Not a HOT Dream

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Abstract

Higher-Order Thought (HOT) theories of consciousness maintain that the kind of awareness necessary for phenomenal consciousness depends on the cognitive accessibility that underlies reporting.

The cognitive accessibility that underlies the ability to report visual experiences depends on the dorsolateral prefrontal cortex, but this area is highly deactivated during the conscious experiences we have during sleep: dreams. HOT has a problem, as I will argue.

I will briefly present HOT theories in the first section. Section 2 offers empirical evidence to the effect that the cognitive accessibility that underlies reports depends on the dorsolateral prefrontal cortex (dlPFC): dlPFC is the neural correlate of HOTs. Section 3 shows the evidence we have of the deactivation of this brain area during dreams and in section 4 I present my argument. Finally, I consider and rejoin two possible replies my opponent can offer: the possibility of an alternative neural correlate of HOTs during dreams and the denial that we have phenomenally conscious experiences during dreams.

1 Introduction

In 'On a confusion about the function of consciousness' [Block (1995)], Ned Block famously maintained that the folk psychological term 'consciousness' equivocates between two concepts: 'access-consciousness' and 'phenomenal consciousness'. The first one has to do with the processing of information. When I look at the cup of coffee in front of me I take in plenty of information: the cup is located in front of me, to the left of my computer, it has a certain shape, most of it is red and it has a rectangle in yellow color. It is filled with a black liquid. When I consciously see the cup my brain processes all this information and this information is available for further reasoning (deciding to drink the coffee), motor control (moving my hand toward the cup), etc. I have access to this information in virtue of my experience. Understanding the mechanisms that underlie these processes constitutes what Chalmers [Chalmers (1996)] calls 'the easy problem of consciousness'. It is, doubtless, a very difficult issue given the complexity of our brains, but the research in neuroscience has made a huge progress in recent years and it is relatively unproblematic.

There is more to consciousness than this information processing. When I see my cup, there is something it is like for me to see the cup, a redness way, among others, it is like for me to have this experience. This is phenomenal consciousness and this is what constitutes 'the hard problem of consciousness'[Chalmers (1996)].

The relation between access and phenomenal consciousness is a controversial issue which cannot be solved without a further clarification of the notions involved. Some form of access seems to be essential to phenomenology, for it is platitudinous that when one has a phenomenally conscious experience, one is in some way aware of it. Let me call this kind of access 'Awareness' following [Block (2007)]. My target in this paper will be theories that maintain that Awareness requires cognitive accessibility, the same cognitive accessibility that underlies reports. In particular, the claim that I am attacking is the claim that the cognitive ability that makes it possible to report the content of a mental state is essential to conscious mental states.

This position has been paradigmatically held by Higher-Order Thought (HOT) theories.[1] For HOT theories, a mental state M is conscious if and only if there is another mental state (Higher-Order) to the effect that one is in M. Being conscious requires being Aware of being in a certain mental state and this Awareness is explained as being the target of the appropriate HOT. One of the main defenders of this theory, David Rosenthal, explicitly endorses the correspondence between HOTs, and hence conscious mental states, and the ability to report being in a particular mental state. In 'Thinking that one thinks' Rosenthal ([Rosenthal (2005)], chapter 2) writes:

> [G]iven that a creature has suitable communicative ability, it will be able to report being in a particular mental state just in case that state is, intuitively, a conscious mental state. If the state is not a conscious state, it will be unavailable to one as the topic of a sincere report about the current content of one's mind. And if the mental state is conscious one will be aware of it and hence able to report that one is in it. The ability to report being in a particular mental state therefore correspond to what we intuitively think of as that state's being in our stream of consciousness. (op. cit., p.55)

My opponent's position maintains that:

A. Consciousness requires Awareness;

B. Awareness depends on the cognitive accessibility that underlies reporting.

This position is maintained, as I have shown, by HOT theories. They are the intended target of this paper.

The position that I will be defending, call it first-order position, maintains that Awareness does not depend on the cognitive accessibility that underlies reporting. Contrary to HOT, the first-order position maintains that there can be cases of phenomenal consciousness on which the subject cannot report.

[1]See [Amstrong (1968), Lycan (1996), Rosenthal (2005)]

In the next section, I will provide empirical evidence in favor of the premises of my argument. Section 3 presents my argument against HOT and in section 4 I consider some possible objections to my argument and offer a rejoinder.

2 The neural correlate of cognitive accessibility for visual experiences: Dorsolateral prefrontal cortex

The evidence for the neural correlate of the cognitive accessibility is based on an experiment performed by Lau and Passingham [Lau and Passingham (2006)].

The experiment is based on a visual discrimination task with metacontrast masking.[2] Subjects are presented with two possible stimuli, either a square or a diamond on a black background. After a short variable period of time, SOA (Stimulus Onset Asynchony), a mask is presented. The mask overlaps with part of the contour of the target without leaving gaps or overlapping with the target spatially (See Figure 1). Subjects in the experiment were asked two questions after the presentation of the target and the mask:

1. Decide whether a diamond or a square was presented.
2. Indicate whether they actually saw the target or simply guessed the answer.

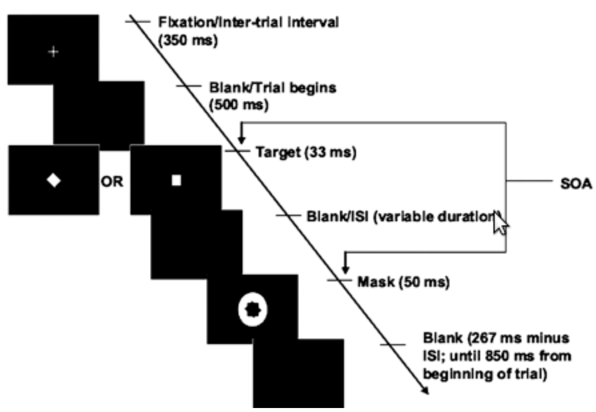

Figure 1: Experiment Set-up [Lau and Passingham (2006)]

The first question is intended to measure the objective performance capacity of the subjects. The second question is intended to measure the perceptual certainty of the subjects, how confident they are on having seen the object.

[2]In metacontrast masking a second stimulus is presented that interferes with processing and consolidation of the target stimulus in conditions where there is no contour overlap between the target stimuli.

This subjective report, according to the author, and to HOT theories, is an indication of phenomenal consciousness.

Figure 2 shows the result as a function of the SOA, the time between the presentation of the target stimulus and the mask. The presence of the mask has nearly no influence on the performance capacity when presented before or close to the stimulus. As the SOA increases, the mask interferes with the target stimulus until it has no effect at all when it is presented much later. The result is a u-shape, where two points with the same performance capacity can be identified.

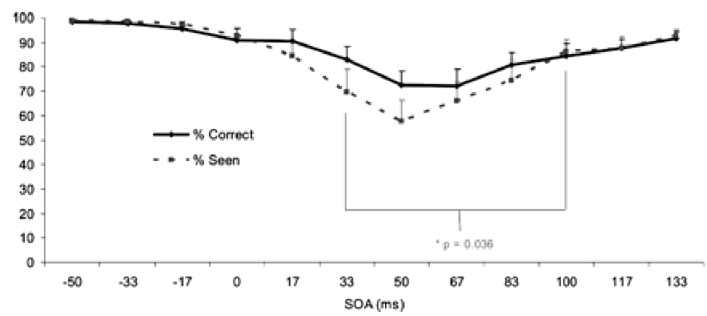

Figure 2: Performance (% correct) vs. Perceptual Certainty (% seen)[Lau and Passingham (2006)]

The interesting finding for the purpose of this paper is that, for some of these pairs of points, the perceptual certainty is radically difference. Whereas in one (short SOA) subjects report being guessing, in the other (long SOA) the subject is fairly confident of having seen the stimulus. For HOT theories, the subject in the second case is phenomenally conscious.

Lau and Passingham performed a fMRI study on the subjects of the experiment. The study revealed that the long SOA condition was associated with a significant increase in activity in the left mid-dorsolateral prefrontal cortex (mid-dlPFC, Brodmann's area 46).

My opponent maintains that Awareness depends on the cognitive accessibility that underlies reporting. In the Lau and Passingham experiment, the subjects report having seen the stimulus in the long SOA condition but not in the short one. Since HOTs are associated with report abilities, Lau and Passingham have found the neural residence of HOTs, at least of visual higher-order thoughts ('I see a square').[3]

[3]Lau and Passingham maintain that consciousness should be associated with perceptual certainty. In [Lau (2008)], Hakwan Lau explicitly endorses the view that phenomenal consciousness should be associated with perceptual certainty. He maintains that consciousness depends on Bayesian decisions on the presence of the stimuli depending on learning processes and the firing patter of the first-order representations. It is unclear to me why a proposal along these lines should be considered a higher-order proposal.

The first-order defender maintains that the curve corresponding to phenomenology could be somewhere in between the two (% correct and % seeing) and is not impressed by the fMRI data, for he would have predicted exactly this result: the judgment of having seeing, that corresponds to a HOT, is reflected in the prefrontal cortex.

So, does the Lau and Passingham experiment bring some light to the debate between higher-order and first-order theories? I think it does but precisely in the opposite direction from which the authors intended. If HOTs *live* (or at least a significant part of their neural correlate is) in the dlPFC, as the experiment shows, and there were a case of phenomenology without activation of dlPFC, HOT theories would be in trouble. It's time for dreaming.

3 Dreams and dorsolateral prefrontal cortex

Dreams are the conscious experiences we have during sleep. Revonsuo [Revonsuo (2000)] defines dreams as '...a subjective experience during sleep, consisting of complex and organized images that show temporal progression'. Dreams are conscious experiences, experiences that are similar in many respects to the ones that we have during wakefulness. Our dreams are highly visual, with rich colors, shapes and movements, and include sounds, smells, tastes, tactile sensations, and emotions, as well as pain and pleasure [Hobson et al. (2000)].

Dreams can be so similar to our waking experiences that the dreamer may be uncertain whether he is awake or asleep. This platitude has been taken for granted by most philosophers. It has, for instance, led philosophers to wonder whether we can distinguish the two states or even whether one could actually be dreaming constantly. This has been referred by Plato, Aristotle and most famously in the Descartes skeptical argument on the First Meditation.[4]

I do not intend to argue that dream experiences are exactly like awake experiences.[5] The only point that is relevant for the purpose of this paper is that we have dreams and that dreams are phenomenally conscious experiences.

Sleep is traditionally divided into two phases: non-rapid eye movement (NREM) sleep and REM sleep.[6] The succession of this two phases is called a sleep cycle, and in humans, it lasts for approximately 90–110 minutes. There are 4-5 cycles per night. It has been established that dreams occur during (though probably not exclusively) REM phase of sleep.

Although there is some controversy as to whether or not there are dreams (or dream-like states) that occur during NREM, there is no doubt that we dream

[4] The common-sense view that dreams are conscious experiences has been explicitly endorsed among others by Kant, Russell, Moore and Freud ([Malcolm (1959)] ,p.4)

[5] According to Tononi ([Tononi (2009)], p.100), dreaming experiences in comparison to waking experiences are characterized by disconnection from the environment, internal generation of a world-analogue, reduction of voluntary control and reflective thought, amnesia and a high emotional involvement.

[6] A more fine-grained categorization of the NREM phase can be done based on EEG, EOG, and EMG patterns. For details see [Tononi (2009)].

during REM phase. If subjects were awakened from that stage of sleep and asked whether they had dreamed, they would say yes at least 80% of the time.

3.1 Neurophysiology of REM sleep phase

There is a global reduction in metabolic activity and blood flow during NREM sleep compared to resting wakefulness that can reach 40% as shown by positron emission tomography (PET) studies
([Braun et al. (1997), Maquet et al. (1996)]). At the cortical level, activation is reduced in the orbitofrontal and anterior cingulate and dorsolateral prefrontal cortex -broadmann area 46 (See Braun et. al table 1 p.1177).

During REM sleep some areas are even more active than in wakefulness, specially the limbic areas. In the cortex the areas receiving strong inputs from the amygdala like the anterior cingulate and the parietal lobe are also activated (Maquet et al. table 1 p.164).[7] On the other hand, the rest of the parietal cortex, the precuneus and the posterior cingulate are relatively inactive (Braun table 2 p.1178).

What is relevant for this discussion is that there is no observed increase in the activity of the dorsolateral prefrontal cortex in the comparison of NREM and REM phases. Quite the opposite, both, Braun and Maquet studies, show a decrease in the activity of the dlPFC during REM phase compared to NREM (which, as shown above, presents a reduction in activity with regard to wakefulness). Specifically Maquet showed a reduction in the area identified by Lau and Passingham (left dorsolateral prefrontal cortex).

All of these regional activations and inactivations are consistent with the differences in mental states between sleep and wakefulness (See footnote 5).

The neural correlate of HOTs lies in the dlPFC; there is an increase in its activity when subjects report having seen the stimulus in comparison with the situation in which they report not having seen it and being guessing -despite the lack of difference in their performance in both situation. This area is highly deactivated during dreams, in particular it is less active during REM than in NREM, but dreams happen during REM phase and rarely in NREM. If HOTs were constitutive of phenomenal consciousness we would expect an increase in the activity in their neural correlate. However, empirical evidence suggests the opposite.[8] Given these elements the reader can easily anticipate my argument

[7] In the Maquet et al. study, the subject were controlled from dreaming (the subject maintained steady REM sleep during scanning and recalled dreams upon awakening). This control is missing in the Braun et al. study.

[8] Lau's proposal [Lau (2008)] is not immediately targeted by my argument. If dlPFC is the neural correlate of HOTs, a decrease in the dlPFC activity seems to indicate a decrease in the HOTs entertained and therefore in our phenomenology. On the other hand, for Lau's theory, the role of dlPFC is to work as a Bayesian decision system that tries to make certainty "accurate judgments." The increase in the noise signals in the sensory cortex during REM phase in comparison to NREM explains dreams.

> By this definition, one hallucinates while dreaming; in dreams we consciously perceive stimuli that are not really there...Dreams are more likely to be reported during a stage of sleep that is characterized by rapid eye movement (REM), and

against HOT theories.

4 The Argument

In this section I present the argument against HOT theories. As I have tried to show in the introduction HOT theories maintain:

A. Consciousness requires Awareness;

B. Awareness depends on the cognitive accessibility that underlies reporting.

The conjunction of A and B give us the first premise of the argument:

1. Phenomenal consciousness depends on the cognitive accessibility that underlies reporting.
2. The cognitive accessibility that underlies reporting in the case of visual experiences depends on the left dorsolateral prefrontal cortex (dlPFC).[9]
3. dlPFC is necessary for visual phenomenal consciousness. (From 1 and 2)
4. We have conscious visual experiences during the REM phase of sleep.
5. dlPFC is deactivated during the REM phase of sleep.
6. dlPFC is not necessary for conscious visual experiences. (From 1 to 5)

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∴ Phenomenal consciousness does not depend on the cognitive accessibility that underlies reporting. (From 1-6)

The conclusion of the argument jeopardizes HOT theories. In the next section I will discuss possible replies to the argument.

> brain activity of relatively high frequency and intensity. Let us assume that the overall signal during REM-sleep is higher. If the brain maintains the same criterion for detection over alternations of REM and non-REM sleep, it would be predicted that false positives are a lot more likely during REM-sleep, because of the higher signal intensity. (op.cit., p.41)

Dreams are for Lau similar to hallucinations, the dlPFC make the wrong *judgment.* Lau has maintained, in private conversation, that, contrary to HOT, the under-activation of the dlPFC during REM phase is favorable to his theory because in dreams perceptual judgments are wrong. However, in order to properly evaluate Lau's claim we need to be told how the decision mechanism is suppose to work and how the decrease of activity in the dlPFC is related to the decision mechanism. We need an explanation of how the decrease in the activity of the dlPFC during REM is related to the failure "to set a appropriately high criterion during REM sleep." so that "one mis-classifies noise as stimuli." (op.cit, p.41). Such an explanation has to be compatible with the fact that the perceptual certainty, that according to Lau corresponds to phenomenal consciousness, is accompanied with an increase in the activity of the dlPFC in the original experiment [Lau and Passingham (2006)].

[9] The motivation for this premise is the Lau & Passingham experiment. As I have presented it, the neural correlate of the difference between subject reporting seeing the target stimuli and not seeing it is in the left dorsolateral prefrontal cortex.

5 Replies

5.1 HOTs have a different neural correlate during dreams

One possible way to resist the argument would be to maintain that HOTs have two different neural correlates. During wakefulness, dlPFC is the neural correlate for visual HOTs, whereas during sleep HOTs have a different neural correlate.

That kind of dissociation seems implausible. Having another area responsible for HOTs during dreams would require a functional duplication and mutual exclusion. Imagine that we have another area that is the neural correlate of dreams during sleep,[10] let me refer to this area as 'the sleep neural correlate of HOT '(SNCHOT). When we have a visual experience during wakefulness, the neural correlate of the corresponding HOT is in the dlPFC, and not SNCHOT, which is not differentially activated as the fMRI in the Lau & Passingham experiment shows. During dream experiences, dlPFC is deactivated and the neural correlate of the HOT would be SNCHOT. Why do we need SNCHOT?

REM sleep seems to be exclusive to marsupial and placental mammals [Winson (1993)]. It is, therefore, reasonable to assume that the only organisms capable of dreams are only those at the top of the pyramid of evolution. The plausibility of SNCHOT depends on the function of dreams during sleep; a function that requires HOTs. If dreams have no function, it seems unreasonable to assume that new changes in brain activity during REM phase appear to give rise to HOTs in other areas that were not present during wakefulness, and the only area they are present during wakefulness seems to be the dlPFC.

Most of the theories of dreaming yield dreams as epiphenomenal. (For a review see [Revonsuo (2000)]) This has been explicitly claimed by Flanagan:

> [Dreams are] a likely candidate for being given epiphenomenalist status from an evolutionary point of view. P-dreaming [phenomenal experiences during sleep] is an interesting side effect of what the brain is doing, the function(s) it is performing during sleep. To put it in slightly different terms: p-dreams, despite being experiences, have no interesting biological function. I mean in the first instance that p-dreaming was probably not selected for, that p-dreaming is neither functional nor dysfunctional in and of itself ([Flanagan (1995)], pp. 9–11).

On the activation-Synthesis theory [Hobson and McCarley (1977)] dreams are the result of the forebrain responding to random activity initiated at the brainstem. Dreams are nothing but noise activity.

Other theories either maintain that dreams have a function in memory processing ([Crick and Mitchison (1983), Foulkes (1985), Hobson (1994)]), in which case there is no function for HOTs and dreams merely reflect the corresponding

[10] A plausible candidate could be the anterior cingulate. As we have seem this area is strongly activated during the REM phase. Furthermore, the anterior cingulate communicates to the relevant sensory and limbic areas.

memory processing and these processes do not require any HOT or are regarded as some kind of hallucinations that protect sleep without any function for the content of dreams [Solms (1997)].

One exception is Revonsuo [Revonsuo (2000)].[11] According to him, the function of dreams is 'to simulate threatening events and to rehearse threat perception and threat avoidance'. But this function can also be performed during wakefulness, so the same structures that we use while we are awake could be used during sleep.

As long as one cannot make the case for the function of HOTs in dreams, and I seriously doubt that it can be made, we have no additional reason for defending the possibility of having an additional neural structure, SNCHOT, that differs from dlPFC. There seems to be no reason for a duplication of the HOT machinery. If this is right and dlPFC is the neural correlate of HOTs responsible for visual experiences, then we have good reasons for believing that there are no visual HOTs during dreams.

An alternative objection would deny that we do not have phenomenally conscious experiences during sleep. This is the next objection I am going to consider.

5.2 We do not have conscious experience during dreams

The common sense position maintains that dreams are conscious experiences and it is a position that has been maintained by philosophers, psychologist and neuroscientists, but not without exception.

The common sense position has been famously rejected by Malcolm [Malcolm (1959)] who asserts that it leads to conceptual incoherency "...the notion of a dream as an occurrence that is logically independent of the sleeper's waking impression has no clear sense." (op.cit., p. 70).

Malcolm maintains that we have no reason to believe the reports given by awakened subjects for there is no way to verify them; they could be cases of 'false memory'.[12] It could be that processes during REM phase are all non-conscious and that on awakening there is a HOT targeting the content of memory and thereby making it conscious.

Whereas Malcolm denies that there are dreams, Dennett has defended a skeptical position. [Dennett (1976)] presents an alternative account in which dreams could be unconscious memory loading processes.[13] According to Dennett, before establishing whether dreams are conscious we need an empirical theory of dreams and that it is "an open, and theoretical question whether dreams fall inside or outside the boundary of experience". Dennett goes a step further, claiming that we have some empirical evidence indicating that dreams are not conscious experiences, for they fail to satisfy well confirmed conditions

[11] See also [Franklin and Zyphur (2005)] for an extension of Revonsuo's proposal

[12] Rosenthal, in conversation, points in the same direction.

[13] It not worth discussing the value of the proposal itself, for it is only intended to present a skeptical argument showing that there can be alternative explanations to dreamer's reports when awakened.

for conscious experience like the activation of the reticular formation (op.cit., p.163).

This position has been challenged by Revonsuo [Revonsuo (1995)] who provides empirical evidence to the effect that there is in fact activity of the reticular formation and important neuro-physiological similarity between dreaming and wakefulness.

> From the standpoint of the thalamocortical system, the overall functional states present during paradoxical sleep and wakefulness are fundamentally equivalent, although the handling of sensory information and cortical inhibition is different in the two states . . . That is, paradoxical sleep and wakefulness are seen as almost identical intrinsic functional states in which subjective awareness is generated. ([Llinas and Pare (1991)], p. 522, quoted in [Revonsuo (1995)])

Unfortunately that would not impress my opponent. According to HOT theory, consciousness necessitates the presence of a HOT; HOTs are absent during dreams so dreams are unconscious experiences.

Skepticism about dreams bases her position on the fact that the access to dreams is retrospective: we recall the dream when we are awakened and we have no reason for trusting these reports. However, there are cases in which some people are aware of being dreaming. This is the case of lucid dreams. In lucid dreams, the dreamer is able to remember the circumstances of normal life and to act deliberately upon reflection.

Although lucid dreams have been reported since Aristotle, many have had their doubts about the reality of these episodes. Dennett endorses this skepticism; he considers that the report of lucid dreams is consistent with the subject dreaming that she is aware of being dreaming. But the empirical evidence suggests that Dennett's hypothesis is wrong.

Roffwarg [Roffwarg et al. (1962)] showed that some of the eye movements of REM sleep correspond to the reported direction of the dreamer's gaze. Based on this evidence, LaBerge and colleagues [LaBerge et al. (1981)] could provide evidence in favor of lucid dreams. They trained subjects and asked them to make distinctive patterns of voluntary eye movements when they realized they were dreaming. These prearranged eye movement signals were recorded by the polygraph records during REM, proving that subjects had indeed been lucid during uninterrupted REM sleep. This result has been replicated by other laboratories. (For a review see [LaBerge 1988]).

The experiments on lucid dreams provide evidence that we have conscious experiences during sleeps, and give us the opportunity to record reports to that effect. The main reason for skepticism is dissolved: there are conscious dreams.

My opponent can still try to resist the argument by maintaining that we have conscious experiences during lucid dreams but not during ordinary dreams, for only during lucid dreams can the subject report on them (according to her, reporting is inextricably linked to HOTs). This half baked reply distinguishing lucid dreams from other dreams seems to be something of a reach. Furthermore, lucid dreams occur during the REM sleep phase, and during the REM phase there is a deactivation of the dlPFC. We have no evidence that there is any activation of dlPFC during lucid dreams and although during all the measurements performed during REM phase such an activity was not found there are no conclusive results that rule out this possibility.[14]

Conclusion

Some philosophers have argued that phenomenal consciousness requires a certain form of awareness, and that this awareness depends on the cognitive accessibility that underlies reporting. Higher-order theories of consciousness are one example.

I have argued that this kind of access is not necessary for consciousness, for we lack it during dreams when we are conscious.

Lau and Passingham experiment provides good evidence for believing that the neural correlate of the reporting access to our visual conscious experiences depends on the dorsolateral prefrontal cortex which is deactivated during dreams.

I have argued that we have no reason to believe that this function is implemented by another area during sleep.

The defender of HOT theory can embrace a skeptical position as to whether we have conscious dreams. This position, which runs against common sense, has been refuted by strong empirical evidence.

The position remaining for HOT theory is not a comfortable one, or so I have tried to argue. If dlPFC is activated during lucid dreams (there is no evidence in favor of this fact), HOT has to maintain an ontological dichotomy with regard to dreams (some dreams are phenomenologically conscious and others are not). If it is not activated, as the evidence available strongly suggest, HOT theory is seriously jeopardized.[15]

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[14]Tononi[Tononi (2009)] considers this possibility, but his motivation is very different. For him, dreams are conscious experiences characterized, among other things, by a reduced voluntary control and reflective thought. Tononi explains this characteristic by the deactivation of dlPFC which is involved in volitional control and self-monitoring. For that reason, Tononi asserts:

> It is plausible, but not proven, that the deactivation of dorsolateral prefrontal cortex that is generally observed during REM sleep may not occur during lucid dreams.

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