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.

There is empirical evidence strongly suggesting that the cognitive accessibility that underlies the ability to report visual experiences depends on the activity of the dorsolateral prefrontal cortex (dlPFC). This area, however, is highly deactivated during the conscious experiences we have during sleep: dreams. HOT theories are jeopardized, 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 the ability to report depends on the dorsolateral prefrontal cortex: 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 that 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 sleep.

Keywords: Phenomenal Consciousness, Higher-Order Thought Theories, Dreams, Dorsolateral Prefrontal Cortex.

1 Introduction

In 'On a confusion about the function of consciousness', Ned Block (1995-2002) famously maintained that our 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 cylindrical shape and red color and it is filled with a black liquid. When I consciously see the cup, my brain processes all this information and this information is typically available for further reasoning (deciding to drink the coffee), motor control (moving my hand toward the cup), etc. Understanding the mechanisms that underlie these processes constitutes what Chalmers (1996) calls 'the easy problem of consciousness'. It is, no doubt, a very complicated issue given the complexity of our brains, but the research in neurosciences has made huge amounts of progress in recent years and it is, from a philosophical perspective, relatively unproblematic.

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

The relation between access and phenomenal consciousness is an important issue that cannot be settled without a further clarification of the notions involved. Even so, some form of access seems to be essential to phenomenal consciousness, 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).

Higher-Order Representational (HOR) theories of consciousness maintain that *Awareness* is a form of representation. That is to say, phenomenally conscious states are states that are the object of some sort of higher-order representation. The kind of representation that is required by the theory makes a basic difference among HOR theorists.[1] Nonetheless, I want to draw an orthogonal distinction to make the target of the argument I am about to present clear. My target in this paper will be theories that maintain that *Awareness* is a form of cognitive access, the same cognitive access that underlies the ability to report −more precisely, higher-order theories that maintain that the cognitive ability that makes it possible to report the content of a mental state is essential to phenomenally conscious mental states. My opponent holds a higher-order cognitive position characterized by the following three claims:

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1 The main concern is whether higher-order states are belief-like or perception-like. The former are called Higher-Order Thought (HOT) theories (Gennaro (1996); Rosenthal (1997, 2005)) and the latter Higher-Order Perception (HOP) or 'inner-sense' theories (Amstrong (1968); Carruthers (2000); Lycan (1996)). According to the former theories, when I have a phenomenally conscious experience as of red I am in a mental state with certain content, call this content “RED”. For this mental state to be phenomenally conscious, there has to be, additionally, a higher-order thought targeting it, whose content is something like “I am seeing RED”. On the other hand, HOP theories maintain that what is required is a (quasi-) perceptual state directed on to the first-order one. A second point of disagreement is whether a given state is conscious in virtue of its disposition to raise a higher-order representation (Carruthers (2000)) or by being actually the target of a higher-order representation (Rosenthal (1997, 2005)); this is the difference between dispositional and actualist HOR theories. According to dispositional HOR theories, the higher-order representation that renders the *Awareness* of the first-order one doesn't have to be actual; i.e., there is no need for the higher-order representation to happen actually, what is needed for a mental state to be conscious is a disposition to be the object of such a higher-order representation.

Higher-Order Cognitive

1. Consciousness requires *Awareness*.

2. *Awareness* requires the right kind of Higher-Order Representation.

3. The right kind of Higher-Order Representation depends on the cognitive accessibility that underlies reporting.[2]

This position has been paradigmatically held by Higher-Order Thought (HOT) theorists.[3] According to HOT theories, a mental state M is conscious if and only if there is another belief-like mental state (a Higher-Order Thought) to the effect that one is in M. Being conscious requires being *Aware* of oneself as being in a certain mental state and this *Awareness* is explained as being the target of the appropriate HOT (e.g. a HOT that is non-inferentially caused). The greatest exponent 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 corresponds to what we*

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2 Note that organisms lacking our ability to report being in a particular mental state might still have the same kind of cognitive accessibility that we have. Hence, lacking the ability to report does not prevent that one can have higher-order representations.

3 Not all Higher-Order theories are committed to these three claims. Consider, for instance, Carruthers (2000)'s dispositionalist view. According to Carruthers, phenomenally conscious states are, roughly speaking, states that are recognized as representations by a Theory of Mind. Each experience would, at the same time, be a representation of some feature of the world (for example, a representation of red) and a representation of the fact that we are undergoing such an experience (a representation of seems red), through the consumer system that is the Theory of Mind.

If these mindreading capacities do not depend on the cognitive accessibility that underlies reporting, as it plausibly doesn't, then Carruther's theory illustrates an example of a Higher-Order theory that is not jeopardized by the success of my argument.

In section 4 I will present a hypothetical cognitive HOR theory that might be immune to my argument.

> *intuitively think of as that state's being in our stream of consciousness.* (Op. cit., p.55, my emphasis)

I will focus on Rosenthal's HOT theory in my criticism for I consider it to be the quintessence of theories that hold a higher-order cognitive position. The position that I will be defending, call it *non-cognitive position*, maintains that *Awareness* does not depend on the cognitive accessibility that underlies reporting. Therefore, it maintains, *pace* HOT theories, that there can be cases of phenomenal consciousness on which subjects might not be able to report due to a failure in the cognitive access.

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

2 The Neural Correlate of Cognitive Accessibility for Visual Experiences: dlPFC

The evidence for the neural correlate of the cognitive accessibility, in the case of visual experiences, is provided by an experiment performed by Lau and Passingham (2006). This experiment suggests that such cognitive accessibility depends on the dorsolateral prefrontal cortex (dlPFC).

The experiment is based on a visual discrimination task with metacontrast masking. Metacontrast masking takes place when a target stimulus is followed, after a short period of time called *Stimulus Onset Asynchrony* (SOA), by a mask that shares a contour with it, leading to a reduction in perceived brightness and to degraded perception of the spatial shape of the target (Haynes and Rees (2003)).

Subjects in the experiment are asked to fixate their gaze and they are presented with one of two possible stimuli, either a square or a diamond on a black background. After a short variable period of time, the SOA, a mask is presented. The mask overlaps with part of the contour of both possible stimuli but it does not overlap with any of them spatially (See Figure 1).

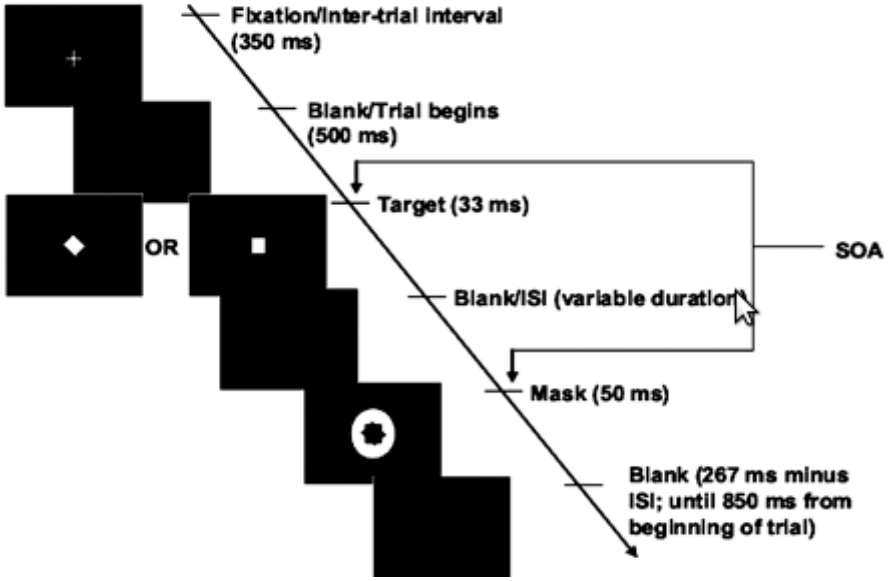

Fig. 1: Lau & Passingham's Experimental Set up.[4]

Subjects in the experiment have to perform two tasks after the presentation of the target and the mask:

1. Decide whether the target stimulus was a diamond or a square.
2. Indicate whether they actually saw the target or were simply guessing in the previous task.

The first question is intended to measure the objective *performance capacity* of the subjects: how good they are at identifying the target stimulus. The second question is intended to measure the *perceptual certainty* of the subjects: how confident they are on having seen the stimulus. This subjective report, according to the authors and to HOT theories, is an indication of phenomenal consciousness.

Figure 2 shows the result as a function of the SOA, the interval between the presentation of the target stimulus and the mask. The presence of the mask has nearly no influence on the performance capacity (represented by a continuous line) nor on the perceptual certainty (represented by the dotted line) when presented before or close to the stimulus. As the SOA increases, the mask interferes with the perception of the target stimulus and both, the performance capacity and the perceptual certainty decrease until a certain point where the influence of the mask starts to diminish, having no effect at all when it is presented much later than the stimulus. The resulting curves have a U-shape, where two points, corresponding to different SOAs, with the same performance capacity and two points, also corresponding to different SOAs, with the same

[4] Lau and Passingham (2006). Copyright (2006) National Academy of Sciences, U.S.A.

perceptual certainty can be identified.

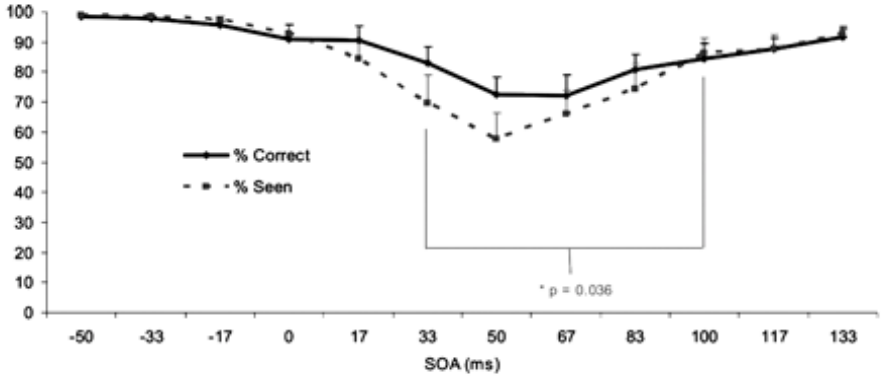

Fig. 2: Performance Capacity (% correct) vs. Perceptual Certainty (% seen)[5]

The interesting finding is that we can detect two conditions under which the performance capacity of the subjects is the same but such that they differ in their perceptual certainty. Whereas in one (short SOA), subjects tend to report having guessed when they were asked about the identity of the stimulus; in the other (long SOA), subjects are fairly confident of having seen it. For HOT theories, the subject is phenomenally conscious only in the second case where she reports having seen the stimulus.

Lau and Passingham performed an fMRI study on the subjects of the experiment. Their 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, subjects report having seen the stimulus in the long SOA condition but not in the short one. Hence, we may assume that they are phenomenally conscious of the stimulus only in the long SOA condition. Since HOTs are associated with reporting abilities, Lau and Passingham have found the neural residence of HOTs, at least for visual higher-order thoughts (thoughts of the form 'I see a square').[6] Rosenthal explicitly accepts the evidence from this experiment as showing that

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5 Lau and Passingham (2006). Copyright (2006) National Academy of Sciences, U.S.A.

6 Lau and Passingham maintain that consciousness should be associated with perceptual certainty. Lau (2008) explicitly endorses this view. He maintains that consciousness depends on Bayesian decisions on the presence of the stimuli relying upon a learning process and on the firing pattern of the first-order representations. Lau named his view Higher-Order Bayesian Decision Theory. It is unclear to me why a proposal along these lines should be considered a Higher-Order Representationalist one. See fn. 12.

the neural correlate of HOTs is in the dlPFC:

> There is, however, some evidence that states are conscious when, and only when, a distinct neural state occurs in mid-dorsolateral prefrontal cortex (area 46) (Lau & Passingham, 2006), and it is reasonable to explore identifying these neural occurrences with the posited HOTs. Rosenthal (2008, p. 835).

On the other hand, the defender of the non-cognitive position would maintain that the curve corresponding to phenomenology could be somewhere in between the two curves in figure 2 (% correct and % seeing) and is not impressed by the fMRI data. The reason is that she would have predicted exactly this result: the judgment of having seeing the stimulus, which corresponds to a HOT, is reflected in the prefrontal cortex.[7]

So, does the Lau and Passingham's experiment bring some light to the debate between higher-order cognitive and non-cognitive approaches? 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 suggests, 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 dlPFC

Revonsuo (2000) defines dreams as “a subjective experience during sleep, consisting of complex and organized images that show temporal progression”. Dreams are phenomenally conscious experiences, experiences that are similar in many respects to the ones 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 considered by Plato, Aristotle and most famously in Descartes’ skeptical argument in the First Meditation. The view that dreams are conscious experiences has been explicitly endorsed, in the

7 This possibility has been suggested by Ned Block in the Second Consciousness Online Conference (http://consciousnessonline.wordpress.com)

philosophical field, by, among others, Kant, Russell, Moore, and Freud (Malcolm (1959, p.4)). Most contemporary philosophers working on dreams also hold this view (see for instance Ichikawa (2009); Ichikawa and Sosa (2009); Metzinger (2003, 2009); Revonsuo (2006); Sosa (2005)).

I do not intend to argue that dream experiences are exactly like waking experiences. According to 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. Furthermore, dream reports may include phenomena that resemble neuropsychiatric conditions such as distortion of time perception, perceived distortion of body parts, bizarre illogical situations, prominence of negative emotions, anxiety and fear, and misidentification syndromes like erroneously recognizing a familiar person despite the lack of any obvious physical resemblance (Karim (2010)). The only point that is relevant for the purpose of this paper is that we have dreams and that dreams include phenomenally conscious visual experiences.[8]

Sleep is traditionally divided into two phases: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep.[9] 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 that occur during NREM, there is no doubt that we dream 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. What happens in the brain during this period?

3.1 Neurophysiology of Sleep

During sleep there is a global reduction in metabolic activity and blood flow in the brain. Compared to resting wakefulness, the decrease during NREM phase can reach a 40% as shown by positron emission tomography (PET) studies (Braun et al (1997)). At the cortical level, activation is reduced in the orbitofrontal and anterior cingulate and dorsolateral prefrontal cortex

8 Some philosophers have tried to resist this claim. I will present their views and offer a rejoinder in subsection 5.2.

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

−Broadmann area 46 (See Braun et al (1997, table 1 p.1177)).

During REM sleep some areas are even more active than in wakefulness, especially the limbic areas. In the cortex, the areas receiving strong inputs from the amygdale, like the anterior cingulate and the parietal lobe, are also activated (Maquet et al (1996, table 1 p.164)). On the other hand, the rest of the parietal cortex, the precuneus and the posterior cingulate are relatively inactive (Braun et al. (1997, table 2 p.1178)).

What is relevant for this discussion is that there is a selective deactivation (compared with wakefulness) of the dlPFC (Braun et al (1997); Maquet et al (1996, 2005); Muzur et al (2002)) during REM phase.[10] Specifically, Maquet et al. showed a very significant reduction in the activity of 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 Schwarz and Maquet (2002); Tononi (2009)). In particular, the deactivation of the dlPFC, which is associated with executive abilities such as expectancy, volitional control and working memory in wakefulness (Fuster (2008)), fits in well with the common loss of self-reflective awareness and rational control in dreams (Kahn (2007)).

According to Lau and Passingham's experiment, 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 having guessed −despite the lack of difference in their performance in both situations. If HOTs were constitutive of phenomenal consciousness we would expect its neural correlate to be active during dreams. However, empirical evidence suggests the opposite. Given these elements the reader can easily anticipate my argument against HOT theories.

4 The Argument

In this section I present the argument against HOT theories in more detail.

Let me start with a simple argument against *cognitive theories of consciousness* in general. I call 'cognitive theories of consciousness' those theories that

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

maintain that the cognitive accessibility that underlies reporting is constitutive of phenomenal consciousness. One example of such cognitive theories is, as we have seen, Rosenthal's HOT theory. Another example is Michael Tye's PANIC theory (Tye (1997, 2002)). According to Tye, phenomenally conscious mental states are states whose content is Poised, in the sense that it is available to first-order belief-forming and behavior-guiding systems; Abstract, meaning that the intentional content is not individuated by the particular things represented; and Non-conceptual in the sense that it is not structured into concepts. Contrary to HOT, PANIC is a first-order theory. It does, however, endorse the claim that phenomenal consciousness depends on the cognitive accessibility underlying our ability to report −on the plausible assumption that it is the same one as the one that underlies belief-forming and behavior-guiding.

The argument against *cognitive theories of consciousness* has the form of a *reductio ab adsurdum*:

(Anti-Cognitive)

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).
3. dlPFC is necessary[11] for phenomenally conscious visual experiences (From 1 and 2).
4. We have phenomenally 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 phenomenally conscious visual experiences (From 4 and 5).

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

Premise 1 is the common claim of what I have called *cognitive theories of consciousness* and the assumption of the argument. Premise 2 is supported by Lau & Passingham's experiment. As I have presented it, the neural correlate of the difference between subjects reporting seeing the target stimuli and not seeing it is in the left dorsolateral prefrontal cortex. (3) follows from these two premises.

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11 Modal claims in this argument are obviously to be read as restricted to *beings like us in worlds with the same laws as the actual one*.

It is hard to deny that we have conscious experiences during sleep and that those experiences include conscious visual experiences. These experiences typically happen during the REM phase of sleep (4). However, as we have seen, there is empirical evidence showing a selective deactivation of the dlPFC during the REM phase (5). (4) and (5) together suggest that the activation of the dlPFC is not required for having a phenomenally conscious experience and lead us to the claim that the dlPFC is not necessary for consciousness (6).

(3) and (6) are contradictory claims, what lead us to reject premise 1, *QED*.

This argument might, however, be invalid. The reason is that one can deny that (6) follows from the conjunction of (4) and (5). This possibility is explored by Lau himself. According to Lau's theory (Lau (2008)), the role of dlPFC is to work as a Bayesian decision system that tries to make “accurate judgments” about the inputs of the sensory cortex. The increase in the noise signals in the sensory cortex during REM phase in comparison to NREM, accompanied by a deactivation of the dlPFC, explains dreams as a malfunction of the decision system.

> 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 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. According to Lau, during sleep the dlPFC is deactivated and, therefore, malfunctioning, making the wrong *judgments*.[12] Lau can, hence, accept (4) and (5) while resisting (6): the dlPFC is malfunctioning due to its deactivation, but its *judgments*, right or wrong, are still required for phenomenal consciousness.

In order to properly evaluate Lau's claim, further details about how the decision

12 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.

mechanism is supposed to work and how the decrease of activity in the dlPFC is related to this mechanism need to be added. We need an explanation of how the decrease in the activity of the dlPFC during REM is related to the failure "to set an 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, which according to Lau corresponds to phenomenal consciousness, is accompanied with an increase in the activity of the dlPFC in the original experiment. It is an open question whether a satisfactory answer can be provided and an empirical issue whether the dlPFC works in this way. If Lau were right then (Anti-Cognitive) would be an invalid argument.

This line of reasoning can be endorsed by defenders of first-order cognitive theories like Tye's PANIC. It seems reasonable to think of the dlPFC as a filter. A state would be available for reporting −and hence poised− if the dlPFC let its content go through; in other words, if the dlPFC decides that the signal arriving corresponds to sensory input and not to noise. A similar reply could be provided by a particular kind of Higher-Order Theory, call it Indexical Higher-Order Representational Theory (IHOR). According to IHOR, in the case of visual conscious experiences, the first-order state with the content *SQUARE* is accompanied by a higher-order indexical thought, encoded in the dlPFC, with the content "I SEE THIS" pointing to the first-order one.[13][14]

This strategy is, however, not available for HOT theories. According to HOT theories, the higher-order state is not indexical as in IHOR, but something like "I SEE A SQUARE" in the previous example. If dlPFC encodes HOTs, we would expect an increase in its activity as the content of conscious phenomenology increases, because we would expect more frequent updates in the

13 If one is interested in this strategy, one would have to elaborate on the mechanisms on which such a demonstration would rely.

14 Those willing to endorse Lau's model of cognitive accessibility will maintain that there are two states involved. The relation between these two states distinguishes higher-order and first-order theories. Lau and Passingham (2006) seem to be silent among the two kinds of theories.

On the one hand, a first-order theory maintains that there is a merely causal relation between the two states, which we can call ANIC and PANIC taking Tye's theory as a model, and that both states have the same intentional object, say the square.

On the other hand, IHOR maintains that the relation between a first-order and the higher-order one is not only causal but intentional. Whereas the first-order state has the square as its object, the higher-order one has the first-order one as its intentional object. IHOR has to make room for cases in which there is no first-order state, cases of misrepresentation. It is unclear to me what would be the phenomenology of cases in which the demonstration fails and there is no first-order state the higher-order one is pointing to. For a discussion on related issues derived of such an intentional relation see Block (2011); Rosenthal (2011); Weisberg (2011).

corresponding HOTs. HOT theory seems to be committed to the claim that there is a monotonic relation between the content of conscious experiences and the activity of the neural correlate of HOTs. It is, therefore, unable to accommodate the data about the brain activity during dreams as we have just seen, blocking thereby the inference from (4) and (5) to (6) in the argument.

In the next section I will discuss possible replies that the defender of HOT theories can endorse against the argument and offer a rejoinder.

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. This way, one blocks step 3 in (Anti-Cognitive), because, in spite of the fact that the cognitive accessibility that underlies reporting in the case of visual experiences depends on the dlPFC, it only does so during wakefulness and, therefore, it is not true that the activity of the dlPFC is necessary for conscious visual experiences (3).

That kind of dissociation seems, however, 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,[15] 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 and Passingham's experiment shows. On the other hand, during dream experiences, dlPFC is deactivated and the neural correlate of the HOT would be SNCHOT. The question is: 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 those at the top of the pyramid of evolution. The plausibility of SNCHOT depends on the function of dreams during sleep; a function that should require HOTs. If dreams have no function, it seems unreasonable to

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

assume that 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.[16] 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, p.9)).

Sometimes it is held that dreams are the result of noise activity or a by-product of the changes in brain activity during sleep. This option is considered by the Activation-Synthesis theory (Hobson and McCarley (1977)), where dreams are the result of the forebrain responding to random activity initiated at the brainstem, the improved AIM (Activation, Input-ouput gating, Modulation) model (Muzur et al (2002)) or by Lau (2008), as we have just seen.

Solms (1997) has recently defended the Freudian view that the function of dreams is to protect sleep. However, Solms does not attribute any functions to the content of dreams, and therefore HOTs, and he also regards dreams as hallucinations that the weakened frontal reflective systems mistake for real perception.

Other theories maintain that dreams have a function in memory processing (Crick and Mitchison (1983); Foulkes (1985); Hobson et al (1994)), in which case there is no function for HOTs and dreams merely reflect the corresponding memory processing −processes that do not require any HOT.

One exception is Revonsuo (2000).[17] According to him, the function of dreams

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16 In the intended sense here, something is epiphenomenal if and only if it lacks biological function. This sense should be contrasted with the sense in which something is epiphenomenal if and only if it lacks causal impact whatsoever.

For a review of these epiphenomenal theories see Revonsuo (2000).

17 See also Franklin and Zyphur (2005) for an extension of Revonsuo's proposal.

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, which 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 and therefore a good support for (3).

An alternative objection would deny that we 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

A different possibility to block the argument is to reject premise (4). The common sense position maintains that dreams are conscious experiences; a position that has been maintained by philosophers, psychologists and neuroscientists, but not without exception.

The common sense position has been famously rejected by 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'.[18] 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 (1976) has defended a skeptical position. Dennett presents an alternative account in which dreams could be unconscious memory loading processes.[19] 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” (op.cit., p.170-71). Dennett goes a step further, claiming that we have some empirical evidence indicating that

18 Rosenthal, in conversation, points in this direction.

19 It is 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.

dreams are not conscious experiences, for they fail to satisfy well confirmed conditions for conscious experience like the activation of the reticular formation (op.cit., p.163).

This position has been challenged by Revonsuo (1995) who provides empirical evidence to the effect that there is in fact activity of the reticular formation and important neurophysiological 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 being phenomenally conscious experiences is based 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. There are cases, however, 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 hypothesis that dreams are unconscious episodes and that the subject is dreaming that she is aware of being dreaming. The empirical evidence suggests, nonetheless, that Dennett's hypothesis is wrong.

During REM sleep all skeletal muscle groups except those that govern eye movements and breathing are profoundly inhibited (LaBerge (2000)); this fact makes it very difficult to collect evidence in favor of lucid dreams beyond subjects' reports upon awaking. Nevertheless, Rowarg 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 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. Furthermore, LaBerge and Dement (1982) recorded lucid dreamers who were asked to either hold their breath or breath rapidly (in their lucid dreams), marking the interval of altered respiration with eye movement signals. The subjects reported having accomplished the agreed-upon tasks a total of nine times, and in every case, a judge was able to correctly predict, on the basis of the polygraph recordings, which of the two patterns had been executed. These results have been replicated by other laboratories. (For a review see LaBerge (1988)).

The experiments on lucid dreams provide evidence that we have conscious experiences during sleep, and give us the opportunity to record reports to that effect. The main reason for skepticism is dissolved: there are conscious dreams. In lucid dreams, subjects can report having an experience. One might be willing to concede that, independently of the preferred theory of consciousness, when subjects report having an experience they are entertaining a HOT. In this case, if dlPFC is the neural correlate of HOTs we should expect an increase in its activity in these cases.

Some authors have hypothesized that the deactivation of the dlPFC observed during REM sleep does not occur during lucid dreams. Dreams are conscious experiences characterized, among other things, by reduced voluntary control and reflective thought. These characteristics fit well, as we have seen (Fuster (2008)), with the independent hypothesis that the dlPFC is involved in volitional control and self-monitoring. For this reason, a reactivation of the dlPFC is expected during lucid dreams (Hobson et al (2000); Kahn and Hobson (2005); Tononi (2009)). Preliminary empirical evidence for this hypothesis has been obtained from a recent study by Voss et al (2009). This study shows that lucid dreaming in trained participants is associated with increasing electroencephalography (EEG) power, especially in the 40-Hz range, over frontal regions during REM sleep. Furthermore, Wehrle et al (2005, 2007) use fMRI to study brain regional activation during lucid dreams and show that in lucid dreams not only frontal but also temporal and occipital regions are highly activated in comparison to non-lucid dreams. Hobson (2009) also refers to preliminary fMRI data gathered by M. Czisch, R. Wehrle and M. Dresler showing that dream lucidity is correlated with increased activation of the cortical areas including the dlPFC.[20]

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20 I am not sure about how to make this reactivation of the dlPFC compatible with Lau's hypothesis about the role of the dlPFC in dreams. Recall that this hypothesis might be endorsed by other cognitive theories, such as PANIC, to block my argument.

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). However, distinguishing lucid dreams from other dreams in such a way that there is phenomenology associated to the former but not to the latter seems to be something of a reach.

6 Conclusions

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 Thought theories of consciousness are an example of this position.

Lau and Passingham's 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 (dlPFC). This would be, accordingly, the most plausible candidate to be the neural correlate of visual HOTs. The evidence seems to suggest that visual HOTs are not necessary for consciousness, because their neural correlate is highly deactivated during the phenomenally conscious experiences we have when we sleep: dreams.

I have argued that we have no reason to believe that visual HOTs are 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 empirical evidence (lucid dreams).

The position remaining for HOT theory is a not very plausible one, according to which, there would be an ontological dichotomy with regard to dreams (some dreams are phenomenologically conscious and others are not).[21]

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