

Lucid and non-lucid dreaming: Thinking in networks

Commentary on “The neurobiology of consciousness: Lucid dreaming wakes up” by J. Allan Hobson

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Hobson provides an important case for lucid dreaming as a valuable tool for consciousness research. Sleep is the most well known change in consciousness on an individual level, but the discussion on the nature of consciousness in relation to sleep seems to be far from settled. This particularly applies to the dissociation between waking and dreaming consciousness, of which the usefulness has been disputed. We would like to take the opportunity to explain why we argue – in line with Hobson (2005, 2009) – that dream consciousness is intrinsically different from waking consciousness and why we think the contrast lucid versus non-lucid dreaming is valid and informative. Moreover, we would like to argue that lucid dreaming in combination with a neural network approach may be most promising to studying consciousness.

1. The validity of the lucid versus non-lucid dreaming contrast

That there is an apparent difference between dream and waking consciousness is beyond doubt. In dreams our consciousness is limited – we don't realize why we are doing particular things, how we got into our current situation or that we can only focus on one thing at a time, making complicated goal oriented actions highly unlikely if not impossible. In dreams, characters can transform into each other, family members can return from the dead and animals can speak, and none of this is evaluated as bizarre. Most critically, becoming spontaneously aware of the state you are in (meta-awareness) is a very rare phenomenon, occurring in the majority of people only a few times per life-time or never (Snyder & Gackenbach, 1988). That normal dream consciousness is rather limited is obvious to most lay-persons, who experience agency and voluntary control of action during awake.

However, critics of the dream-wake consciousness dissociation rightly point out that we don't know how persons would respond to dream oddities during the day, simply because person transformations, attacks by monsters and the talking dead don't occur. For instance, most subjects don't

notice a crucial personal transformation of the main actor in a short movie (LaBerge, 2000), and this can be taken as evidence that waking consciousness may not be that different from dream consciousness. Additional arguments are that during the day, people also do not continuously think about their state of consciousness, or remind themselves where they were 15 minutes ago. These arguments claim that waking consciousness should not be exaggerated. An additional argument has been proposed by content analyses of dreams, which have shown that although dream bizarreness occurs, many dreams actually have realistic content related to daily cognition, with dream characters that the dreamer knows, performing actions that the dreamer also performs during the day, in environments that may not always be familiar but are typically realistic (Domhoff, 2000). Although such findings are intriguing, with the limitation that they depend on subjective reports that may be distorted or biased, they are not evidence against a strict dissociation between dreaming and waking consciousness.

Whether or not people typically do particular things, is not relevant for the question whether they can. We argue that the difference between dreaming and waking consciousness is not that in dreams, people have fewer meta-cognitions than during awake (e.g. where am I, is this possible, what am I doing here?), but that in dreams, people normally can't. Naturally, lucid dreaming training can induce such meta-cognitions in dreams as a step to becoming lucid, but everyone who has once become lucid knows how difficult it is for instance – even when lucid – to try to mentally back-reconstruct what happened in the last few minutes. During the day, such mental back-reconstruction is done with ease. This shows a crucial difference between a content-related approach to dream consciousness and a structure-related approach to dream consciousness. Take the following situation: Between city A and B lies a bridge that connects both cities during the day, but is closed for traffic during the night. Arguing that dreaming and waking consciousness are the same because of the absence of meta-cognitions in both states is like saying that there are no differences in the how well A and B are connected because you do not see any cars driving during either day or night. A structural approach to dream consciousness focuses more on whether it is theoretically possible to go from A to B, i.e. whether there is a road (as in waking) or whether the bridge is closed for traffic (as in normal dreaming). Mental back-reconstruction is just one example of a meta-cognition that is much easier in the waking state than in the dreaming state, but the same

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applies to other meta-cognitions. That people do not have them during the day is irrelevant, what matters is whether they can. In a similar manner does a content-related approach of dreams not prove that because dream topics are largely similar to waking cognitions or concerns, that therefore dreaming consciousness is the same. People can process the exact same mental imagery or language in several modes of awareness, ranging from full-blown awareness and attention to passive consumption.

Therefore, we propose that the lucid versus non-lucid dreaming contrast is informative for differences in consciousness, and that this contrast reveals those regions whose activity and/or functional connectivity are crucial to allowing full-blown consciousness, as in an open or close bridge that allows traffic to pass. Hobson's reference to Edelman's distinction between primary and secondary or higher-order consciousness is most valuable, since the contrast between non-lucid and lucid dreaming mirrors the contrast between primary and higher-order consciousness. In Edelman's (2003) words: "Higher-order consciousness allows its possessors to go beyond the limits of the remembered present of primary consciousness. An individual's past history, future plans, and consciousness of being conscious all become accessible." Lucid dreaming may be critical to fully understanding the neural correlates of higher-order consciousness, because in contrast to coma-wake and sleep-wake comparisons there is no major shift in vigilance state as defined by formal criteria: lucid REM sleep still is REM sleep proper according to the classical Rechtschaffen and Kales (and new AASM) criteria. Lucid dreaming therefore provides the only case we know of, that can contrast primary consciousness as experienced in dreams with full-blown higher-order consciousness within the same vigilance state.

2. Neural correlates of consciousness: thinking in networks

Approaches to a cognitive neuroscience of dreaming propose that prefrontal deactivations observed in REM sleep subsolve the cognitive deficits experienced in normal dreaming (Hobson & Pace-Schott, 2002; Schwartz & Maquet, 2002; Nir & Tononi, 2010). Consequentially it was proposed that lucid dreaming might be associated with prefrontal activations compared to non-lucid dreaming (Hobson et al., 2000; Tononi, 2009), which could indeed be demonstrated recently by quantitative EEG data (Voss et al., 2009). The precuneus can be seen as another region of interest associated with lucid dreaming, since it has been proposed to generally subsolve processes of self-directed cognition (Cavanna & Trimble, 2006) – which are obviously involved in a state of awareness of the own state of consciousness. As suggested by Hobson in accordance with others (Tononi & Edelman, 1998; Tononi, 2004; Boly et al., 2008), any approach to consciousness needs to include large scale brain network modelling. In line with this approach there is a growing body of research studying the brain in the resting state. One of the described resting state networks, the so called default mode network, has often been named as a precursor to consciousness. However, as research has shown that this network continues to fluctuate in light sleep, and can even be detected in deep sleep (with less within network connectivity; Horovitz et al., 2009; Sämann et al., 2009), coma (Boly et al., 2008), or in anesthetized monkeys

(Vincent et al., 2007), its role has been recently redefined with regard to its pattern of anti-correlation with the so-called attention system. The pattern of activity of these anti-correlated networks has been proposed to direct awareness rather than sustain consciousness: i.e. when the attention system is more 'active' the organism's attention is shifted to external stimuli, and conversely, when the default mode is more active the attention shifts inwards, e.g. to mental imagery (memory reprocessing or future imagination). Note that the anti-correlation is crucial to this shifting between externally and internally directed awareness (Fox & Raichle, 2007; Boly et al., 2008), and that this correlation disappears in deep sleep (Sämann et al., 2009). Recently another resting state network has been described: The so called frontoparietal control system has been proposed to integrate information from the default mode network and its opposed attention system (Vincent et al., 2008). Due to its role as a kind of meta network, the frontoparietal control system might be seen as an ideal candidate for underlying processes of meta cognition – and therefore meta consciousness in general and lucidity in particular.

3. Conclusions

If the contents are separated from the mode or structure of consciousness (primary vs. higher-order order), crucial differences between dreaming and waking consciousness become obvious. In this line of thought, the REM sleep-internal contrast between lucid and non-lucid dreaming can be seen as a paradigmatical contrast between primary and higher-order consciousness. A network approach, with a dimension separating contents from the mode of consciousness, may be most useful to studying this complex phenomenon. Consciousness researchers should consider including lucid dreaming as a promising method to eliciting the neural correlates of consciousness.

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