What is the State-of-the-Art on Lucid Dreaming?

Recent Advances and Questions for Future Research

Ursula Voss & Allan Hobson

Lucid dreaming may be defined as the conscious awareness that one is dreaming while dreaming. Instead of incorrectly assuming that one is awake, the dreamer gains insight about her or his real state of consciousness. Lucid dreaming is rare and evanescent, which probably accounts for lingering doubts about its veracity and for its marginalization in science. The purpose of this paper is to review the evidence that lucid dreaming is a real phenomenon, including evidence for its occurrence, underlying mechanisms, and scientific value. Based on admittedly still limited but fast-growing empirical evidence, we will introduce four hypotheses centred around lucid dreaming that are deduced from empirical work and that will hopefully have a bearing on future consciousness research. The Brain Maturation Hypothesis (1) relates steps in ontogenetic brain development to the frequency of naturally occurring lucid dreams in children and adults, suggesting that in the immature brain, spontaneous and involuntary lucid dreaming results from accidental and untypical activation of the frontal cortex during REM sleep. The Hybrid State Hypothesis (2) and the Space of Consciousness Model (SoC) (3) build on the electrophysiological peculiarities observed in REM-sleep-induced lucid dreams, showing a wake-like EEG pattern in frontal parts of the brain and an REM sleep-like EEG in posterior areas. The Gamma Band Hypothesis (4) proposes that the same kind of oscillatory activity known to accompany conscious awareness in the awake brain promotes conscious awareness in REM sleep dreams. Finally, we present first experimental evidence that lower gamma band activity is indeed a necessary condition for the elicitation of conscious awareness in dreams.

Keywords
Brain maturation | Lucid dreaming | REM sleep | Spaces of consciousness model | States of consciousness

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1 Background

Given its robust and revealing features, it is surprising that dream lucidity was not recognized by philosophers of mind until recently (Metzinger 2003, 1993; Noreika et al. 2010; Revonsuo 2006; Windt in press; Windt & Metzinger 2007). Although it was described by Aristotle (without using the term, in 350 BC), lucid dreaming first appears in the *experimental* literature of the late nineteenth century (Maury 1861; Saint-Denis & Marquis 1982). It was described as a vehicle for self-experimentation (Arnold-Forster 1921) in the early 20th century and reported on subjectively (van Eeden 1969). The modern laboratory study of lucid dreaming

1.	While dreaming, I was aware of the fact that the things I was experiencing in the dream were not real.	0 1 2 3 4 5
2.	While dreaming, I was able to remember my intention to do certain things in the dream.	0 1 2 3 4 5
3.	While dreaming, I was aware that the self I experienced in my dream wasn't the same as my waking self.	0 1 2 3 4 5
4.	In my dream, I was able to manipulate or control other dream characters in a way that would be impossible in waking.	0 1 2 3 4 5
5.	While dreaming, I thought about other dream characters.	0 1 2 3 4 5
6.	While dreaming I was able to successfully perform supernatural actions (like flying or passing through walls).	0 1 2 3 4 5
7.	The emotions I experienced in my dream were exactly the same as those I would experience in such a situation during wakefulness.	0 1 2 3 4 5
8.	While dreaming, I was aware of the fact that the body I experienced in the dream did not correspond to my real sleeping body.	0 1 2 3 4 5
9.	I was very certain that the things I was experiencing in my dream wouldn't have any consequences on the real world.	0 1 2 3 4 5
10.	While dreaming I was able to successfully control or change the dream environment in a way that would be impossible during wakefulness).	0 1 2 3 4 5
11.	While dreaming, I saw myself from outside.	0 1 2 3 4 5
12.	While dreaming, I thought about my own actions.	0 1 2 3 4 5
13.	While dreaming, I had the feeling that I had forgotten something important.	0 1 2 3 4 5
14.	While dreaming, I was able to change or move objects (not persons) in a way that would be impossible in waking.	0 1 2 3 4 5
15.	While dreaming I was not myself but a completely different person.	0 1 2 3 4 5
16.	While dreaming, I often asked myself whether I was dreaming.	0 1 2 3 4 5
17.	The thoughts I had in my dream were exactly the same as I would have in a similar situation during wakefulness.	0 1 2 3 4 5
18.	While dreaming, I had the feeling that I could remember my waking life	0 1 2 3 4 5
19.	While dreaming, I was aware of the fact that other dream characters in my dream were not real.	0 1 2 3 4 5
20.	Most things that happened in my dream could have also happened during wakefulness.	0 1 2 3 4 5
21.	I watched the dream from the ouside, as if on a screen.	0 1 2 3 4 5
22.	While dreaming, I often thought about the things I was experiencing	0 1 2 3 4 5
23.	I was able to influence the story line of my dreams at wil/at libitum.	0 1 2 3 4 5
24.	While dreaming, I was able to remember certain plans for the future.	0 1 2 3 4 5
25.	While dreaming, I felt euphoric/upbeat.	0 1 2 3 4 5
26.	While dreaming, I had strong negative feelings.	0 1 2 3 4 5
27.	While dreaming, I had strong positive feelings..	0 1 2 3 4 5
28.	While dreaming, I felt very anxious.	0 1 2 3 4 5

Figure 1: Lucidity in Dreams (LuCiD) scale (adopted from Voss et al. 2013).

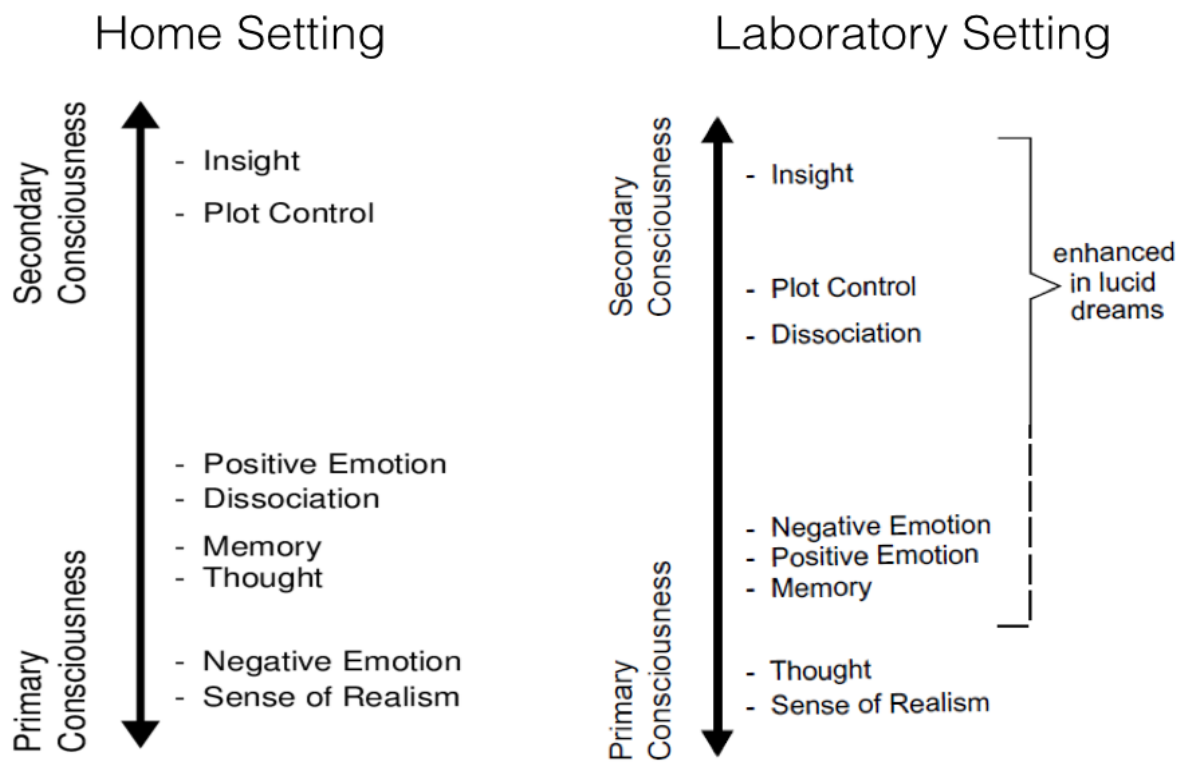

Figure 2: (partially adapted from Voss et al. 2014): Positions on the primary to secondary consciousness axis are based on the logarithm of ratios of mean scores in lucid and non-lucid dreams. All factors have been identified as components of dream consciousness.

a) Rank order of logarithm of mean scores derived from dream reports collected in a home setting. Note that these reports were often recorded in the morning instead of immediately following an awakening from REM sleep. Judging from our admittedly limited experience, these reports are less distorted and more story-like than those following forced awakenings in the laboratory.

b) Rank order of logarithm of mean scores derived from dream reports following forced awakenings from REM sleep in a laboratory setting. Lucid dreams, which are thought to add elements of secondary consciousness, are characterized by increased ratings in reflective INSIGHT, CONTROL over the dream plot, and DISSOCIATION. To a lesser extent, they are accompanied by access to waking MEMORY, as well as NEGATIVE and POSITIVE EMOTIONS.

was pioneered by Hearne (1978) and LaBerge, beginning in 1980 (1980).

In this paper, we will summarize our five years of scientific research on lucid dreaming, provide a systematic overview of our work, and present new hypotheses about the *why* (because of fluctuations in brain networking) and the *how* (through local changes in lower gamma band activity) of lucid dreaming. Regarding the *why*, our "Brain Maturation Hypothesis" proposes that the probability of lucid dreaming occurring spontaneously is strongly enhanced during the time of cerebral diversification and, most importantly, integration of the frontal lobes into the cortico-cortical and cortico-thalamic networks (Fuster 1989; Goldman-Rakic 1987; Zilles et al. 1988).

As to the *how* of lucid dreaming, we will outline our experimental findings, focusing on the increase in lower gamma band activity in

fronto-temporal brain areas (Gamma Band Hypothesis). We will then move from our first attempts to provide a brain-based explanation of empirical findings (Hybrid State Hypothesis, see Hobson & Voss 2011; Voss et al. 2013) to a three-dimensional model of consciousness, allowing for a more structured classification of various states of consciousness, ranging from near-death to highly vigilant wakefulness ("Space of Consciousness", SoC, compare Voss & Voss 2014).

The presentation of our empirical contributions will begin with a quantitative analysis of lucid dream subjectivity. This study demonstrates that the most robust difference between lucid and non-lucid dreaming is the increase in insight into the nature of one's current conscious state that accompanies lucidity. Based on admittedly few recordings (unpublished) of false awakenings, we are currently inclined to assume that there is no notable difference between, for example, the apparent but non-veridical insight accompanying a false awakening and actual (lucid) insight into the fact that one is dreaming. In both falsely and correctly perceived insight into the current state of arousal, the brain apparently operates in a dissociative mode, allowing for a state-related form of meta-awareness similar to the awareness of mind-wandering described for the wake state (Schooler et al. 2011; Metzinger 2013). However, as our experimentally deduced hypotheses are based on those instances in which the dreamer *correctly* achieved insight into the fact that she was dreaming while the dream continued, we will restrict our discussion of dream lucidity to these instances.

In discussing these results, we will go so far as to suggest that lucidity, as the name implies, *is* insight. We then turn to sleep laboratory studies revealing that the principal brain correlate of lucid dreaming is 40 Hz activation of the frontal cortex. When we electrically stimulated the frontal brain via the scalp, we were able to induce both an increase in 40 Hz brain activation and the subjective experience of lucidity. In our discussion of these results we suggest that the experimental study of lucid dreaming is a powerful paradigm for understanding the brain basis of conscious experience.

2 Quantification of dream lucidity as subjective experience

Perhaps the most problematic aspect of conducting research into lucid dreaming is the difficulty of obtaining both qualified and quantified evidence of the secondary consciousness in dreams. By secondary consciousness we mean the subjective awareness of our state in dreaming, and particularly meta-awareness, meaning an instance of actively acquired self-knowledge or a sudden insight, regardless whether it is accurate or counterfactual (see Metzinger 2013). Meta-awareness is most clearly manifest in waking consciousness. Dream consciousness, by contrast, is called primary (following Edelman 1992) because while it is both richly perceptual and powerfully emotional, it is weakly cognitive with conspicuous defects in insight (the main focus of this paper) orientation, and memory, though this does not mean that all thinking is missing (Hobson et al. 2011; Kahan & Sullivan 2012; Kahn & Hobson 2005). See Hobson & Voss for detailed discussion of this phenomenology (2010).

Regarding qualification, Hearne (1978) and LaBerge (1980, 1985) took advantage of the fact that humans can be trained to voluntarily move their eyes in Rapid Eye Movement (REM) sleep and thereby to signal conscious awareness while dreaming. Although care must be taken to minimize the rate of false positive responses, LaBerge's method has proven quite useful in our own attempts to reliably identify lucid dreaming objectively (Voss et al. 2009).

With respect to quantification, it is important to note that until recently, lucid dreaming was not quantitatively defined. While some authors described lucid dreams in a narrow sense as dreams in which one knows that one is currently dreaming (LaBerge 1985; LaBerge & Gackenbach 2000), others subscribed to a broader definition of lucidity as an all-pervading experiential phenomenon, which is purportedly characterized not only by reflective insight into the fact that one is currently dreaming, but also by full intellectual clarity including: the availability of autobiographic memory sources, the ability to actively control the dream, as well as

an overall increase in the intensity of multimodal hallucinatory imagery. This state is often described as taking on a hyper-real quality (Tart 1988; Metzinger 2003; Windt & Metzinger 2007). While sharing an interest in the broader definition, we restrict our attention here to the narrower one in which insight into the fact that one is currently dreaming represents the core criterion for lucidity.

In an attempt to be better able to assess the major and minor determinants of dream lucidity, we developed a Lucidity and Consciousness in Dreams Scale (LuCiD) which was based on hypotheses derived from theory and which we analysed and validated using factor-analysis (Voss et al. 2013). The LuCiD scale presents an important step towards shedding light on the relationship between lucid dreams and other types of dreaming, as well as on the evaluation of cognition in the dream state and its relationship to other aspects of dreaming, such as the intensity of hallucinatory imagery and dream control.

The scale items were constructed by an interdisciplinary team of philosophers, psychiatrists, and psychologists. Our results are based on reports of more than 300 non-lucid and lucid dreams, and verified by reports following forced REM sleep awakenings in the laboratory. Our analysis identified eight factors involved in dream consciousness. Although it is of course possible that our initial item pool did not exhaust all theoretically possible elements, we consider these results a first step in the search for an empirical definition of dream consciousness. According to the factor analysis that we performed, lucid dream consciousness can best be described by the factors (1) INSIGHT into the fact that what one is currently experiencing is not real, but is only a dream; (2) a sense of REALISM, pertaining to the similarity between emotions, thoughts and events with wakefulness as judged after awakening from the dream; (3) CONTROL over the dream plot; (4) access to waking MEMORY; (5) THOUGHT about other dream characters; (6) POSITIVE EMOTION; (7) NEGATIVE EMOTION; and (8) DISSOCIATION akin to taking on a third-person perspective (for a copy of the LuCiD scale see Figure 1).

The factor analysis results support both the restricted definition of lucidity that we have adopted and the broader definition utilised by others. The strength of the factor INSIGHT favors the simple definition, while the wide range of other factors (see Figure 2) favors the more complex definition. While both types of definition certainly have their merits, this difficulty in defining lucid dreams brings some important questions to the fore. What, for instance, is the exact relationship between metacognitive insight into the dream state and the hallucinatory quality of the dream (for the relationship between thinking and hallucinations across the sleep-wake cycle, see Fosse et al. 2001)? And how do these aspects of dream lucidity, in turn, influence the ability to engage in deliberate dream control, which fluctuates considerably?

3 Lucid vs. non-lucid dreams

3.1 Non-lucid dreams

According to our analysis, non-lucid or "normal" dreams are characterized by low absolute values in all factors except REALISM. Non-lucid dreams seem almost to completely lack INSIGHT, CONTROL, and DISSOCIATION. Although mean scores for THOUGHT are higher than those for MEMORY, both are low if we are considering absolute values. Results also show relatively low mean values for NEGATIVE EMOTION. However, as most of our data were collected in a laboratory setting, known to increase positive emotionality in dream imagery (e.g., Hartmann et al. 2001), some caution is advised regarding the interpretation of results with respect to both negative and positive emotion.

3.2 Lucid dreams

Lucid dreams differ from non-lucid dreams in six of the eight factors identified in the LuCiD scale. The leading factor in lucid dreams is INSIGHT. Regarding the relevance of the other factors, we observed different rank orders for dream reports following sleep in a home setting (Figure 2a) and those from forced awakenings in

the laboratory (Figure 2b). The data of our new laboratory study (Voss et al. 2014) confirm the findings depicted in Figure 2b, suggesting that the leading factors in dream lucidity are INSIGHT, CONTROL, and DISSOCIATION. Although, as pointed out by Windt (2013), dream reports in general must be considered trustworthy sources of evidence about subjective experience during sleep, the degree to which these reports can be used to draw scientifically sound conclusions about the dream state strongly depend on the quality of the experimental protocol. Such a protocol is more easily established in a laboratory setting, rendering immediate recalls of the dream experience, which must be considered more reliable with respect to distortions and intermixture with waking thought than those recorded in a home setting (Foulkes 1979; Voss et al., unpublished data), although dreamers might feel less inclined to report on sexual or aggressive content. Furthermore, reports from home settings usually lack information about the particular sleep stage (REM or NREM) in which the dream evolved. Typically, NREM dreams are less bizarre and more story-like (e.g., Dé Waterman & Kenemans 1993).

With regard to the distinction between primary and secondary consciousness in dreams, our findings indicate that INSIGHT is a defining feature of lucidity and that this core aspect of secondary consciousness is related to the emergence of other features of secondary consciousness. Lucid dreamers are able to reflect not only upon the fact that they are currently dreaming, but also upon the unfolding dream events.

The relationship between INSIGHT and CONTROL is clear, as realizing that one is dreaming is an important condition for trying to control not only one's own behavior in the dream, but the dream itself. It must be pointed out, though, that CONTROL is much more infrequent than lucid INSIGHT, and the low covariance of this factor indicates a strongly limited variability of scores, suggestive of a floor effect. In other words, very few participants reported to have experienced some (however small) level of control over the dream plot (see Voss et al. 2013). Despite this limitation, lucidity appears to be characterized not only by lucid insight. INSIGHT also facilitates the emergence of other aspects of secondary consciousness in dreams such as dissociative thought and access to waking MEMORY. Similarly, while our study found non-lucid dreams to almost completely lack INSIGHT, CONTROL, and DISSOCIATION. THOUGHT, e.g., about other dream characters, was not completely absent in non-lucid dreams (Kahn & Hobson 2003).

A surprising finding of our study was that lucid and non-lucid dreams were not distinguished by a difference in the sense of REALISM. Whereas we previously thought that lucidity was characterized by a lack of bizarreness (see Voss et al. 2013), further exploration suggests that this factor is associated with the degree to which the dream feels real. Lucid dreams feel as subjectively realistic as non-lucid dreams. This finding was fully replicated in our most recent study (Voss et al. 2014). A question we are currently not able to answer is whether both dream types are equally bizarre (see also Windt 2013).

Our finding of realistic conviction stands in apparent contrast to reports from other authors who found that the onset of lucidity is often accompanied by a change in the overall experiential quality of the dream, noting that lucid dreams are often described as taking on a surreal, dream-like quality (cf. LaBerge 1985; Brooks & Vogelsong 2000; Tholey & Utecht 2000). At present, we are inclined to think that perhaps the different perceptions may be related to the already-mentioned confounding of wake- and sleep-induced lucid experiences. To our knowledge, lucid dreams entered through the wake state (e.g., Wake-Induced Lucid Dreaming, WILD, see Stumbrys et al. 2012) and those arising out of REM sleep have not been systematically compared with regard to phenomenology or Electroencephalography (EEG). Nonetheless, we think it plausible to assume that the WILD technique will result in more wake-like experiences, simply because they arise out of the wake state or the transition from waking to sleep, usually at the beginning of the night or after morning awakenings. A return to the wake state is in most cases easily ac-

complished. By contrast, dreamers who achieve lucidity out of REM sleep remain in REM sleep, not always being able to wake up voluntarily (Voss et al. 2009, 2014; Voss & Voss 2014). Regarding REALISM, lucid dreams arising out of REM sleep are apparently not accompanied by a change in the subjectively experienced realism of the dream.

3.3 Natural frequency of lucid dreams: The brain maturation hypothesis (1)

REM-sleep-induced lucid dreaming is unique because it represents an exceptional state in which the brain is in two states at the same time: awake and asleep. However, while many have experienced the phenomenon, few experience it on a regular basis. Why? So far, predisposing psychological variables have not been clearly identified (Schredl & Erlacher 2004). We have long speculated (Hobson 2009), and Schredl & Erlacher (2011) have confirmed, that lucid dreaming is negatively correlated with age. Why? And when does lucid dreaming actually set in? These questions need to be addressed in order to provide at least some clues about a very important question: Why does lucid dreaming occur at all?

To investigate the natural frequency of lucid dreaming in children and young adults, we interviewed almost 800 students aged 6–19. Students were recruited from local schools in and around Bonn, Germany, thanks to the enthusiastic cooperation of teachers and parents. Each student was interviewed alone, during school hours, and asked to provide a dream report and to answer questions about dreaming, lucid and non-lucid. In addition, to account for social desirability, students were tested for suggestibility (see Voss et al. 2013), which led to the exclusion of almost 100 data sets.

The main findings of our survey were a surprisingly high incidence of reported lucidity in the young and more frequent lucidity in those who are intellectually more capable. In total, 52% of participating students reported to have recalled at least one lucid episode in their life. The highest incidence rate of recent lucid dreams was observed in the young. Frequency rates seem to remain at steady levels until age 16, after which they drop dramatically.

In our study, only one third of lucid dreamers claimed to be able to change the dream plot, showing that plot control is not automatically activated in lucid dreaming. As in previous reports (e.g., Wolpin et al. 1992), plot control was significantly associated with frequency of lucid dreaming, suggesting that it is susceptible to training. Plot control was also found to vary with age. It remained at relatively high rates (up to 50% of lucid dreams) from 6 to 14 years and started to decrease from that age on. Lucid dreaming incidence or frequency was not related to sleep duration or napping.

Based on previous research into lucid dreaming, we are inclined to interpret these results as evidence that lucid dreaming is an exceptional mental state occurring naturally in the course of brain maturation. It is noteworthy that the peak in spontaneous occurrence of lucid dreaming coincides with the final stages of frontal lobe myelination and a time of synapse expansion and dendritic growth. These neurobiological changes provide the prerequisites for the integration of the frontal lobes (which are REM sleep-atypically activated in lucid dreaming) into the cortico-cortical and cortico-thalamic networks (Fuster 1989; Goldman-Rakic 1987; Zilles et al. 1988).

Lucid dreaming may thus occur naturally during the final stages of frontal lobe integration, a process similar to an upgrade of computer hardware. It seems to us most likely that the peak in spontaneous dream lucidity in childhood and puberty (Stumbrys et al. 2014; Voss et al. 2013) is nothing but an accidental confounding of conscious states during a time of high cerebral diversification. In an adult, mature brain system, relatively firm covariates for states of arousal have been established, For example, the frontal lobe activity during waking is usually enhanced, whereas it is down-regulated during REM sleep. Our Brain Maturation Hypothesis speculates that during childhood and puberty, frontal lobe activity is sometimes decoupled from the arousal state so that frontal lobes can become active in a state for which this type of activity is untypical. An intriguing

finding is that not only lucid insight but also dissociative phenomena like derealization and depersonalization can easily be trained in the laboratory during this same period in ontogenetic development (Leonard et al. 1999). DISSOCIATION is a key factor that discriminates between lucid and non-lucid dreams (Figure 2, see also van Eeden 1969; Voss et al. 2013, 2014). In lucid dreams, dissociation is often described as taking on a visual third-person perspective, documenting a split between dreamer and dream observer (Gabel 1989; Rossi 1972) ("I see myself from the outside"), whereas non-lucid dreams are typically experienced from the first-person perspective, at least in adults (Foulkes et al. 1990; Gackenbach 2009; Snyder 1970; Voss et al. 2013). At this point, it may be important to note that we do not categorically differentiate between observer dreams and lucid dreams. Based on the results from our LuCiD scale study and in agreement with Gabel (1989), who speaks of "reflections of a dissociated self-monitoring system" (p. 560), we make a quantitative distinction between dreams experienced as first- or third-person, since DISSOCIATION is, next to INSIGHT and plot CONTROL, a key factor that discriminates lucid from non-lucid dreams (see Figure 2).

The fact that lucid dreaming is more readily experienced by those who are more advanced in abstract thinking and charged with reflective insight implies that lucid dreaming is indeed related to brain maturation. Support for this interpretation comes from a study by Lapina et al. (1998). Although details of method and sample characteristics have not been reported, the authors claim a higher level of lucidity in advanced learners. If this is true, however, then why does lucid dreaming decrease in early adulthood, considering that, surely, older students have acquired a higher level of abstraction than younger ones? At this point, we can only speculate about possible and probable causes. One explanation that should be further investigated is that lucid dreaming occurs naturally in the immature but developing brain.

Lucidity could thus be a transient dissociative state during brain maturation that is normally lost in adulthood but still accessible through training.

3.4 The hybrid state hypothesis (2) of lucid dreaming

The quantification of subjective experience in dream lucidity led us to assume that when the brain-mind shifts from non-lucid to lucid dreaming, it becomes a hybrid state with elements of both waking and dream consciousness. In lucid dreaming, thinking is only partially ruled by primary consciousness. To some extent, the dreamer has—however limited—access to secondary consciousness, enabling her to reflect on her present state. Aside from knowing that the on-going dream is not real, the dream is often experienced as if it were seen from the outside, almost as if the dream were an on-going theatrical production or motion picture (Voss et al. 2014).[1] In other words, lucid dreams can be considered dissociated states of consciousness in which the dream self separates from the on-going flow of mental imagery. The dream is still a dream, but the dreamer is able to distance him or herself from the on-going imagery and may even be successful in gaining (at least partial) control over the dream plot. This phenomenological dissociation is physiologically accompanied by highly selective increases in gamma band activity around 40 Hz in fronto-temporal areas of the brain (Dresler et al. 2012; Voss et al. 2009, 2014), while occipito-parietal regions retain a typical REM-sleep profile. For lucid dreams arising out of REM sleep, we have been able to document the maintenance of sleep throughout the lucid dream, suggesting that lucid dreaming alters REM sleep without surpassing it: REM sleep atonia is unchanged, rapid eye movement bursts (REMs) continue as in REM sleep. However, the EEG frequency spec-

1 We realize that focusing on DISSOCIATION appears to neglect other important aspects of lucid dreaming like agency and knowledge about the ability to exert control, which often seem to occur simultaneously. As a matter of fact, we have observed a significant effect on control, however, during stimulation with 25 Hz but not with 40 Hz, suggesting that oscillatory activity is indeed related to specific brain function. As this is an intriguing but also surprising finding, it is in need of thorough further testing. Please keep in mind that the study of lucid dreaming is still in its fledgling stages and that we have only just begun to explore its possibilities.

trum is significantly altered (Voss et al. 2009). Normally, REM sleep dreams are accompanied by strongly attenuated activation and synchronicity in the gamma frequency band (Castro et al. 2013; Gandal et al. 2012; Voss et al. 2009), especially in frontal parts of the brain (Castro et al. 2013; Voss et al. 2009) suggestive of reduced conscious awareness and executive ego functions (Desmedt & Tomberg 1994). By contrast, gamma band activity in lucid dreaming is significantly increased, while all lower frequencies remain unchanged. This finding strongly suggests that sleep and even REM sleep is indeed maintained. Based on reports of our subjects on their lucid experiences we must assume, however, that lucid dreams push the arousal system towards waking while remaining within the region occupied by REM sleep and thus representing a substate located at the inner boundaries of the REM sleep area within the SoC. Lucid dreaming is, thus, a fragile, destabilized hybrid state. Several participants in our studies have stated that it takes effort to dream lucidly and that such dreams are easily interrupted by noise or state of mind.

Report of a lucid dreamer, f, 30 years old: "To me, being lucid is always a very exciting incident […] In this state it feels like a struggle in my brain between keeping the dream-scenery and waking. In these short periods of lucidity the awareness of the acting dream body and the real body in bed exist simultaneously and it costs a lot of concentration to keep the balance between both" (for further examples, see Voss & Voss 2014).

We also suggest that lucid dreaming is not just a hybrid state but actually the realization of two normally distinct global functions that usually don't occur simultaneously. This fits in well with the common description of lucid dreams as (partial) awakening in our dreams and involving a split between dreamer and dream-observer, who coexist and change relative dominance of the mind at will (Occhionero et al. 2005). The implications of this line of reasoning have profound impact on the theory of mind. There are two selves, suggesting that the self is a construct elaborated by the brain (Metzinger 2003, 2009, 2013). The two selves of the lucid dreamer are mediated by distinct brain regions: dreaming is ponto-occipital while lucidity is fronto-cortical. Normally these two brain regions play a winner-takes-all game and dreaming is non-lucid. We come back to this point when we present our physiological model below.

We are attracted by the idea that a key cognitive component of waking, namely insight, can be admixed or even actively injected into REM sleep. Determining the degree to which this enhancement of lucidity is voluntary necessitates a better understanding of altered states of waking conscious awareness, such as hypnosis or mind wandering. We need to know more about conscious state control and to bring that understanding into conjunction with our attempt to understand and influence consciousness.

3.5 Space of Consciousness Model (3)

To speak of lucid dreaming as a hybrid state implies, of course, that states in general have boundaries and intermediates (so-called hybrids). We have, in a recent publication (Voss & Voss 2014) taken this thought further and proposed a model based on the assumption that consciousness is a dynamical process unfolding in a phenomenal state-space continuum occupied by states of arousal such as waking, sleep, and coma. Normally, waking and dreaming constitute two distinct partitions in this state-space. In our new model, what we have called the *hybrid of lucid dreaming* is depicted as a region within the state of REM sleep that stretches REM state variability to the point of destabilizing it, bordering on waking without inducing a complete change of the global configuration.

In our SoC model, we define consciousness as a three-dimensional *space* occupied by *states* that vary as a function of sensing, judging, and motor control. "Sensing" refers to the ability to experience physical and mental fluctuations. "Judging" is meant to describe varying degrees of higher-order cognitive capacities such as reflective awareness, including the ability to dissociate, to think about the past and contemplate the future, and make decisions. The "motor con-

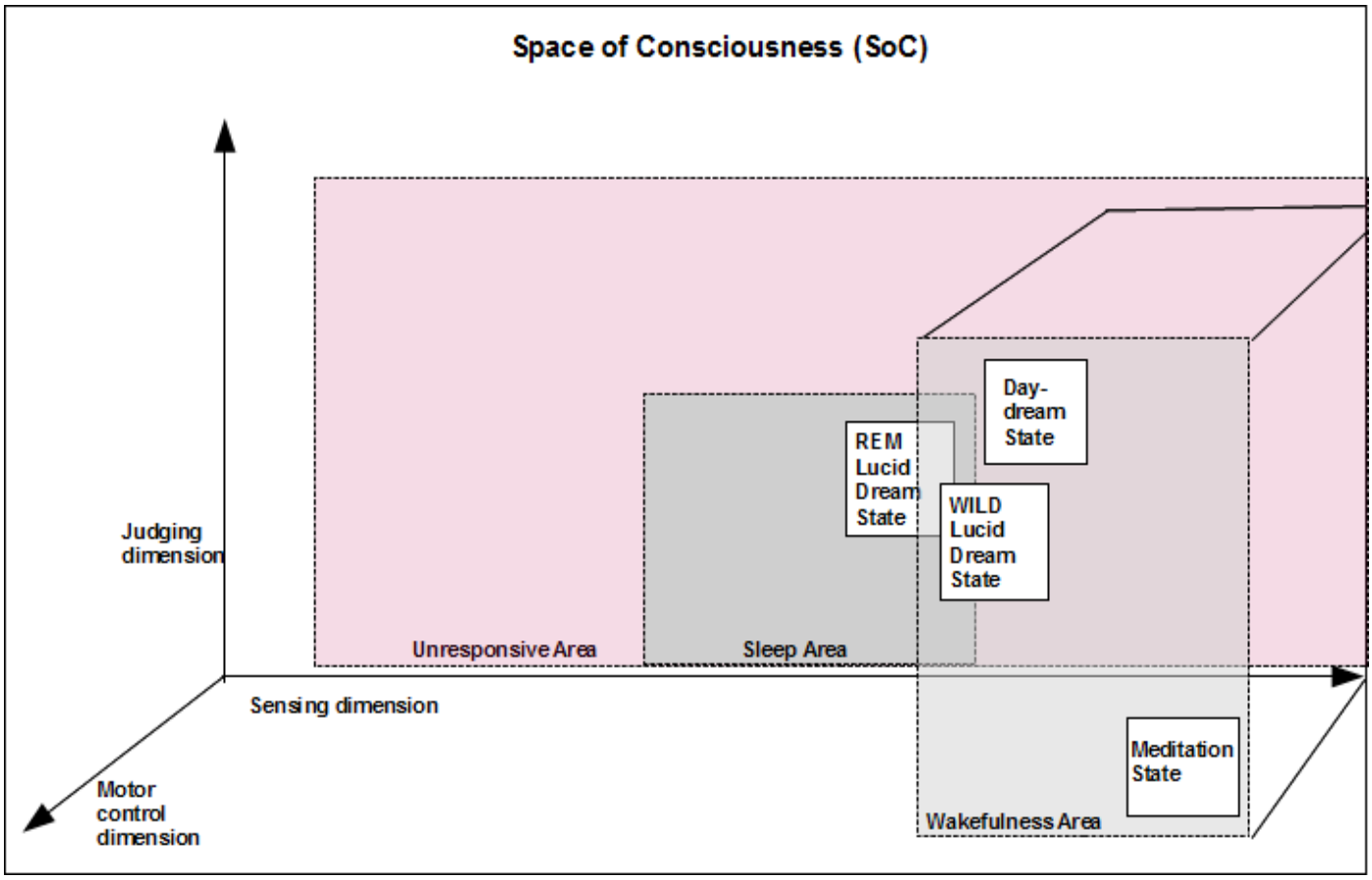

Figure 3: 3-dimensional Space of Consciousness Model (adapted from Voss & Voss 2014, p. 32).

trol" dimension was introduced to allow enough space to position different types of unresponsive states such as coma (low motor control, low sensing, and low judging) and, for example, locked-in-syndrome, which would be low in motor control but high in sensing and high in judging. Our model is even broad enough to include artificial intelligence (e.g., high judging and low sensing) and to span all forms of animal life as well (see Tononi 2004). Importantly, we do not differentiate between internal and external sources of information or state-dependent neurochemical modulations, as laid out in the AIM model (Hobson et al. 2000; for an early version see Hobson & McCarley 1977). Our space-state model is exclusively phenomenological. The main questions it addresses center around state boundaries and within-state variability.

The *space* is divided into subspaces, corresponding to *states* of arousal, such as waking, sleep, or coma. These *States* largely determine the ability to interact with the external world. We may think of this total space as originating at the near-death state, spanning over several stages of sleep and wakefulness to some ultimate wake-state of focused attention (see Figure 3). However, it should be kept in mind that the near-death state may not at all be one of minimal expressions of judging and/or sensing (Borjigin et al. 2013; Nelson 2014) so that another altered state may more accurately define the true origin of the SoC.

Lucid dreaming briefly creates a trajectory that dynamically *integrates* the region normally occupied by waking experiences with that of dreaming.

Each state, occupying some area within the SoC, can also be described by a finite number of attributes, and each state possesses a limited degree of variability. Within the partition characterizing wakefulness, for example, we find mind wandering, meditation, and hypnosis, as well as focused attention. Regarding lucid dreams, we assume that wake-induced lucid dreams can be represented by trajectories leading the system very close to the borders, but

which still remain within the overall region inhabited by wake states, whereas REM-sleep-induced lucid dreams initially belong to the sleep state and then evolve towards a brief and unstable integration of the phenomenological substates of waking and dreaming.

Some new questions that derive directly from the model concern (1) the exact number of separable states; (2) specification of the sufficient and causally enabling (perhaps even necessary) conditions allowing for transition from one state into another; and (3) the volume and the dimensionality (the "depth") of a given region in state-space characterizing each individual state, some perhaps extending over such a broad spectrum of conscious experiences that substates can be defined within the total of SoC and some occupying only a diminutive space such as coma. An example of a high-volume region in phenomenal state-space is wakefulness, covering a wide range of substates including WILD, mind-wandering, focused attention, and hyper-arousal. Another region is sleep, providing a smaller and more dimensionally limited, but nonetheless also considerable range of substates such as light sleep, slow wave sleep, REM sleep (both phasic and tonic), and lucid dreaming.

The SoC model is only an approximation, but we hope that it will prove useful in the generation and testing of specific hypotheses. With regard to lucid dreaming, we hope that this model will contribute to understanding and categorizing the many different aspects and conditions of insightful dreams such as those arising out of the wake state (WILD) versus those arising out of REM sleep. We would expect wake-induced lucid dreams to be accompanied by a much greater motor control, for example, than lucid dreams arising out of REM sleep, simply because WILD are located near the borders of the wake state whereas REM lucid dreams occur in sleep.

3.6 EEG changes associated with lucid dreaming

Our first quantitative EEG study on lucid dreaming aimed to identify changes in brain activity, provided they turned out to be measurable. For this purpose, we trained a relatively large group of students (N = 20) at Bonn University in lucid dreaming. Following several months of preparation, we took those who had achieved lucidity at home 2–3 times per week into the sleep laboratory at the Neurological Clinic of Frankfurt University Hospital.

Although our subjects were highly motivated, our hopes of being able to trace a multitude of lucid dreams soon had to be abandoned, since our enduring attempts yielded EEG recordings of only three spontaneous lucid dreams! Results of this meagre yield were published (Voss et al. 2009), showing that lucid dreaming occurs when activity in the lower gamma band around 40 Hz increases, particularly in frontal parts of the brain. In other words, the results suggested that normal dreaming is cognitively impaired because of frontal lobe deactivation and lucidity only occurs when that deactivation is suspended, either spontaneously or by design.

This finding is depicted in Figure 4, showing single subject 40 Hz EEG power (36–44 Hz) during waking with eyes closed (top), lucid dreaming (middle), and normal non-lucid REM sleep (bottom).

Another finding concerns EEG coherence, or synchronicity (see Figure 5). Whereas the coherence between different brain areas is high in waking (top), it is very low in non-lucid REM sleep (bottom). In lucid dreaming, however, it is significantly increased in comparison to non-lucid dreaming, especially between anterior and posterior parts of the brain (middle).

In this first study, we encountered several methodological difficulties.

1. For the subjects, achieving lucidity in a laboratory setting was difficult. In all three instances, lucid dreaming occurred in the late morning hours, i.e., after 8am. Our study was conducted in the sleep laboratory of the Neurological Clinic at the Frankfurt University Hospital. This implied a noisy early morning routine in which patients were frequently moved for examination purposes, breakfast was served, and floors were cleaned with heavy machinery. It is our opinion now that lucid dreaming arising out of REM sleep

is a fragile state that can be easily disrupted by ambient noise.

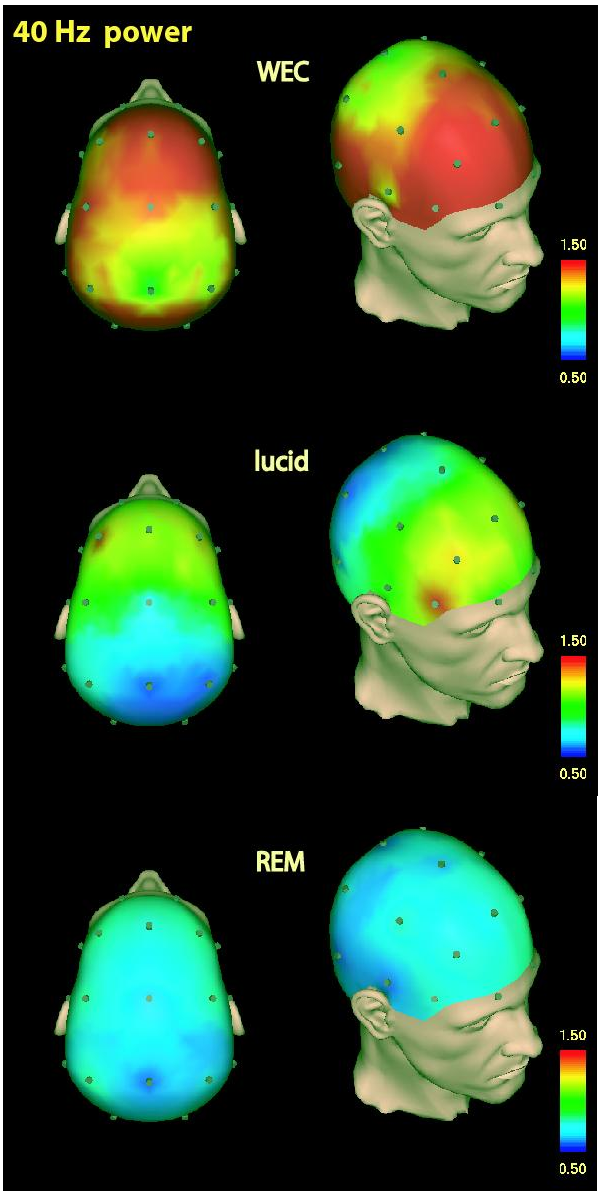

Figure 4: (adapted from Voss et al. 2009). Single subject 40-Hz standardized CSD power during **W**aking with **E**yes **C**losed (WEC) (top), lucid dreaming (middle), and REM sleep (bottom). Topographic images are based on movement-free EEG episodes and are corrected for ocular artifacts.

2. Several authors have cautioned that some of the variance in gamma activity might be caused by microsaccadic eye movements (Trujillo et al. 2005; Yuval-Greenberg et al. 2008; Weinstein et al. 1991) and by scalp EMG activity (Whitham et al. 2008; Whitham et al. 2007). Although it is not known, at this point, whether microsaccades are present in steady-states, especially sleep, we have, for publication purposes, conducted a very conservative signal analysis using current source densities (Current Source Densities, CSD). By using this method, we may have overcorrected our EEG scalp potentials, which means that the actual increase in lower gamma band activity is probably even greater than reported.

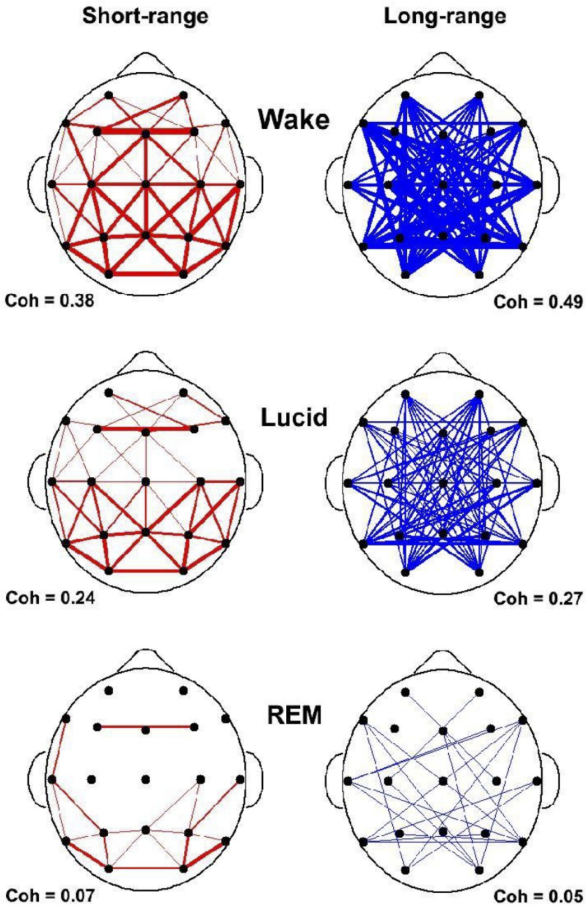

Figure 5: State-dependent short and long range coherences in the 40 Hz frequency band during Waking with Eyes Closed (WEC) (top), lucid dreaming (middle), and non-lucid REM sleep dreaming (bottom). Coherences are indications of interscalp networking and synchronization. Short-range (N = 55 pairs) was defined as less than 10cm and long-range (65 pairs) as larger than 15cm inter-electrode distance. Coherences are lowest in REM sleep and strongly enhanced in lucid dreaming.

3. Our subjects reported themselves to be less lucid in the laboratory than at home. When

asked to specify this subjective rating, we found that the subjects' responses were vague and mostly concerned with the amount of plot control achieved in the dream.

The findings of our 2009 study indicate that when subjects became lucid, they shift their EEG power, especially in the 40Hz range and especially in frontal regions of the brain. This shift is, in part, a consequence of pre-sleep auto-suggestion, indicating that REM dream consciousness, which is largely automatic (i.e., spontaneous, involuntary, and intrinsic), is partially subject to volitional force. This observation and its interpretation have an obvious relationship to the question of free will, an implication we will discuss later. Our speculative hypothesis is that dream lucidity arises when wake-like frontal lobe activation is associated with REM-like activity in posterior structures.

3.7 The gamma band hypothesis (4)

In our study of EEG tracings during lucid dreaming, the most striking finding was that lucidity was accompanied by an increased activation of the frontal lobes of the brain. This applies both to synchronicity and to consciousness-related frequencies (around 40 Hz). This observation has led us to propose a "gamma band hypothesis" (Voss et al. 2012; Hobson & Voss 2011), suggesting that brain activation in the 40 Hz frequency range is related to secondary consciousness. We have, in a recent study (Voss et al. 2014), investigated this hypothesis by fronto-temporal application of weak electrical currents in various frequencies. The study was aimed at testing for causality. If activity centered around 40 Hz was causally related to secondary consciousness as expressed in lucid dreaming, then the application of 40 Hz should induce lucid dreaming, provided that it is possible to change brain function in a frequency-specific way through mild electrical stimulation.

3.8 Induction of lucidity via electrical stimulation

In our latest study, we set out to test the hypothesis that lower gamma activity in the frontal and temporal parts of the brain causally enables lucidity during dreaming. If the observed gamma activity during naturally-occurring lucid dreaming plays a causal role in lucidity, we predicted that facilitation of that frequency band with 40 Hz transcranial alternating current stimulation (tACS) over fronto-temporal areas would increase the probability of lucid dreaming. On the other hand, tACS with a lower or higher frequency should have no effect or even suppress lucid dreaming. The current strength was kept below arousal threshold (250 µA) in order not to awaken the subjects. Participants were inexperienced lucid dreamers without psychopathology or sleep problems. They were not asked to try to have a lucid dream. Instead, they were told that the study goal was to investigate the effects of mild electrical stimulation in different frequencies on dream content and sleep parameters. While we were doubtful whether it was at all possible to enforce a specific rhythm on the brain ("driving fields"), results suggest that it is indeed possible to change brain activation in a frequency-specific way (see Figure 6). However, we only observed such an effect for frequencies within the lower gamma frequency band. Stimulation with higher or lower frequencies did not result in a measurable change in the respective frequency band, i.e., stimulation with 2 Hz did not lead to an increase in delta frequency band power.

Regarding lower gamma band stimulation, the induced change in lower gamma band brain activity was obviously potent enough to alter conscious awareness in the dream with increased LuCiD ratings especially for INSIGHT and DISSOCIATION. Again, this was not observed following stimulation with either higher or lower frequencies.

In this experiment, we tested twenty-seven healthy subjects, during up to four non-consecutive nights. Testing was conducted in a neurophysiologic sleep laboratory at Goettingen University Hospital. We tested during the summer break of the laboratory and on weekends, which provided a quiet environment and which allowed subjects to continue sleep beyond normal hospital wake-up hours. Participants were allowed

to sleep uninterrupted during the first half of the night until at least 3am.

Starting at 3am, stimulation (30s long) was conducted during REM phases, and subjects were awakened shortly after this stimulation. At this time, they were asked to provide a dream report and ratings to all items of the LuCiD scale. The study was performed double blind, so that neither the subject nor the interviewer knew the stimulation frequency applied. In a repeated measures design, all participants were exposed to all stimulation conditions, i.e., sham (no current applied), 2 Hz, 6 Hz, 12 Hz, 25 Hz, 40 Hz, 70 Hz, and 100 Hz (details of methods, see Voss et al. 2014).

Note that we only applied tACS during REM phases, as lucid dreams arising out of REM sleep were our main research interest. Repetitive stimulation during other sleep stages would have exhausted the experimental protocol and would have led to many undesired side effects such as sleep-deprivation from repetitive early awakenings, changes in sleep architecture, carry-over effects from stimulation in other sleep stages, time-of-night effects, etc.

As shown in Figure 6, only stimulation in the lower gamma band, i.e., stimulation with 25 and 40 Hz, led to an increase in activity in this particular frequency band.

At present, we can only speculate why the other frequencies were not as easily adopted by the brain. Lower frequencies might not have been readily entrained because of state-dependency, as proposed by several authors (Buzsáki & Draguhn 2004; Vyazovskiy et al. 2009; Tononi et al. 2010; Brown et al. 2012; Suh et al. 2010). It is possible that if we had tried to induce a frequency typically enhanced in slow wave sleep (SWS), for example, such stimulation might have disturbed physiological sleep-dependent oscillations, which would prevent the brain from accepting such a driving field. This notion is supported by direct current (DC) studies (equivalent of 0 Hz) of brain stimulation in REM sleep (Jakobson et al. 2012a; Stumbrys et al. 2013). Both group of researchers were unable to alter on-going mental activity at 0 Hz, just as we were unable to induce lucidity at 2, 6, or 12 Hz. Interestingly, dream reports were less frequent in these stimulation conditions (Voss et al. 2014). However, this does not explain why stimulation with higher frequencies, i.e., 70 and 100 Hz, did not lead to an increase in these frequency bands. It also does not explain why a DC stimulation during stage 2 sleep reportedly effected an increase in visual dream reports although, in this case, the effect was apparently small and, according to the authors, possibly due to arousals and short awakenings (Jakobson et al. 2012b). At this point, we speculate that lower gamma band frequencies lead to a visible effect because they are linked to the unfolding of secondary consciousness in dreams.

The most striking finding was that subjects reported the ability to "see myself from the outside" and to "watch the dream from the outside as if it was displayed on a screen". These items belong to the factor DISSOCIATION. Apparently, our subjects took on a third-person perspective following lower gamma band stimulation but not stimulation in any other frequency (2 Hz, 6 Hz, 12 Hz, 70 Hz, 100 Hz) or sham (no current applied).

However, although we were able to induce secondary consciousness in dreams through stimulation with 40 Hz, a similar though smaller effect was observed for stimulation with 25 Hz. Surprisingly, 25 Hz stimulation was associated with CONTROL over the dream plot, whereas stimulation with 40 Hz was not. This finding suggests that specific brain rhythms may be directly linked to cognitive functions and that we have just begun to discover their potential.

Surprisingly, we found no evidence of theta-gamma coupling, as would be expected from NREM sleep studies (Marshall et al. 2011). At present, we think this may be related to the fact that NREM sleep is highly synchronized, perhaps facilitating such coupling, whereas NREM sleep is desynchronized. As is often the case in science, answering one question generates several others. We will continue to search for answers and also look forward to the extension of our studies by other laboratories.

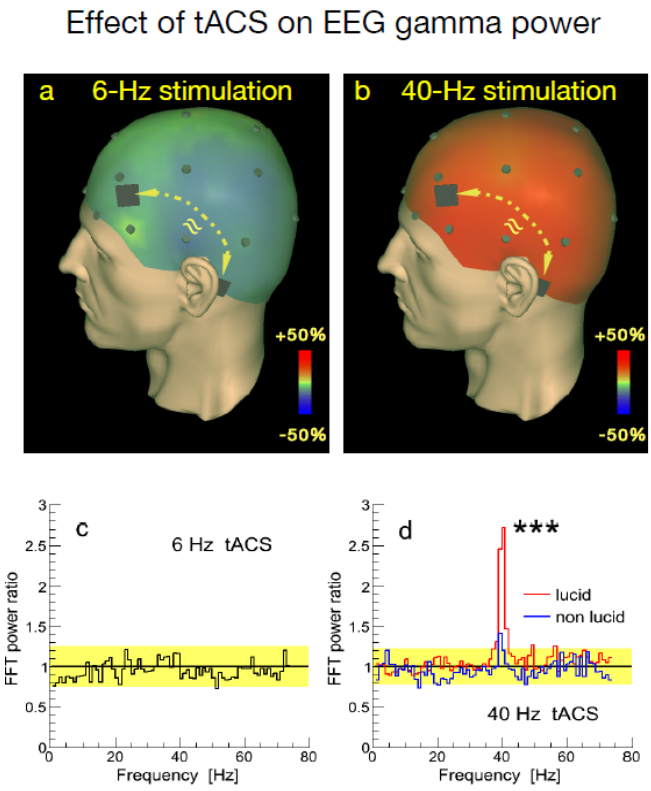

Figure 6: Effect of transcranial alternating current stimulation (tACS) on EEG gamma power. tACS electrodes were placed bilaterally at frontal and temporal positions (black rectangles) and current flowed back and forth between these electrodes. EEG electrode placements are indicated as dark dots.

a) Stimulation with 6 Hz resulted in no change in lower gamma activity around 40 Hz (37–43 Hz).

b) Stimulation with 40 Hz led to a strong increase in lower gamma activity around 40 Hz.

c) Grand average Fast Fourier Transform (Fast Fourier Transform, FFT) power ratios of activity during vs. activity prior to stimulation for the 6 Hz stimulation condition. Yellow shading represents mean values 2 standard errors (s.e.). Any excursions outside of this range would be considered significant at least at the $p < .05$ level. However, with 6 Hz, we see no significant stimulation-induced increase in 6 Hz activity.

d) Grand average FFT power ratios of activity during vs. activity prior to stimulation for the 40 Hz stimulation condition. Yellow shading represents mean values 2 standard errors (s.e.). Note that lucid dreams (red line) are accompanied by a significantly larger increase in the 40 Hz frequency band than non-lucid dreams (blue line) (independent two-sided t tests between lucid and non-lucid dreams during stimulation with 40 Hz: $t_{40Hz} = 5.01$, $df = 35$, $p < 0.001$).

3.9 Brain Correlates of Lucidity and a Neuropsychological Model.

Our findings of frontal cortical EEG activation to a level intermediate between non-lucid dreaming and waking is compatible with the hybrid state formulation derived from subjective data. More specifically, we attribute the findings to sufficient activation of executive ego functions in the frontal lobes (Baddeley 1992; Goleman & Davidson 1979), but not so intense an activation as to disenable the REM sleep generator in the pons and posterior thalamocortical brain that is the physical substrate of dreaming. This formulation is resonant with the oft-repeated complaint that dream lucidity is difficult both to attain and maintain. The hybrid state of waking and dreaming is thus both rare and fragile, suggesting that it is not an adaptive condition for survival and has been eliminated, or reduced to a very low level, by evolution.

It is not difficult to imagine why it would be maladaptive to program waking and dream consciousness at the same time. We will come back to this consideration when we discuss clinical implications below, but at this point we wish to stress the winner-takes-all model that we have sketched as the protoconsciousness hypothesis (Hobson 2009). According to that model, both waking and dreaming are states of consciousness engendered by specifiable brain mechanisms. Waking is governed by aminergic dominance, and dreaming by cholinergic dominance, but both states depend on suppression but not total obliteration of the other. Waking and dreaming are competitive and cooperative brain-mind states.

Of course there is more to the neurophysiology of the differential brain mediation of waking and dreaming. In addition to the chemical neuromodulation mentioned above, we know that REM sleep dreaming is mediated by the active inhibition of both sensory and motor input and output. The data from our studies of lucidity now further suggest that the two states are also differentiated by regional activation of

the cortex. Waking and lucid dreaming are both favored by strong 40 Hz power in the frontal EEG, indicating that frontal lobe activation is a critical mediator of both waking and lucid dream consciousness. Because this sort of activation has been found to correlate with lucidity, we hypothesize that it mediates the wake state component of lucidity. This supposition is also supported by the finding of frontal lobe inactivation in REM sleep, which is correlated with non-lucid dreaming (Braun et al. 1997; Dang-Vu et al. 2007; Desseilles et al. 2011; Nofzinger et al. 1997).

An additional nicety of the theory is that the voluntary eye movements by which lucid dreamers indicate their awareness of their conscious state to third-party observers (Hearne 1978; LaBerge 1980) is evidence of frontal eye field activation in lucid dreamers. This volitional override of the brain stem saccadic eye movement generator is further evidence of the change in the balance of brain-power in several states of consciousness. In lucid dreaming, the wake state control of gaze is returned via frontal lobe activation. According to Metzinger (2013), this is tantamount to the activation of an "epistemic agent model" (EAM), a representation of the self as knowing. This would seem to clinch the argument that conscious states are electrophysiologically differentiated and explained by neurophysiology. This is not surprising, but its specification has been greatly advanced by the scientific investigation of lucid dreaming. A speculative hypothesis that we believe must be tested is that waking entails not only frontal lobe dominance in mediating thought and top-down eye movement control, but that the brain stem itself is primarily harnessed to the analysis of external data with relative suppression of its internal program (see also Activation-Input Gating-Modulation, AIM model, Hobson 1992).

Unfortunately we have no animal model for dream lucidity because we have every reason to suppose that reflective insight such as observed in lucid dreaming necessitates sufficient language capacities assumed essential in the formation of abstract thought (Einstein 1941) or reporting of such. For this reason, we assume that infra-human mammals, which lack significant language capability, cannot become lucid or report their non-verbal dreams. Whatever one thinks about animal dreams (and we suppose that primary consciousness does accompany their very elaborate REM sleep), no one believes that they are capable of verbally reporting their subjective experience. Dogs and cats do, however, whimper, twitch, and run in their sleep (Lucretius 1995), lending credence to the hypothesis of primary dream-consciousness in animals other than human beings. Animals may dream, and they may become lucid in their dreams, but we doubt the latter and can never offer scientific judgment about either possibility.

The exploration of the physiology of primary consciousness is in its infancy and can be expected to flourish in the future even if we have only rats for subjects (Datta & Hobson 2000; Datta & MacLean 2007). But if we want to learn more about secondary consciousness, we will have to put up with rather severe limitations (Dresler et al. 2012). We trust that advances in brain imaging technology may help this situation. Meanwhile, we hold that the study of lucid dreaming, however difficult, conveys insights about the brain basis of consciousness that is obtainable in no other way.

4 Summary and outlook

What we have learned so far is that the occurrence of lucid dreaming seems to be facilitated by brain maturational processes, in particular the integration of the frontal lobes into the cortico-cortical and cortico-thalamic networks, as outlined in thesis no. 1. Moreover, in lucid dreaming arising out of REM sleep, the apparent spatial dissociation between two states of arousal, waking (rostral) and sleep (caudal) is accompanied by the phenomenological dissociation expressed in an altered conscious awareness, for example, by changing from a first-person to a third-person perspective. This observation has led us to propose that lucid dreaming is to be regarded as a hybrid state (thesis No. 2) within a state-space continuum (thesis No. 3). Another observation concerns changes in frequency-specific oscillatory activity, with significant increases in lower gamma band activity in

lucid dreams, suggesting that lower gamma band activity plays an important role in achieving and/or maintaining a lucid dream. By electrically stimulating the dreaming brain in this frequency band we have been successful in trying to elicit lucid dreams, suggesting a causal role for the gamma frequency band, perhaps not only in lucid dreaming but in higher-order consciousness per se (thesis No. 4).

In spite of this basic scientific progress, our conclusions are only speculative and in need of experimental testing. One future line of research might be the spatial networking involved in consciousness. In our research, we have only stimulated the brain through bilateral frontotemporal stimulation. We found only lower gamma band activity to be successful in inducing lucid dreaming. What happens, however, when we use different frequencies in rostral and caudal areas? Another question in need of attention is that of applicability. Will wake-training in gamma band activity through Neurofeedback and/or tACS increase the rate of lucid dreaming? What about effects on higher cognitive functions? Finally, we hope that our findings might some day be implemented in clinical settings. This concerns, for example, comatose or locked-in patients who are, through their trauma, confined to a particular state and who may benefit from the possibility of maximally utilizing state capacities.

We have now reviewed and discussed the current state of the art with respect to lucid dreaming. Having been *very* skeptical at first about whether such research could be conducted at all using a rigorous scientific protocol, we have grown increasingly optimistic—if not enthusiastic—about the prospects for the study of lucid dreaming, allowing us to monitor the brain as the mind changes conscious states. In that spirit, lucid dream science may be likened to a moon landing: yes it was hard to achieve, but we did it, and returned to *tell the tale.*

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Insight: What Is It, Exactly?

A Commentary on Ursula Voss & Allan Hobson

Lana Kühle

In "What is the state-of-the-art on lucid dreaming? Recent advances and questions for future research", Ursula Voss and Allan Hobson provide a detailed view of the features characterizing lucid dreaming and put forward four innovative hypotheses to explain why and how lucid dreaming occurs, as well as how lucid dream states are related to other states of consciousness. Their aim is to show that not only is there benefit to studying lucid dreaming in itself, as this would give us a deeper understanding of dream consciousness, but also that it is an important endeavor because of the kind of conscious state lucid dreaming is. To be sure, Voss and Hobson make important in-roads into the empirical study of lucid dreaming that ought to sprout new and exciting research in the area. As I will show, however, there remains much conceptual work to be done. In this commentary I tease out three aspects of Voss and Hobson's view that would greatly benefit from philosophical consideration. First, I highlight the lingering confusion with what exactly insight is, and I point to how one might go about clarifying this notion. Second, I argue that our understanding of insight and meta-awareness in lucid dreaming could be greatly increased by looking at how these concepts are used and understood in relation to meditative states. Last, I explore the role of the body in lucid dreaming and argue that one's bodily awareness in lucid dreams is far more multi-faceted than at it might at first seem.

Keywords
Bodily awareness | Consciousness | Dreaming | Insight | Lucidity | Meditation | Meta-awareness

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1 Introduction

In "What is the state-of-the-art on lucid dreaming?—Recent advances and questions for future research", Ursula Voss & Allan Hobson (this collection) aim to defend the veracity of, and value in empirically studying lucid dreaming. They provide a detailed view of the features characterizing lucid dreaming as well as hypotheses for why and how lucid dreaming occurs. As they claim, not only is there benefit to studying lucid dreaming in itself, as this would give us a deeper understanding of dream consciousness, it is also an important endeavor because of the kind of conscious state lucid dreaming is. The authors argue that the study of lucid dreaming will also deepen our understanding of the structure of consciousness more broadly—the nature of meta-awareness, the notion of a self, and its relation to our ability to be meta-aware, etc.

To be sure, I think that Voss and Hobson make important in-roads in defending the vera-

city of lucid dreaming and putting forward hypotheses that ought to sprout new and exciting research in the area, as I will elaborate in section 2. However, I think there remains a need for caution in how we describe and define lucid dreaming, a great need for further clarification of what lucidity involves, and potentially fruitful connections to be drawn between lucid dreaming states and meditative states. In what follows, my goal is to elaborate on each of the following three points with a view to generating future discussion and discovery not only in the area of lucid dreaming research, but also in areas of meditation research and embodied awareness research.

The first point on which I focus—in section 3—is the concept of "insight". To be sure, Voss and Hobson do offer us a definition of insight—an awareness of being in a dream, knowing that what one is currently experiencing is not real, etc.[1] However, their definition conflates and confuses whether the insight involved in lucid dreaming is a state or an ability, and whether it is an epistemic or phenomenal state/ability. In other words, does it involve knowledge of something, is it simply experiential, or is it an ability to do or know something, etc.? In this section, then, I delve deeper into what the authors mean by "insight" and explore these questions, as well as inquire whether insight is best understood using epistemological or phenomenological frameworks. Moreover, I consider what the consequences of an underdeveloped understanding of the concept of insight might be for the current state of research on lucid dreaming.

The second point on which I focus—in section 4—is the authors' suggestion that we look at other states of waking consciousness with a view to determining how exactly insight comes to co-occur with REM sleep. I consider the potential similarities between lucid dreaming and meditation, and suggest that there are fruitful connections to be drawn between the meta-awareness associated with insight in lucid dreaming and the meta-awareness involved in certain meditative practices.

The third point I consider—in section 5—is the experience of the body in lucid dreaming. In particular, I argue that if we accept one of the authors' hypotheses—the Hybrid State Hypothesis—then we can enrich our understanding of the bodily awareness involved in lucid dreaming by looking at certain accounts of bodily awareness in waking consciousness. More specifically, I offer one interpretation for why the dual experience of the dream body and the real body in lucid dreaming is said to demand a lot of concentration by appealing to my recent work on bodily awareness in waking experiential consciousness. Before I begin exploring each of these three points, however, let me first summarize Voss and Hobson's important contributions.

2 Voss & Hobson—A summary

In their piece, Voss and Hobson consider the latest empirical evidence on lucid dreaming and set forth four hypotheses that, they suggest, would begin to explain the whys and the hows of lucid dreaming. The four hypotheses proposed—the BMH (Brain Maturation Hypothesis), the GBH (Gamma Band Hypothesis), the HSH (Hybrid State Hypothesis), and the SCH (Space of Consciousness Hypothesis)—are based on five years of scientific research on lucid dreaming and, together, are meant to provide a multi-faceted picture of what lucid dreaming is, how it arises, why it arises, and how it relates to other states of consciousness.

The first hypothesis they propose is the BMH (Brain Maturation Hypothesis), which serves as a potential explanation for *why* there is lucid dreaming. Evidence shows that lucid dreaming occurs naturally and most often during certain periods of brain development and maturation in children and young adults.[2] The empirical evidence also suggests that lucid dreams are peculiar mental states that occur during the final stages on frontal lobe integration and, as such, are "nothing but an

1 See Voss and Hobson's target article in this collection, and their development of the LuCiD (Lucidity in Dreams) scale in Voss et al. (2013).

2 See Schredl & Erlacher (2011), as well as the Voss & Hobson target article (this collection).

accidental confounding of conscious states during a time of high cerebral diversification" (Voss & Hobson this collection, p. 8). For these reasons, Voss & Hobson hypothesize that "during childhood and puberty, frontal lobe activity is sometimes decoupled from the arousal state so that frontal lobes can become active in a state for which this type of activity is untypical"—the BMH (this collection, p. 8). This, they propose, explains *why* lucid dreaming occurs.

Voss and Hobson then offer three other hypotheses—GBH, HSH, and SCH—as explanations of *how* lucid dreaming occurs. The GBH (Gamma Band Hypothesis) provides an account of how lucid dreaming arises by appealing to specific changes in brain activity associated with the onset of a lucid dream during ongoing REM sleep. Specifically, this hypothesis holds that the principle brain correlate of lucid dreaming is 40Hz activation of the frontal cortex—activation at this frequency brings about the meta-awareness associated with secondary consciousness. The HSH (Hybrid State Hypothesis) & SCH (Space of Consciousness Hypothesis) shift away from particular brain activity and, rather, provide a brain-based explanation and classification, respectively, of what lucid dreaming is in relation to other mental states. The HSH suggests that lucid dreaming involves elements of both waking and dreaming consciousness, and is, indeed, a destabilized hybrid state involving both frontal cortex activation, as suggested by the GBH, and REM sleep cortical activation. The HSH explains the *how* of lucid dreaming by offering a way to reconcile the subjective reports of lucid dreamers with the empirical data of cortical activation. The SCH lays out a three-dimensional model with which to categorize various states of consciousness and to see how the spectrum of mental states relate to one another along certain variables. This model allows us to situate lucid dreaming within a state space of consciousness and ascertain the similarities it might hold with other waking states of consciousness. These four hypotheses work together to consolidate the quantitative and qualitative data on lucid dreaming and provide a picture of why and how lucid dreaming occurs. For my purposes here, I will set aside the BMH and the GBH and will instead return to the HSH and the SCH in sections 4 and 5.

Importantly, the authors specify that their interest lies in considering REM-sleep lucid dreaming. In other words, the focus of their paper is to consider cases where the dreamer correctly achieves insight into the fact that he or she is dreaming while the dream continues (see Voss & Hobson this collection, p. 4). The authors appeal to the Lucidity and Consciousness in Dreams Scale (LuCiD) they developed to assess the various features of a lucid dream state, and with this they describe eight features of lucid dream consciousness: insight, realism, control, memory, thought, positive emotion, negative emotion, and dissociation.[3] Of these eight factors, three are highlighted as particularly important to the study of lucid dreaming—insight, control, and dissociation—as they do not typically appear in non-lucid dreams.[4] The core criterion of lucid dreaming, however, appears to be insight. This feature, once it appears, then causally enables the possibility of control and dissociation. One of the issues that I will explore further in the next section is whether insight should be thought of as an epistemic or a phenomenal state, and what either of these interpretations might mean for understanding the role of insight in lucid dreaming.

Most of Voss and Hobson's article discusses the features of insight and dissociation in relation to recent empirical evidence, and although there is indeed very illuminating discussion of these features, I nonetheless think there is still much conceptual confusion and semantic vagueness with regard to what exactly they are and how they relate to our non-dreaming conscious states. As I show in the next section, this is where philosophical considerations can help clarify the conceptual landscape and help move the empirical project forward.

3 Voss and Hobson don't discuss the possibility of there being varying degrees of lucidity, and thus how these features might relate to such varying degrees. For a discussion of this, see Noreika et al. (2010).

4 There are rare cases where some of these aspects do occur in non-lucid dreaming states. See Voss et al. (2013) and Voss et al. (2014).

3 Understanding insight

The first element of Voss and Hobson's piece on which I want to focus my attention is the concept on insight. More specifically, I want to explore what the notions of lucidity and insight involve and how they relate to dream consciousness. As the authors clearly state throughout their paper, lucidity involves insight, and insight seems to be the key feature of lucid dreaming as it serves the basis of dream lucidity and enables the other elements of dream lucidity to arise, e.g., dissociation, control, etc. Without insight, it appears, one could not have lucid dreaming. Or, at the very least, it seems conceptually essential to have insight in order to be in a state of lucid dreaming.[5] Given the importance of insight, it is key that we obtain a clear view of precisely what it is.

In the first place, I think it is necessary to distinguish between the *state* of insight and what one has insight about—let us refer to this as the *content* of insight. With regards to the state of insight, it is not so clear what this precisely is, and the authors do not adequately clarify it. For example, if it is an epistemic state, then it would have an intentional object. The questions then become: what are the intentional objects of the state of insight? What kind of knowledge does the state of insight involve? It is in the second section of their paper, "Quantification of Dream Lucidity as Subjective Experience", that Voss and Hobson attempt to describe and define what the state of insight is. There, they liken insight to a subjective awareness of our mental state. This subjective awareness, they go on to claim, is a form of secondary awareness, or meta-awareness that arises in lucid dreaming. They define meta-awareness, following Metzinger (2013), as "an instance of actively acquired self-knowledge or a sudden insight, regardless whether it is accurate or counterfactual" (Voss & Hobson this collection, p. 4). In short, insight appears to be a form of awareness that arises out of a more primary awareness, and it allows the subject to attend to, or "see" what is occurring in primary awareness.

Now, a number of questions and issues arise from this definition of the state of insight. First, it seems quite problematic to define insight as a form of meta-awareness, and then to define meta-awareness as an instance of sudden insight. Perhaps, however, we might want to rely on the first half of the disjunct in the definition quoted above and understand insight as a form of actively-acquired self-knowledge. Given that the authors refer to insight as a form of reflection (Voss & Hobson this collection, p. 6) and as a form of knowing (ibid. p. 8) elsewhere in the text, I will assume that this is the more accurate reading of the definition. However, this still raises questions. In what way are we to understand "actively acquire" in the case of lucid dreaming? What does the dreamer *do* in a non-lucid dream state to acquire insight and thus bring about lucid dreaming? Is lucid dreaming an ability?[6] If so, then perhaps it is trainable. Trainability might, in turn, provide us with an answer to the first two questions: namely, what might be involved in actively acquiring insight and what exactly the dreamer does. If it is an ability, perhaps the ability in question is one of moving into a state of meta-awareness. Moreover, if the ability to shift into a state of meta-awareness is an element of what the subject "does" to actively acquire insight while dreaming, then looking to other mental states that involve meta-awareness and that are also "trainable" could be beneficial.

One such set of mental states that involve an aspect of trainability are meditative states. Meditation is a practice, and with practice one is able to achieve and sustain certain forms of awareness—focused attention, open awareness, etc.[7] If we take the element of practice in meditation as being akin to a form of trainability, and the forms of awareness in meditation to be

5 We might not, however, be warranted to make a similar empirical claim, i.e., that insight is empirically essential *and* sufficient for lucid dreaming. Indeed, there is controversy over whether insight is empirically sufficient for lucid dreaming. See Voss et al. (2013) and Windt & Metzinger (2007) for further discussion of this issue.

6 For a review of the ways in which lucid dreaming is trainable see Stumbrys et al. (2012).

7 Focused attention meditation involves developing one's ability to concentrate on an object for an unlimited amount of time. Open presence/awareness meditation involves opening one's awareness to all experiential aspects of the moment, e.g., mental states, bodily sensations, environmental stimuli, etc., and not attending to anything in particular.

akin to meta-awareness, then looking at the practice of meditation—what one does, how one improves, and so on—might be informative in ascertaining whether actively acquiring insight in lucid dreaming is something that is trainable.[8] As I will detail in the next section, I believe there are also other reasons to consider meditation in relation to lucid dreaming.

Another line of questioning that arises from Voss and Hobson's definition of the state of insight relates to the concept of self-knowledge that, they claim, is an element of insight. How are we to understand the concept of "self-knowledge" as it applies to the insight gained in lucid dreaming? What is the "self" involved? And how strict a use are we making of the concept of knowledge—do we mean a justified true belief? The state of insight seems to involve very different characteristics. Voss and Hobson hold that insight involves knowledge, or the realization that one is dreaming, and they also describe insight as an experiential phenomenon, and one that involves reflection. The issue here is that "knowledge", "realization", "experiential phenomenon", and "reflection" are not interchangeable concepts. It remains quite unclear from the descriptions of insight provided whether we should view the state of insight as an epistemic or phenomenal state of consciousness. Based on the information Voss and Hobson provide in their piece, I am inclined to move away from an epistemological view of the state of insight as I think the concept of self-knowledge is too complex for the phenomenon that Voss and Hobson describe. What I mean here is simply that with the concept of self-knowledge come notions of identification, veridicality, the self, and so on, and I do not think that such a complex concept is necessary to account for the *experience* of insight in lucid dreaming. As Voss & Hobson explain, insight is "[t]o some extent, the dreamer [having]"—"however limited"—"access to secondary consciousness, enabling her to reflect on her present state" (this collection, p. 8), and "[b]y secondary consciousness we mean the subjective awareness of our state in dreaming" (ibid., p. 4). Instead, I would suggest using the concept of self-awareness to capture what is involved in insight, and by self-awareness I mean here simply the awareness of being in a certain experiential moment.[9] So, in the case of insight, one becomes aware of dreaming—a self-awareness—rather than acquiring the self-knowledge that one is dreaming. Perhaps, however, there is reason to separate the concept of insight from that of lucidity, and with this distinction we might want to describe lucidity as a phenomenal state and insight as an epistemic state. I think there might be good reason to take this route, and I explore this in the next section by considering the potential relation between insight in lucid dreaming and insight in meditative states.

Now, these are issues that arise when considering what is meant by the "state" of insight. As I distinguished earlier, however, there is also the "content" of insight. With regards to the content of insight, in cases of lucid dreaming things are relatively clear: one gains insight on the nature of one's current dream state, i.e., that one is currently dreaming. In other words, insight involves coming to realize *that* one is dreaming. This way of describing what occurs in insight, however, could be seen as problematic in that it takes insight to involve a particular kind of knowledge, namely, knowledge-THAT. If indeed insight involves knowledge-THAT, then this opens the door to theory-contamination; that is, the content of insight is contaminated by what one already believes about dreams, consciousness, etc.[10] Although I grant that this issue shows that there is a need to clarify what exactly the content of insight is, I am uncertain that it is as problematic as it might at first seem to hold that insight involves knowledge-THAT. How else would one be able to "realize" that one was dreaming if one was not able to identify, to some degree, that the state one is in is a dream state? Moreover, it certainly seems that to perform such an identification one

8 The Tibetan Buddhist practice of dream yoga is a particularly interesting area worthy of exploration in relation to this issue. See LaBerge (2003) for a discussion of dream yoga in relation to lucid dreaming research.

9 The "self" in self-awareness here does not refer to an ego or any robust notion of a self. Moreover, the kind of awareness I'm suggesting is not a categorical awareness, i.e., an awareness of the experiential moment as belonging to a category of consciousness (see Metzinger 2009). Rather, it is meant simply to point to a reflexivity of awareness (see the concept of "pre-reflective self-awareness" in Zahavi 2005).

10 Thanks to Thomas Metzinger for pointing out this issue.

would rely on theory-contaminated beliefs—certain conceptions of what a dream is like, etc. Perhaps there is no way of avoiding theory-contamination altogether, and thus the issue becomes one of determining how much contamination is allowable in the case of insight.

I certainly grant that given the state of research into lucid dreaming—it is still very much in its infancy, no doubt—it is not unexpected that a clear understanding of a complex concept such as "insight" is still lacking. To be sure, the authors have provided a good starting point for developing a full description of the state of insight. However, given that it is, arguably, the key element of dream lucidity, I worry about how well we can empirically investigate, or interpret our empirical findings of the whys and hows of lucid dreaming if we don't first ensure that we have a working understanding of insight. To define insight as a form of meta-awareness, or secondary consciousness that involves actively acquired self-knowledge, is not informative enough to allow us an understanding of what insight in dream consciousness is or why it is so special and important.

To be sure, I think it would be entirely inappropriate to hold Voss and Hobson accountable for not teasing out the concept of insight further. They are empirical researchers, and as such have paved the way for future research in this area. However, I think that the lack of conceptual clarity and the semantic vagueness that remains in this area point to the need for philosophical inquiry and the value of integrating philosophical work with empirical work on lucid dreaming. It now lies in the hands of philosophers to ensure that the future progress of this research is based on a strong conceptual foundation. One direction to take in this endeavor is to follow Voss and Hobson's suggestion and look at other areas of research concerned with meta-awareness, reflection, and insight. In the next section, I propose that one such area is that of meditation.

4 Lucidity, meta-awareness, and meditation

The second point I want to focus on is Voss and Hobson's desire to consider other states of consciousness to better understand the state of lucid dreaming. In particular, they express an interest in considering altered states such as hypnosis or mind wandering. I suggest that there might also be benefit in considering meditation. Specifically, I think we can fruitfully make use of how the notion of insight in meditative experiences is developed to clarify that of insight in lucid dreaming. We would first have to show that there are enough important similarities between the notion of insight involved in meditation and the notion of insight involved in lucid dreaming, and this will be my aim in what follows.

To be sure, there are many and various meditation styles and practices, each with its own experiential path to higher states of awareness. Broadly speaking, there are three categories of meditative practice, each with variants, and there is overlap in some respects between the categories.[11] First, there is focused attention meditation—this involves developing one's ability to concentrate on an object for an unlimited amount of time. Second, there is open presence meditation—this involves opening one's awareness to all experiential aspects of the moment, e.g., mental states, bodily sensations, environmental stimuli, etc., and not attending to anything in particular. Third, there is insight meditation—this involves developing mindfulness or meta-awareness over one's mental states. More specifically, and most interestingly when compared to the concept of insight in lucid dreaming, "[insight meditation] is also one of the earliest and most fundamental forms of meditation. For Buddhist theorists, [insight meditation] is a style of meditation that, in combination with the focus or stability provided by cultivating [focused attention], enables the practitioner to gain insight into one's habits and assumptions about identity and emotions" (Lutz et al. 2007, p. 504). For my purposes here, I will set the finer variations among these three main styles of meditation aside since I'm merely concerned with drawing out the similarities, in broad strokes, between the sought-after meditative state and the insight it is intended to provide,

11 See Lutz et al. (2007) for a more detailed account of the various styles of meditative practice and their historical roots.

and the lucid dreaming state and the insight required to bring it about. Interestingly, however, the concept of insight applied to the practice of insight meditation is quite similar in many respects to the concept of insight applied to the experience of lucid dreaming.

To be sure, the concept of insight, as it relates to meditation, is very complex, and also not fully defined. There are many levels of insight, and many aspects of mental life, the self, and life more broadly that one achieves insight about, depending on the style of meditation one engages in and the level of mastery one develops in one's meditative practice. For example, in the practice of focused attention meditation, a novice practitioner might be said to have gained insight upon becoming aware of the difficulty involved in maintaining attention on the flow of the breath through the nostrils. The insight here is of a particular aspect of mental life, namely, the fleeting nature of attention. Whereas in the case of an experienced practitioner with hours of meditative experience, the insight gained may involve the nature of the self—for example, that it is characterized by desire and craving, or that it is ultimately an illusion. Nevertheless, I think that we can certainly make use of the way the concept of insight is broadly understood in meditation to clarify its relation to lucid dreaming, if it has any relation.

First, I take it that when we speak of insight gained through meditation, we aren't referring to a particular state that is achieved, but rather to a form of knowledge that is gained within a state of consciousness. The state from within which we might be said to achieve insight is a state of meta-awareness, but being in this state doesn't necessarily imply that insight has been achieved. For example, the novice practitioner may become meta-aware of what it is like to try to maintain focused attention on the breath, but this doesn't necessarily mean that he gains knowledge from this about the nature of attention and consciousness more broadly. Conversely, it seems that in the case of lucid dreaming, at least as described by Voss and Hobson, insight is understood to be synonymous with meta-awareness. This seems a natural understanding given that, as per Voss and Hobson, when lucidity is achieved there is necessarily insight. That is, one could not, it appears, be meta-aware of their dreaming without having insight into the fact that they are dreaming. However, is this really *insight*? This is where I think we may want to tease apart the notions of lucidity and insight, following our understanding of meta-awareness and insight in cases of meditation.

In the case of lucid dreaming, there certainly is the experience of coming to realize one is in a dream state. This is the phenomenological interpretation of the state of insight I discussed in the previous section—what I also called the self-awareness of dreaming. However, we may want to refer to this aspect of lucid dreaming as lucidity, rather than insight. In other words, when lucidity occurs while dreaming, why should we not be satisfied saying that one has simply become aware of their dreaming? Why should we take this to be insightful? Maybe because lucidity doesn't merely involve a passive awareness of the dream state, but also an understanding by the dreamer of *what* she has become aware of—and this enables dissociation, plot control, etc. The suggestion that there is now an understanding that the dreamer has of being in a dream, however, brings into the picture the epistemological interpretation mentioned earlier. Given this, insight is better viewed as an epistemic state. In fact, maybe there is not only a need to dissociate lucidity from insight in the case of lucid dreaming; we may want to grant that both admit to phenomenological and epistemological degrees.[12] As we see in meditation, there are many levels of insight—many areas of our existence of which we can gain knowledge—and so maybe there is also reason to think that there are further forms of insight to be had in lucid dreaming as well. One particularly interesting point of convergence between the empirical work on lucid dreaming and meditation is in the phenomenon of dream yoga.[13] As a result, we might not want

12 This very idea has been explored in Windt & Metzinger (2007), as well as in Noreika et al. (2010).

13 In particular, the case of Tibetan dream yoga mentioned earlier, which involves using meditative practice in the dream, might be an instance of exploring just how meditation and lucid dreaming can come together, and could be informative for our understanding of

to define insight as a state of consciousness, or as a meta-awareness. Rather, we may instead see insight as a form of knowledge that accompanies lucidity, and lucidity as a form of meta-awareness.

Another area of similarity between meditation and lucid dreaming that I want to explore lies in the structure of each of these experiences.[14] Both seem to involve some form of dissociation. As Voss & Hobson (this collection) describe, "lucid dreams can be considered dissociated states of consciousness in which the dream Self separates from the ongoing flow of mental imagery. The dream is still a dream but the person is able to distance him/herself from the ongoing imagery and may even be successful in gaining (at least partial) control over the dream plot" (pp. 8–9). The experiential feature of separation of the dreamer from the dream while the dream continues to unfold is akin to the observational stance that one strives to take in meditation, in particular in focused meditation. When meditating, one aims to become aware of one's stream of consciousness—one tries to separate oneself, as it were, from the stream of thoughts, beliefs, desires, etc., in order to become aware of its transient nature. For example, one becomes aware of, say, the fleeting nature of attention and mental life. Similarly in lucid dreaming, one becomes aware of being in a dreaming state.

However, the concept of "self" that seems to underlie Voss and Hobson's discussion of lucid dreaming is quite different from how the self is understood in meditation. Voss and Hobson appear to have a very robust sense of self at play, and I'm not quite sure why this is so, or whether we want to bring such a conception of self into the picture. One of the most telling passages in their article, and one that I find most problematic is the following:

> This fits well with the common description of lucid dreams as (partial) awakening in your dreams and of involving a split between dreamer and dream observer who coexist and change relative dominance of the mind at will (Occhionero et al. 2005). The implications of this line of reasoning have profound impact on the theory of mind. There are two selves suggesting that the self is a construct elaborated by the brain (Metzinger, 2003, 2009, 2013a). The two selves of the lucid dreamer […] (Voss & Hobson this collection, p. 9, emphasis added).

Why would we want to describe the result of the dissociation in lucid dreaming as one that involves a split between a dreamer self and a dream-observer self? Furthermore, on the basis of what would there be reason to argue that the self is a construct?

If the experience in lucid dreaming is one of shifting back and forth between being meta-aware of being in dream consciousness and being in the dream itself as the dreamer, why would we not want to speak of this as a change in experiential perspective rather than as an experience of two selves?[15] Moreover, if we look to how similar meditative experiences are described, we don't speak of there being two selves, the self within the stream of consciousness and the self that observes the stream of consciousness. Rather, we speak of our shifting experiential perspectives wherein we move, as a single subject of experience, from being within the flow of consciousness to observing the flow of consciousness. Furthermore, one of the insights gained from meditative practice is that there is indeed no self.

I grant that it is perhaps in keeping with the subjective reports of lucid dreamers to speak of two selves in the lucid dream state. If the subjective report that Voss & Hobson quote in their paper (this collection, p. 9) is but one example of the way in which subjects describe their experiences, then it certainly seems nat-

both the nature of meditative states and that of lucid dreams. As LaBerge notes, "for more than a thousand years Tibetan Buddhists have believed that it is possible to maintain the functional equivalence of full waking consciousness during sleep. This belief is not based on anything as tenuous as theoretical grounds but upon firsthand experience with a sophisticated set of lucid dreaming techniques collectively known as the Doctrine of Dreams or dream yoga" (2003, p. 233).

14 See Evan Thompson's entry in this collection, as well as Thompson (2014).

15 The shift in experiential perspective might even be more complex than this; see Rosen & Sutton (2013) for an interesting discussion of self-representation in dreams.

ural to take on such a view of the self. However, I suspect that the subjective reports may be constructed in a manner that is biased by a certain colloquial manner of speaking about the self,[16] and thus don't rightly capture if and what the self is in relation to the structure of consciousness. Certainly I am not suggesting that we shouldn't take the subjective reports seriously—indeed I think that they provide invaluable information into the phenomenology of lucid dreaming. However, we must be careful to properly interpret these reports, and perhaps this will involve developing ways to discover whether certain biases have come into play in the subject's report of her experience, and how these biases have affected the qualitative data.

5 The hybrid state hypothesis and bodily awareness

The third and last point I want to consider is the place of the body, and bodily awareness, in lucid dreaming. I was particularly struck by two lucid dreamer reports. The first is the one that Voss & Hobson quote in their paper wherein the lucid dreamer explains that "[i]n these short periods of lucidity the awareness of the acting dream body and the real body in bed exist simultaneously and it costs a lot of concentration to keep the balance between both" (this collection, p. 9). The second comes from Dutch psychiatrist Frederik van Eeden, who coined the phrase "lucid dreaming":

> In January, 1898 [...] I was able to repeat the observation. [...] I dreamt that I was lying in the garden before the windows of my study, and saw the eyes of my dog through the glass pane. I was lying on my chest and observing the dog very keenly. At the same time, however, I knew with perfect certainty that I was dreaming and lying on my back in my bed. And then I resolved to wake up slowly and carefully and observe how my sensation of lying on my chest would change to the sensation of lying on my back. And so I did, slowly and deliberately, and the transition—which I have since undergone many times—is most wonderful. It is like the feeling of slipping from one body into another, and there is distinctly a double recollection of the two bodies. I remembered what I felt in my dream, lying on my chest; but returning into the day-life, I remembered also that my physical body had been quietly lying on its back all the while. This observation of a double memory I have had many times since. It is so indubitable that it leads almost unavoidably to the conception of a dream-body. (van Eeden 1913)[17]

I found the description of there being two bodies rather interesting, and, particularly in the subject report cited by Voss and Hobson, the mention of the cost of concentration to be very intriguing. To be sure, there is but one physical body, namely the one lying in bed. Yet the dreamer experiences both the body in bed and the body with which she is engaged in the dream, and finds it somewhat demanding to maintain an experiential balance between both. In this last section, I put forward an explanation of this experience by relying on the Hybrid State Hypothesis alongside my work on bodily awareness during waking consciousness.

According to the HSH Voss and Hobson put forward, lucid dreaming is a hybrid state with both elements of waking and dream consciousness. This is so because there is a dissociation that occurs between the dream self and the ongoing dream imagery. Physiologically, although brain activity associated with REM sleep continues, in lucid dreaming there arises, in addition, brain activity in parts of the brain associated with conscious awareness and executive ego functions. The hypothesis, then, is that "lucid dreams push the arousal system towards waking yet remaining within the region occupied by REM sleep [...]. Lucid dreaming is, thus, a fragile, destabilized hybrid state" (Voss & Hobson this collection, p. 9). If this hypothesis is correct, then there may be value in looking at how we are aware of our body in a waking con-

16 This, as Metzinger would point out, would be another instance of theory contamination.

17 Thanks to Metzinger for pointing out this classical description of a lucid dream experience.

scious state to help better understand the seeming duality of bodily awareness involved in lucid dreams. More specifically, if we take seriously the above-quoted subjective report, then the hybrid state hypothesis in combination with certain hypotheses about bodily awareness in waking conscious states might shed light on how the experience arises.

What I find particularly interesting about the reports are two things:

> a. the simultaneous experience of a dream body and the real body in bed; and
>
> b. the amount of concentration needed to keep the balance between both.

In regards to the first, I find myself wondering the following: what does the subject mean by simultaneous, here? Does she mean that both bodies are experienced *at the same time*, or rather, that there is a very quick and continuous shift back and forth from the dream body to the real body, such that it *seems* like they are both being experienced simultaneously? I am inclined to think that what is happening is a very quick attentional shift back and forth between the two "bodies". My reasons for thinking this come from how I account for our bodily awareness in waking life.

I take it that in our everyday experiential lives we are aware of our body both as an object and as a subject. The distinction between awareness of the body as object and as subject stems from the Phenomenological tradition[18] and it is best understood as follows. I can be said to be aware of my body as object when I direct my attention to my body and thereby perceive it as I would any other object in the world. The key characteristic of our awareness of the body as object is that it is attentional. Alternatively, I can be said to be aware of my body as subject when I am aware of my body as that *through* which I experience the world—not as an object onto which I turn my attention, but rather as that which engages with my environment. My awareness of my body as subject is also referred to as a bodily self-awareness, and it is characterized by an inattentional awareness —a form of awareness that does not involve holding attention to an object.[19]

Now, my typical experiential consciousness involves a bodily self-awareness, although it doesn't always involve an awareness of the body as object. This is because I don't always attend to my body. Take, for example, my sitting in a chair reading a book. Typically, my attention lies with the book—I focus on the words on the page, say. In attending to the book, I don't simultaneously attend to my hands holding the book, although they are certainly a part of my overall experience insofar as they don't disappear from my awareness entirely. I certainly can shift my attention to my hands, and thereby become aware of them as object; however, in doing so, I contend, I am no longer attentively aware of the words I was reading a moment ago. In fact, I take it that if I were to try to be aware of my hands and the words on the page simultaneously, I would find this quite difficult as it would involve a continuous and rapid shift in attention back and forth between the words and my hands. I think a similar account holds in the case of lucid dreaming with regard to the dream body and the real body.

I propose that in the case of one's bodily awareness in lucid dreaming, the real body is experienced both as subject and as object. It is the subject's actual body, and therefore one that she is aware of as subject, but in addition her experience of her real body, in the lucid dream, is of her body as an object—she becomes aware of her body as object by her attention shifting to it momentarily. However, her attention does not remain with her real body; instead it quickly shifts back to the dream body as well. In that experiential moment, the dream body becomes an object for her as she attends to it. I think the further clue as to why we should interpret the experience of the body in lucid dreams as one of shifting attention, and even perhaps competing attention between the real and the dream body, comes from the second element of the subject's report men-

18 A philosophical tradition most often associated with the work of Husserl, Merleau-Ponty, Sartre, etc.

19 I develop this distinction further in my thesis, "Embodiment and Subjectivity—the Origins of Bodily Self-Awareness".

tioned above—the claim that "it costs a lot of concentration to keep the balance between both".

Why is there a need to keep a balance between the real and the dream body? Perhaps because, as the HSH suggests, there are elements of both waking and dreaming states at play. If we take bodily awareness to be a fundamental element of waking consciousness—or even consciousness tout court, as I do—as well as a key element of dream consciousness, then it makes perfect sense that in a lucid dream the subject finds herself with these two bodies that must be balanced in the same way that the waking and the dream states must be balanced to remain in the lucid dreaming state.[20]

The question then becomes: why does it cost a lot of concentration to maintain this balance? I think the answer to this question brings us right back to my suggestion above, namely that the simultaneity of the dream and real body experience is one of shifting, or even competing attention. If there is a continuous shift in attention, rather than a joint experience of both bodies, then this would explain the apparent cost of trying to maintain concentration on both bodies in a lucid dream state. It would be like walking a tightrope, trying to avoid leaning too far to the right or too far to the left, and doing so by continuously shifting your body to maintain that balance. It would require an incredible amount of concentration—in a general sense, one experiences everything all at once, but in a more precise sense, one's attention is continuously shifting between one's body and one's environment in order to maintain balance.[21]

One last point of inquiry. As I mentioned above, there is a distinction to be made in accounting for our bodily awareness in waking experiential consciousness between our awareness of the body as object and our awareness of the body as subject, i.e., bodily self-awareness. However, I wonder if a similar distinction might also apply in cases of lucid dreaming given the HSH. In other words, is there a bodily self-awareness—of the real body or even the dream body in a lucid dreaming state? And, if so, how does it relate to the awareness of the dream body and the real body described by subjective reports? To begin answering these questions we would need to explore the subjective reports of lucid dream experience in relation to bodily awareness more specifically. Perhaps we might begin by looking back upon the report by van Eden. Indeed, I certainly take this to be an interesting avenue of exploration given the ever-increasing interest in taking an embodied approach to consciousness.

6 Conclusion

In closing, let me review the three points of inquiry on which I chose to focus here. First, I inquired as to what exactly the concept of insight involves in the case of lucid dreaming and whether we should think of insight as a phenomenal or epistemic state. I suggested that the lack of clarity with regard to the concept of insight shows the need for rigorous philosophical inquiry with a view to laying down a solid conceptual foundation from which to pursue future empirical research. Second, I inquired as to how meditation and lucid dreaming are similar and where research on meditation might provide information to research on lucid dreaming. I highlighted some interesting overlaps in the concepts of insight in meditative practice and lucid dreaming, and explored the feature of dissociation in lucid dreaming in relation to the notion of a self. Third, I looked at how we are aware of our body in lucid dreaming and considered whether our accounts of bodily awareness in waking consciousness can be used to inform our understanding of bodily awareness in lucid dreaming. I also suggested that the distinction between awareness of the body as object and of the body as subject used to describe waking bodily awareness could help us tease out the ways in which the body is experienced in lucid dreams.

20 The place and role of the body, and our bodily awareness in lucid dream states, is far more complex than I can show here—in fact, there are instances of bodiless dreams. Although a complete consideration of these issues is beyond the scope of this commentary, an excellent discussion of this topic can be found in Windt (2010).

21 This is also how lucid dreams are commonly described in the literature, i.e., as a balancing act. See LaBerge (1985) and Brooks & Vogelsong (2000).

As I stated above, the empirical study of lucid dreaming is still very new and, thus, still very much in an exploratory phase. As a result, it is easy to point out various areas for further inquiry and suggest avenues of future investigation. However, it is nonetheless important to acknowledge the work that Voss and Hobson have done to advance our understanding of the phenomenon of lucid dreaming. Not only have they provided a convincing account of why lucid dreaming occurs (BMH), they also put forward an interesting hypothesis for the neural basis of lucid dreaming (GBH). Moreover, their HSH and SCH will serve to further the conceptual analysis of lucid dreaming and its relation to other mental states across the spectrum of sleeping to waking consciousness. In short, I agree with Voss & Hobson that "the experimental study of lucid dreaming is a powerful paradigm for understanding the brain basis of conscious experience" (this collection, p. 4). Moving forward, we must now expand the area of research to allow for important philosophical considerations that will strengthen the conceptual framework underlying this exciting new paradigm.

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Reflections on Insight

A Reply to Lana Kühle

Ursula Voss

In this reply to Kühle, I will respond to her comments on the role of insight in lucid dreaming, especially regarding the question of whether it may be knowledge-based or instead express a sensorial experience. My answer rests on experimental findings, acknowledging Kühle's remarks, and taking her methodological challenges into account. I will challenge her proposal that insight might be called a state, opting for a definition of a transient thought atypically embedded within the state of dreaming, which may suffice to retrospectively call a REM dream lucid, but which will not satisfy the assumptions underlying the existence of a state.

Keywords
Insight | Lucid dreaming | Lucid scale | REM sleep

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1 Introduction

The commentary by Kühle reminds me of a remark made by a distinguished and renowned Swiss sleep researcher who asked me recently, during a lengthy discussion of our work on lucid dreaming, "how can you be sure that what you call a dream really exists". In other words, he wanted to know how we could prove that dream narratives were memories of REM-sleep mental activity instead of, say, fantasies occurring during the process of awakening or memories of hypnagogic hallucinations, etc. It struck me then that I had neglected to openly postulate the key assumption that our work rested upon, namely that dreams really exist. So I still owe him a detailed response and Kühle's commentary provides me now with the opportunity to generate an adequate reply. In the following, I will focus on Kühle's main argument, which seems to circle around the definition of "insight" and the question of whether it represents an epistemological statement or a phenomenological experience. I will shortly enter into discussion of whether it is justified to define insight as a state, as this assumption is not to be deduced from our work but certainly points to a need for clarification. While interesting, I will refrain from commenting on her speculations on whether insight may or may not be an ability

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except for proclaiming that in my view, insight represents nothing but a result of neurobiological processes we still know far too little about. However, it is a fact that entering the state of lucid dreaming can be trained. Can insight per se be trained? I doubt it. Can the ability to generate insight be trained? According to recent studies on gamma-band activity in the developing and mature brain (see references in the main text), it is at least a possibility.

2 The role of insight in lucid dreaming

In her commentary, Kühle claims that the way we use the term "insight" leaves many—mostly philosophical—questions unanswered. While I certainly agree in principle that solving one question often generates many others, I also believe that there is some need for clarification regarding terminology. It seems that the discussion of what insight is and what it isn't reveals one of the key methodological differences between our disciplines. Whereas philosophy of mind is mainly involved in meta-theory and the conceptualization of psychological theories, the focus of experimental psychology lies on the testing of hypotheses, albeit neither foci apply exclusively. By definition, however, experimental psychology aims at identifying cause-and-effect relationships between observable phenomena by applying experimental methods to induce controlled manipulations of so-called "independent variables", leading to reproducible changes in "dependent variables". Although experiments are hypothesis-based, testing specific (confirmatory) or unspecific predictions (exploratory) derived from theory, progress is often made when such an experiment leads to an unpredicted result. Such was the case in the construction of our LuCiD scale.

In the set of lucid and non-lucid dreams investigated and reported on by our group (Voss et al. 2013), we identified a factorial structure in which eight item clusters (which differed from the theoretically predicted ones) showed sufficient common variability to consider the items within each cluster related. These eight factors accounted for a large portion of variance in dream consciousness as defined a priori, and based on theoretical considerations. The items in the item pool statistically identified as the single factor we referred to as "insight" pertained to the verbal communication that one *knew* one was dreaming while the dream continued. As such, insight would have to be regarded (in an epistemological sense) as understanding that at a particular moment within the dream, the dreamer acquired knowledge about his or her state of consciousness, which would be the hybrid state of lucid dreaming.

As Kühle correctly points out, this may or may not be true, however. It is just as possible that a dreamer who states upon his or her awakening: "I *knew* it was a dream while the dream continued" only thought that he or she knew, while in truth, he or she may have *sensed, felt, or experienced* that the ongoing dream action was not real. This would then pertain to a phenomenological experience similar to what Duncker (1947) refers to as "conscious participation" (p. 505), describing the sensorial experience that one is, at a particular moment, consciously aware of (pp. 508–509). On the other hand, even if we really experienced insight in a phenomenological sense, how can we be sure that this experience was not the result of the epistemological recognition of some sort of incongruence within the dream at some particular point in time? To me, this line of thought resembles that revolving around the question of whether we can be certain that a dream is really a dream and not something else. Philosophically, this is of course fascinating. But to experimental psychologists, such a discussion is unsettling because it is so difficult to translate into testable, i.e., operationalizable, hypotheses. Our admittedly very pragmatic approach is to define underlying assumptions such as *"we assume that dream reports generated from REM sleep awakenings are mentations generated during REM sleep and (fractionally) remembered (at least) until questioning" or "we assume that verbal accounts are reliable and valid".* These assumptions can then again be challenged by separate experimental studies. In the case of doubting the existence of REM sleep dreams, an experiment

could be set up, for example, interrupting different states of arousal such as meditation, daydreaming, NREM sleep, or REM sleep and questioning the subject with respect to immediate recollections of mental activity. A comparison would lead to the conclusion that reports from REM sleep awakenings differ fundamentally from reports gathered from other states of arousal. This has, of course, been successfully achieved and repeated many times. However, the question is still not solved. It is doubtful, for example, whether an arousal from REM sleep enables as accurate a report as an arousal from the meditative state. Similarly, we cannot exclude the possibility that REM sleep alters mnemonic processes in a different way to NREM sleep, so that obvious discrepancies in NREM and REM reports are due to state-dependent retrieval and filtering processes and not at all related to different fantasies generated during the particular state.

In the same way, it certainly is appropriate to wonder about the true nature of what we refer to as "insight". To psychologists, the explanation that a factor name is really only an attempt to describe a commonality between different but related observations is probably satisfactory. To philosophers, this will of course not be the case. However, with psychological pragmatism in mind, I would like to point to some empirical findings (and their immanent difficulties) regarding the question on how to further explore the nature of insight in lucid dreams: when we constructed the LuCiD scale (Voss et al. 2013), we started out with a set of 50 items that were selected on the basis of theoretical consideration. In a first step, these items were tested on a large sample of dreamers, leading to 158 dream narratives considered valid. These were then analyzed for factorial structure as well as for item reliability. Several items that might have been potentially informative regarding the question of epistemology vs. phenomenology proved either indistinct in differentiating between lucid and non-lucid dreams or they yielded too high statistical item difficulties so that they had to be eliminated from further evaluation. Some examples are:

- While dreaming my sensations were the same as when I imagine something or daydream during wakefulness
- While dreaming I was convinced that I was awake.
- I wasn't in the dream, I had no self.
- While dreaming I felt that I knew where I was sleeping.
- While dreaming I was more than one person.

This finding of no-difference is of course by no means sufficiently informative to consider the question of insight in dreaming solved or even solvable. The finding of high item difficulty in particular poses some problems: items are considered difficult if they do not yield a reasonable number of affirmative answers (Moosbrugger 2008; Schermelleh-Engel & Werner 2008). Thus, an item that is not often selected as true will be eliminated from analysis although it might contain valuable information, e.g., that the statement is considered false by the majority of participating subjects. Further, in the case of subjects awakened from sleep, they may not affirm an item although it is true, simply because they are not yet able to comprehend its content (sleep inertia). For example, the item "I wasn't in the dream, I had no self" was not often selected as true. Was this because in most cases, dreamers felt they did have a self or was it because they didn't understand what was asked of them? I hope that this example highlights some of the problems that arise when we try to subject philosophical theory to experimental testing. Perhaps a different design, opting for a specific comparison of questions addressing epistemology vs. phenomenology during a steady state of wakefulness (such as mind-wandering or meditation) might generate more concrete answers, avoiding sleep inertia effects should they exist. We look forward to such results.

3 Insight as a state of consciousness?

According to Kühle, our results suggest that insight may be considered a state. Moreover, she claims that the LuCiD scale does not allow for the identification of different lucidity

levels. These assumptions are not to be deduced from our research but must stem from a misconception or misunderstanding of the factorial structure of the LuCiD scale. Concerning this matter, we reported that dream consciousness can be described by eight factors, six of which are capable of distinguishing between lucid and non-lucid dreams: insight, control, dissociation, positive emotion, negative emotion, and memory. A person can have a range of scores in each factor, for example in insight, such that scores are graded and allow for varying degrees of lucidity. Furthermore, the factors identified are correlated, i.e., not independent (see Voss et al. 2013), which means that one factor alone may not be sufficient to define a lucid dream. Our results also suggest that a dream might be considered lucid even with low scores of insight! So the assumption that the state of lucid dreaming is equivalent to the proposed state of insight cannot be inferred from our data. Kühle's proposal reveals another problem, however, that we tried to address with our Space of Consciousness model (SoC), which is the definition of "state". What is the relationship between a state of arousal and a state of consciousness? In the case of insight, the recognition "I am dreaming" may be only a fleeting thought. But this thought is embedded in relatively enduring neurophysiological patterns such as regional changes in blood oxygen levels (see Dresler et al. 2012) and enhanced gamma activity in frontal regions (Voss et al. 2009; Voss et al. 2014). Our suggestion to situate lucid dreaming within the SoC attempts to incorporate theses observations. In my view, a state is comparable to background activity enabling or disabling certain transients such as thoughts or memories. It is courageous to consider a fleeting thought a state, and I think such definition would need more detailed specifications. Of course, one may ask whether a dream would be considered lucid even in the absence or perhaps following the thought "this is a dream". According to our model, this assumption would have to be affirmed. If the state of lucid dreaming is considered a neurophysiological state of sleep bordering wakefulness, enabling the mind to produce a transient thought (insightful thought), this thought may or may not be repeated several times within the state of lucid dreaming. The important factor is, as Kühle proposes, capability. During the state of lucid dreaming, the mind is able to be insightful. It is not the other way around, such that the mind is able to enter a lucid dream during the thought of insight. The importance of insightful thought thus does not lie in its being a state but in it being measurable! We cannot expect a subject to provide a truthful answer to the question "were your frontal lobes producing gamma band activity?" We can, though, ask about the quality of their thoughts and sensations. Finally, if, in spite of my objections, we define insight as a state of consciousness, how would this state be defined in terms of arousal (see the SoC model), or in terms of other determinants such as, for example, judging, sensing, or moving? Supposed insight were defined as a point in the SoC. Where would it be located? Within mindwandering, meditation, lucid dreaming, focused attention—or all of these?

4 Conclusion

While Kühle's comments are greatly appreciated, they show how important dialogue between the different disciplines involved in studying consciousness really is. Neuroscience, psychology, and philosophy are all connected in their quest for a better understanding of the true nature of consciousness and its underlying physiology. They depend on each other to formulate predictions based on theory, and to test and reappraise these on the grounds of cause-and-effect relationships established through experimental testing. Experimental research rests upon certain assumptions that may not or may only fractionally apply to philosophy. The most important assumptions of dream science are to consider it true that there exists a real world (1), that REM sleep dreams exist (2), that healthy awake humans are able to make valid statements about knowing and feeling (3), and that restrictions to this ability (e.g., sleep inertia) can be reliably identified (4).

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