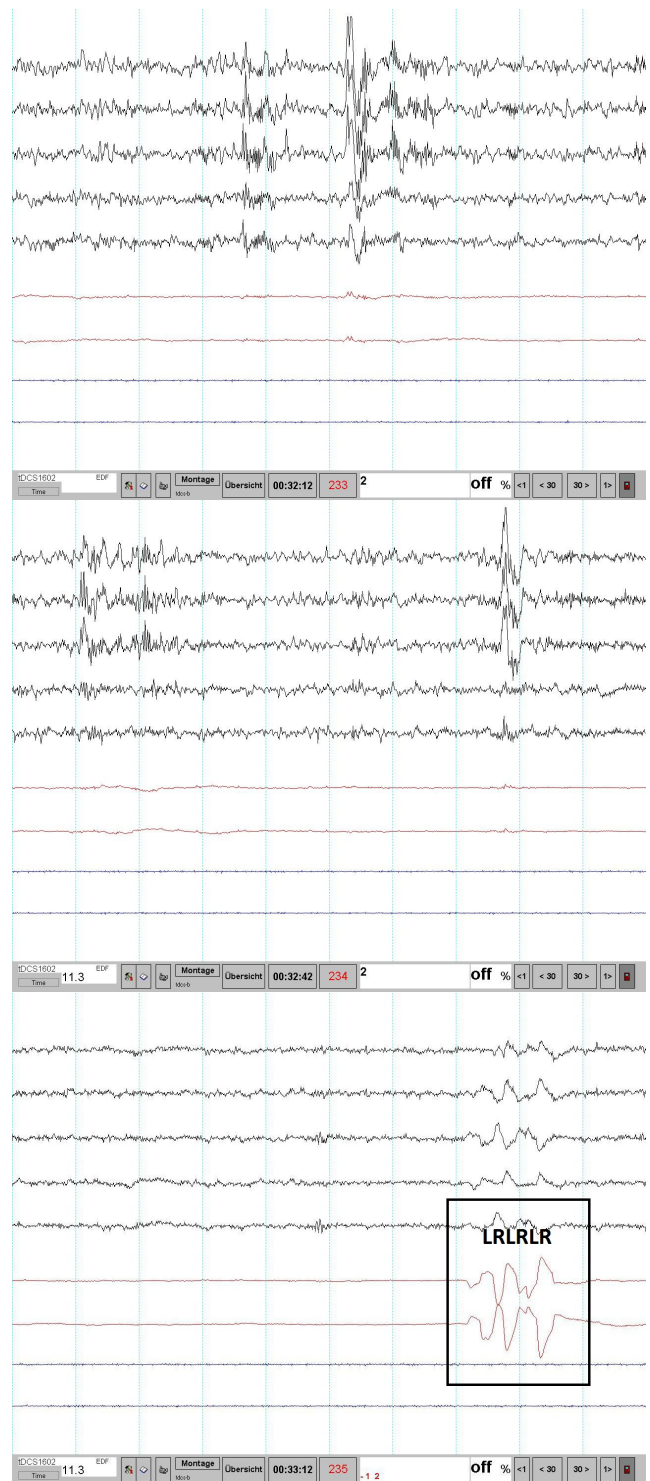


Figure 1. Case 1: Eye-signal with two epochs preceding it.

4. Discussion

The two cases described above provide some further preliminary evidence that lucid dreaming can occur during NREM sleep. The biggest limitation is that due to the strict experimental procedure no awakenings were possible at the time and these eye signals can not be directly confirmed. In the first case, although the participant confirmed earlier eye-signalling in the morning, it might have been that this dream report relates to a different sleep period. In the second case, the participant can not recall anything, yet persisting eye-signalling pattern which corresponds to the instructions given before the sleep (to signal about once a minute while lucid), suggests that lucidity might have occurred and the signals are not just a random or automatic eye activity. Furthermore, the eye signals in the second case also occurred with some signs of arousal, which indicate that this might have been not during unequivocal N2 sleep stage but perhaps rather in a some mixture of N1 and N2. Despite these shortcomings, this opens further discussion about conscious awareness in different stages of sleep.

REM sleep and NREM sleep seem to have different brain activation patterns (Hobson et al., 2000). During NREM sleep the brain is generally less active than during both REM sleep and wakefulness, while the overall activation during

REM sleep is similar to wakefulness. Cortical areas, which are selectively deactivated during REM sleep and the activation of which is associated with lucid dreaming, such as the dorsolateral prefrontal cortex, precuneus, cuneus (Dresler et al., 2012; Kahn & Hobson, 2005; Voss, Holzmann, Tuin, & Hobson, 2009) are also deactivated during NREM sleep (Braun et al., 1997; Maquet et al., 1997). Considering lower general brain activation patterns in NREM sleep, it is possible that to achieve lucidity during NREM sleep is more difficult than during REM sleep. Further support for this comes from the study by Purcell and her colleagues (1986), who found that overall self-reflectiveness in NREM dreams is lower than self-reflectiveness in REM dreams. While no difference in this study was found between self-reflectiveness in N2 and N3 dreams, the brain activity during different NREM sleep stages also slightly differ (Kaufmann et al., 2006), therefore it is worth to discuss lucidity according to the different NREM sleep stages.

N1. Findings from the earlier studies (Dane, 1984; LaBerge et al., 1981, 1986) suggest that of all NREM sleep stages lucid dreaming can most often occur during N1, however such lucid dreams usually are quite short. In fact, dreams collected from N1 and REM sleep seem to be strikingly similar (Oudiette et al., 2012), as well as brain EEG activity during both these stages (Bódizs, Sverteczki, & Mészáros, 2008). The fifth substage of N1 sleep (NREM1), characterised by low voltage theta waves, especially resembles REM sleep, including EEG and eye-movement pattern, mentation recall rate and memory processes involved (Stenstrom, Fox, Solomonova, & Nielsen, 2012). Furthermore, there is a special class of lucid dream induction techniques, so called Wake-Initiated Lucid Dreaming (WILD), where the dreamer aims to enter the dream directly from wakefulness by retaining consciousness while falling asleep (Stumbrys et al., 2012) and some of these techniques are based on concentration on hypnagogic imagery occurring during N1 sleep (e.g. Tholey, 1983).

N2. Lucidity during N2 seems also to be possible (Dane, 1984, also this study), yet much less frequent and usually preceded by some arousal (which might help to initiate lucidity). Lucid dreams are also brief.

N3. Up to our knowledge, no lucid dream reports so far had been obtained from N3 (deep sleep) stage. However one study found that long-term practitioners of transcendental meditation who claim to experience witnessing during deep sleep (lucid awareness without involvement in dream activity), had increased theta2-alpha1 EEG power as well decreased chin EMG during N3 sleep (Mason et al., 1997), which suggest that at least in trained subjects lucid awareness might also be possible during N3.

Wittmann and Schredl (2004) proposed the idea that perhaps the mind never sleeps and it is only due to memory failures we can not recall preceding mental processes during some awakenings. Therefore, at least theoretically, it should be possible to become aware of our mental processes through the whole sleep-wake cycle in all stages of sleep (Stumbrys, 2011). While lucidity in REM sleep is relatively frequent and well established, lucidity in NREM sleep seems to be much rarer and much more difficult to achieve. The duration of signal-verified NREM lucid dreams is also quite short – there might be that eye-signalling disrupts NREM sleep. While during REM sleep the skeletal muscles of the sleeping body are actively suppressed by neural structures in the brain stem, keeping dreamers from actually acting

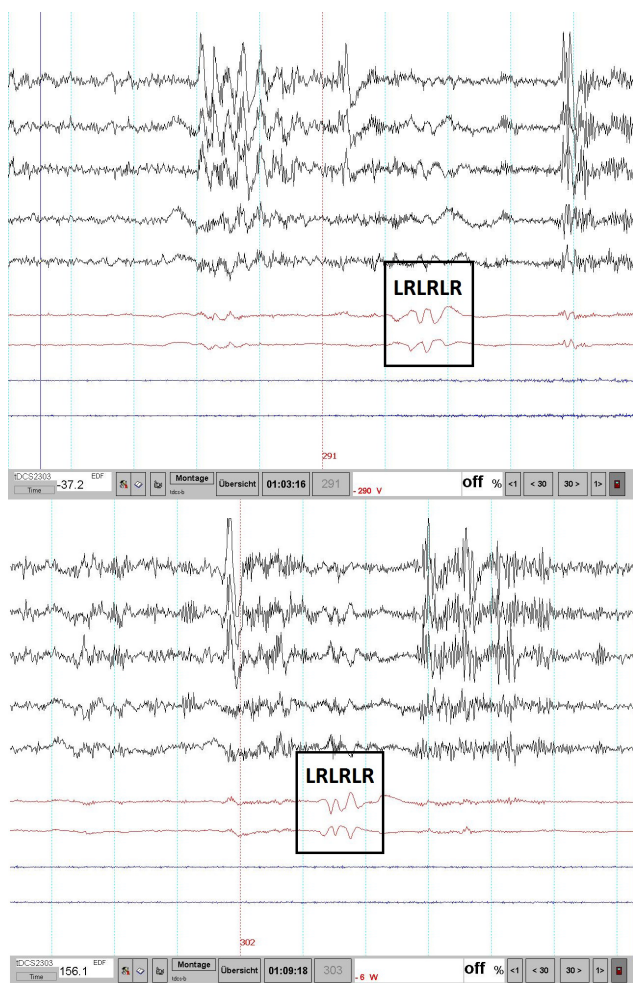


Figure 2. Case 2: Two episodes of eye-signalling

out actions in their dreams, such mechanism is not present during NREM sleep (Hobson et al., 2000). Therefore, while theoretically the dreamer might signalise lucidity using any part of his or her muscles during NREM sleep, any such signalling might be disruptive for the NREM state itself and will just awaken the sleeping person. On the other hand, the absence of sleep atonia brings also a methodological problem when conducting an experiment in a sleep laboratory: It might not be clear whether the participant was not really awake at the time of the signalling if this, for example, would occur during N1 sleep.

One other interesting observation is that *all* possible instances of NREM lucidity has been observed so far were only from female participants: two our participants, 17 participants from Dane's (1984) study and two participants from LaBerge et al (1981) (no gender-specific data was provided by LaBerge et al., 1986). While it well established that women have better dream recall than men (Schredl & Reinhard, 2008), gender differences in lucid dream frequency are negligible (Schredl & Erlacher, 2004; Snyder & Gackenbach, 1988; also cf. Schredl & Erlacher, 2011). Although it is premature to assert any gender differences in relation to NREM dream lucidity, this is something that could be taken into account in future studies.

While different external stimuli (light, acoustic, vibro-/electro-tactile, etc.) have been successfully presented to trigger dream lucidity during REM sleep (Stumbrys et al., 2012), it is not clear whether such stimuli can trigger lucidity during NREM sleep – something to be clarified in future studies. However one study (Conduit, Bruck, & Coleman, 1997) has already showed that the presentation of light and sound stimuli during NREM sleep increased visual imagery as well as EEG alpha activity, which has been linked with lucidity during REM sleep (cf. Ogilvie, Hunt, Tyson, Lucescu, & Jeakins, 1982; Tyson, Ogilvie, & Hunt, 1984). Future studies should also clarify whether brain regions involved in attaining lucidity in REM sleep, namely prefrontal, occipito-temporal cortices, precuneus, cuneus, parietal lobules (Dresler et al., 2012; Voss et al., 2009), are also the ones involved in attaining lucidity in NREM sleep.

The further question is about perceptual properties and content of NREM lucid dreams. In one of our cases, the participant did not report any visual imagery, only a floating sensation. NREM dream reports are usually less vivid with lesser involvement and are more thought-like (Hobson et al., 2000). This parallels a distinction made in Tibetan sleep and dream yoga (Norbu, 1992; Wangyal, 1998). The aim of this advanced tantric practice (usually dated back to 8th century) is to develop constant non-dual awareness across the sleep-wake cycle. This yoga contains two alternative practices: dream yoga and sleep yoga (or a practice of natural light). While dream yoga aims to develop awareness in dreams, the aim of sleep yoga, which is considered to be more difficult to master, is to develop awareness in dreamless sleep, where no dream imagery is present. Therefore it might be possible to speculate that a parallel could be made between dream yoga and attaining dream lucidity in REM sleep, and sleep yoga and attaining dream lucidity (or perhaps – lucid witnessing, cf. Mason et al., 1997) in NREM sleep. According to Tibetans, ultimately one practice leads to another (i.e. by becoming lucid in dreams, the adept starts becoming lucid in dreamless sleep and vice versa) (Wangyal, 1998), which would suggest that highly experienced lucid dreamers might be better candidates for lucidity

during NREM sleep.

The more fundamental question is about the concept of lucidity itself. The term lucid dreaming, coined originally a century ago by a Dutch psychiatrist van Eeden (1913), is conventionally understood as awareness of dreaming while dreaming (cf. Stumbrys et al., 2012). However the notion of dreaming itself is extremely diverse and without a single accepted definition (Pagel et al., 2001). Pagel et al. suggest addressing three different axes when defining dreaming: Wake/sleep, Recall, and Content. When following these notions in the context of dream lucidity, it is clear that awareness of dreaming (Content axis) and some recall afterwards in the waking state (Recall axis) should be present; however the exact positioning across the Wake/Sleep continuum is much less evident. While awareness of any mention occurring while person is asleep, can be considered as lucid dreaming (or lucid witnessing, when the person is a detached observer of own sleep mentation), it is somewhat less clear whether the notion of dream lucidity should be extended to hypnogogic and hypnopompic phenomena occurring at the boundary between sleep and wakefulness or other dream-like states such as meditation, hypnosis, drug-induced conditions or day dreaming. The notion of lucidity perhaps can even be extended to wakefulness: Tibetan dream and sleep yoga, for example, aims to develop constant non-dual awareness across the whole sleep-wake cycle and it has been suggested that notion of mindfulness in wakefulness is comparable to the notion of lucidity in sleep and dreams (Stumbrys, 2011). Yet, if the notion of dream lucidity will be expanded too far, there is a risk that the term itself will become diluted and overly abstracted. Therefore a consensus agreement is needed to define more precisely what is meant by the notion of lucid dreaming and create a vocabulary that is distinct for the various states and is helpful in clarifying variable psychophysiological states that can support self-reflective awareness. One option would be to use the term "REM lucid dreaming" or "REM lucidity" to denote conscious awareness during REM sleep and "NREM lucid dreaming" (or "NREM lucidity") to refer to conscious awareness occurring during NREM sleep.

In conclusion, there is some preliminary evidence that lucidity can occur during NREM sleep, although it appears to be much more difficultly achievable than during REM sleep. The instances of NREM lucid dreaming confirmed with eye-signalling are usually very brief. Of different NREM sleep stages, lucidity seems to be most likely during N1, somewhat less likely during N2 and yet to be observed during N3. Further studies should clarify whether lucidity in NREM sleep can be triggered by providing some external stimuli or by some other means (e.g. cognitive techniques, such as WILD, or application of drugs, see Stumbrys et al., 2012) and explore neurological mechanisms underlying it. Perceptual and dream content differences between REM and NREM lucid dreams should be also be explored. Gender effects might be taken into account.

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