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# Why do we remember our dreams so well?

## Implications of dream recollection on the imagination vs. hallucination debate

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**Abstract**
Why is dream memory so good? This loaded question appears to be based on an incorrect assumption, considering that bad memory of dreaming is, after all, well documented. However, whether dream memory is good or bad depends on what we compare these recollections to. Dream recollection is usually compared to memory of waking perceptual experiences, yet there is disagreement about whether this comparison is appropriate. Preliminary evidence suggests that dream memory is not bad compared to imagination memory and this may have implications for what it means to dream. Here we consider exactly how bad – or good – dream memory is compared to imagination that occurs while mindwandering and argue that while, prima facie, dream memory appears to provide an argument for the imagination model, this argument turns out to be unconvincing. There are many adverse conditions that would explain why memory of dreaming is worse than memory of waking events or hallucinations under the hallucination model. Further, if, as preliminary evidence might suggest, dream memory turns out to be somewhat better than imagination memory, this currently has no explanation under the imagination model. However, NREM dreams display the type of memory one might expect from imaginative dreaming. While the goodness or badness of memory in dreams should not be seen as a definitive argument for a particular model of dreaming, it should instead be taken as a piece of the broader landscape of abductive reasoning in this debate.

**Keywords**
Dreams · Hallucination · Imagination · Memory · Mindwandering

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# 1 Introduction

How well we remember our dreams should be considered as part of a broader inference to the best explanation about the nature of dreams. Arguments about the nature of dreams often progress in part by comparing cognitive and phenomenal features of dreams with those of waking states such as perception, hallucination, and imagination. If significantly similar, dreams could be considered as perceptual, hallucinatory, or imaginative states. However, dream recall has not yet been included as part of this debate. Here we consider how dream recall compares to recall of these waking experiences and how this evidence contributes to the debate about whether dreams are imaginative or hallucinatory states.

In the empirical literature, dream recall is described as particularly bad, however, whether dream recall is good or bad depends on what we compare these recollections to. Dream recollection does indeed seem bad when compared to memory of waking perceptual experiences, yet there is disagreement about whether this comparison is appropriate. Perhaps a better comparison is with waking imagination. The imagination model, the view that dreaming is a type of imagination (Ichikawa, 2009; 2016; Sosa, 2005; see also McGinn, 2006; Sartre, 2004), is gaining traction in the philosophical literature. Preliminary evidence suggests dream recall is not so bad compared to recall of spontaneous, sensory imagination; the subtype of imagination that, we argue, would make the best analogy with dreaming under the imagination model. We refer to this as 'imaginative mindwandering'. In fact, poor memory for dreaming is just what the imagination model theorist might predict. Whether this should be seen as evidence in support of the imagination model, however, requires a nuanced assessment of the empirical and philosophical literature.

The most widely accepted model of dreaming is the hallucination model, that dreams are simulations of a world in which we feel immersed, and we generally take this simulation to be real while dreaming (Revonsuo, 2009; Windt, 2010). Is dream recall more like recall of waking hallucinations or imagination? Ceteris paribus, we would expect mental states of the same kind to have similar cognitive profiles, thus, cognitive similarities could be taken as part of a broader argument in support of one theory over another. At first glance, dream recall appears to count in favour of the imagination model over the hallucination model. On further evaluation, however, we argue instead that a memory-based argument in support of the imagination model does not work for rapid eye movement (REM) dreams, but only *potentially* for non-REM (NREM) dreams.

We present evidence that both dream and imagination recall are significantly poorer than recall of waking perception or hallucination. It is plausible that, on average, we should have similar memory access to mental states of the same kind, all things being equal. In other words, similar kinds of experience should be similarly memorable. If we are to claim that mental state type A is a subclass of mental state type B, but we have poor memory retention of A and good memory retention

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of other forms of B, then we need to explain why memory for each state differs despite being of the same type. Without such an explanation, this would be some evidence that A is not a type of B. Thus, if dream recall is far worse than waking hallucination recall and we have no explanation for this, we have some evidence against dreams being hallucinatory. However, if, as preliminary empirical evidence might suggest, recall of imaginative mindwandering turns out to be as bad as REM dream recall, this seems to favour the imagination model.

Mental states, nonetheless, are complex, and we might expect all things *not* to be equal. Thus, we need to take into account these potential disanalogies and assess whether they are relevant. For instance, if two mental states differ in terms of some feature related to memory, say mental state A has neural conditions consistent with normal waking memory and mental state B has conditions consistent with poor memory but nonetheless, recall of each state is similar, this could be seen as an argument *against* the two states being of the same type. Otherwise, how is it that one state has similar memory capacity but different memory-related neural activation? There would likely be a further, unknown difference affecting memory. Thus, to make a memory-based argument for either the hallucination or imagination model, we must assess two things: firstly, what recall is like for dreaming compared to imagination and hallucination and secondly, whether there are relevant differences between the dreaming and waking mind that affect memory. As we will see, while dream and imagination recall seem similar, there are neural differences, and thus the evidence from memory turns out to be *inconsistent* with the imagination model, at least for REM dreams.

The state of the brain during sleep suggests that dream recall should be poor indeed, but if dream recall is in fact similar to recall of imagination, a new puzzle emerges. Given the state of the brain during sleep, how could dream recall not be significantly *worse* than waking imagination if the imagination model is correct? There are neuroactivational and neuromodulational changes in sleep associated with poor capacity for memory encoding, such as the shift from aminergic to cholinergic modulation and a drop in norepinephrine (Hobson et al., 2000; see also Becchetti & Amadeo, 2016; Murchison et al., 2011). These conditions, we argue, suggest that the poor memory we have of REM dreams cannot be used to support the imagination model. If dreaming is a type of imagining, imagination while awake has poor recall, and the dreaming brain is altered compared to the waking brain in ways that reduce memory capacity, dream recall should be far worse than that of waking imagination recall. There is no evidence that REM dream recall is this bad although a case for NREM dream recall being worse than imagination recall can be made. While the evidence about recall of imagination is yet too preliminary to make any strong claims, this paper explores how an examination of dream recall might shed light on the debate about the nature of dreaming.

We begin by briefly introducing the imagination and hallucination models, two influential theories of dreams, in section 2. As the hallucination model is currently the accepted view, we focus more on outlining the motivations put forward

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by imagination theorists in support of their view. Section 3 provides an analysis of dream recall and discusses the similarity in recall capacity of imagination and dreaming, arguing that both are quite poor compared to memory of waking events and hallucinations. We propose that dream recall appears akin to imaginative mindwandering recall, with some preliminary evidence suggesting that REM dream memory is somewhat better. We conclude, however, that REM dream memory does not support the imagination model for all dreams. Poorer memory of NREM dreams nonetheless is consistent with the view that some dreams are imaginative mindwandering states. Section 4 outlines possibilities for future research, highlighting the limits to our current knowledge of imagination recall and suggests how to fill the gaps in this knowledge.

# 2 Differing views on the nature of dreams: Hallucination or imagination?

Whether dreaming should be considered a type of hallucination or imagination has attracted increasing debate in recent years[1]. According to the orthodox hallucination view, to dream is to find ourselves in a world where, unaware that we are dreaming, we experience events and carry out activities. Dreams are the "experience of a hallucinatory world, which is taken for reality" (Meier, 1993, p. 61) or "phenomenal simulations" during which "the dreamer remains oblivious to their hallucinatory character" (Windt & Metzinger, 2007, p. 207). In contrast, according to the imagination view, dreams are a type of imagination that is "like vivid daydreams" (Ichikawa, 2008, p. 119) in which we lose ourselves in the experience of an imagined world. Contrary to what we might think about believing dreams to be real, imagination theorists contend that we don't falsely believe the contents of dreams to be true, but rather we only imagine that we believe them to be true.

If dreams are vivid hallucinations, it is surprising that one minute, the dreamer experiences something so seemingly memorable, and the next, lacks any recollection of it. We begin with an overview of the poor dream recall puzzle before introducing the imagination model as a potential solution to this puzzle.

## 2.1 Dreams as hallucination and the "poor recall" puzzle

According to the hallucination model, dreams are a type of hallucination that is immersive and multimodal, and they occur when we are isolated from the external environment whilst asleep. Here we take hallucination to be an experience that

[1] An alternative view is that dreams are sui generis, neither a type of hallucination nor imagination (Windt, 2015b). If this is the case, then dreams would have their own cognitive and phenomenal profile. Supporting this theory involves collating evidence that the profile of dreaming is sufficiently different from either hallucination or imagining. Different theories of sui generis dreaming would have different predictions about dream memory. For the purposes of this paper, we focus on whether dream memory is consistent with either imagination or hallucination.

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seems "just like a veridical perception of a worldly fact or facts, yet in which there are no suitable facts for the hallucinatory state to acquaint us with" (Fish, 2009). Hallucinations are experiences of objects or events that appear to be present in absence of said object or event[2]. Dreams involve not only visual and auditory experience but also touch, taste, smell, kinaesthetic, vestibular, and proprioceptive hallucinations (Foulkes, 2014; Hobson et al., 2000; Pagel et al., 2001). The experience of the dream world and body involves a hallucinated simulation or virtual reality (Revonsuo, 1995, 2009). This immersiveness presents a difference between dreams and most waking hallucinations where a hallucinated object may be experienced while also perceiving the physical environment.

While experiencing a dream, we can think, emote, and even imagine. On analysis of the phenomenology of 635 dreams collected upon waking from REM sleep, Snyder (1970) concluded that while dreaming, we are also thinking, remembering, deciding, experiencing a sense of agency, and having emotions. The hallucination model allows for the possibility that imagining, daydreaming or mindwandering could occur while dreaming. For instance, I could imagine an apple while dreaming of a scene where no apples are present (Kilroe, 2013; Rosen, 2024)[3]. While one might imagine or think during the dream, in this view, the dream world itself is considered hallucinatory and the dreamer usually believes in the reality of the dream's immersive virtual imagery (Windt, 2010).

Given that dreams under the hallucination model can be vivid, realistic experiences, our poor memory of dreaming seems puzzling and in need of explanation. Evidence suggests that we have several dreams per night, as discussed in more detail in section 3, but we forget an overwhelming majority of them. As we will see, memory of dreaming is far worse than memory of waking experiences or hallucinations despite these experiences seeming as if they should be quite memorable. However, this perplexity may arise misleadingly from the fact that we are comparing dream memory with memory of waking *events*. An alternative is that dreams are imagination, a type of mental state that is inherently fleeting.

[2] There is some debate about whether hallucinations are a type of perception or not. Disjunctivists consider any experience that is object-independent to be non-perceptual, and that perception and hallucination are thus different in kind. There is disagreement among disjunctivists, however, as to whether hallucination and veridical perception can share the same phenomenal character while having a different nature (Soteriou, 2020). For our purposes here, we draw on empirical work about the phenomenology and cognitive features of imagination, perception, and hallucination. Focusing on memory, we do not engage in the disjunctivist debate about whether hallucinations are a type of perception. How well we remember these states is our main focus.

[3] One could even suggest that this is common, but that we tend to forget this aspect of our dreams because our memory of imagination is worse than our memory of hallucination. More on this below.

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## 2.2 An alternative view: Dreams as imaginative mindwandering

Imagination model theorists describe dreaming as a type of imaginative activity. In our view, the most plausible interpretation of "imagination" in this context is the type of sensory imagination that occurs while mindwandering, a type of relaxed mental activity. This is because dreaming, like mindwandering, is generally unintended and uncontrolled, but also, according to imagination theorists, shares the phenomenal features of imagination. We begin by outlining some of the motivations behind the imagination model as most of these arguments still apply after we make the clarification that dreaming shares features with mindwandering. Then, drawing on the imagination model, we explain how dreaming as imaginative mindwandering strengthens the imagination model. Our specification overcomes one of the weaknesses of the imagination model, the argument that imagination and dreaming are subject to the will.

### 2.2.1 Support for the imagination model

Ichikawa explains that the imagery that occurs while imagining is "usefully thought of as the simulation of percept" (Ichikawa, 2009, p. 105). We can thus take dreaming of seeing a scene to be like simulating the same scene when awake with closed eyes. In Ichikawa's version of the imagination model, "dreams typically involve neither misleading percepts nor false beliefs but instead involve imaginative experiences" (Ibid, p. 104). In other words, I don't *really* believe what is happening, I only *imagine* I believe it[4]. If I dream that I'm being chased by a lion, I am "imagining that [I am] being chased by a lion, while still tacitly believing [myself] to be safe in bed" (Ichikawa & Sosa, 2009, p. 239; see also Sosa, 2005). To the external observer, dreamers do not appear to believe what they dream since while dreaming, they lie motionless in their beds, so their behaviour shows no sign of such a belief. As McGinn claims, if dreams are hallucinations and if we observe someone dreaming of seeing a tiger, we should also see them "leap from the bed and run for the door" (2006, p. 94)[5].

[4] Some may interpret the imagination model as a view according to which in dreams it appears to me as if I am being chased by a lion, but this is only an imaginative act, and at a phenomenological level, I believe that the experience is occurring to me. However, this is not the interpretation of the authors as this would provide a disanalogy between waking imagining and dreaming. When imagining, we generally do not believe what is happening is true at the phenomenological level. Ichikawa puts significant effort into describing phenomenological similarities between dreaming and imagining from the first-person perspective, so for our purposes here, we contend that phenomenology is an important aspect of arguing whether dreaming is an imaginative or hallucinatory state.

[5] Note that this is not only true for REM sleep, which is usually explained by muscle atonia (Hobson et al., 2000) but also for NREM sleep. Although the aim of this paper is to focus on what dream recall can teach us about the ontology of dreaming, the fact that no such mechanisms as atonia prevent dreamers from acting out their dreams in NREM sleep is worth mentioning

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Ichikawa highlights two final similarities between dreaming and imagination. Firstly, both dreams and imaginations can be phenomenologically indeterminate in that we can have, for instance, indeterminate colour (Schwitzgebel, 2002, 2003). Secondly, both dreams and imaginations are "subject to the will" – although we may not constantly be in control of either type of mental state, it makes sense, for instance, to try to control imagination. I can usually choose to represent an imagined object or event differently. While imagining a pink unicorn, I can choose to instead imagine that it is purple. What's important for Ichikawa is the *potential* for dreams and imagination to be controlled. It seems that we don't often *take* control of our dreams or don't *realise* that we can control our dreams, but the potential to do so is demonstrated in "lucid control dreams" (Kahan & LaBerge, 1994) – when dreamers realise they are dreaming and do take control of the environment, changing elements within the dream scene.[6] Lucid dreaming and telekinesis dreams, dreams in which we are not lucid but control some elements of the dream (Barrett, 1992; Rosen, 2022), are examples which show that dreaming can be controlled, but they are rare (Rosen, 2021b), and our focus here is non-lucid dreams.

While it is not our goal here to evaluate these arguments, the issue of being subject to the will is important for our purposes. Imagination appears far easier to control than non-lucid dreaming – we can choose to imagine whatever we like with little effort. Imagination that occurs whilst 'mindwandering', however, seems less controlled than, say, intentional imagination. Mindwandering is, as we explain in the following, a type of uncontrolled, drifting, or unguided mental activity, after all. For this reason, we analyse how imagining under the imagination model could be better understood if we draw from the current literature on mindwandering.

### 2.2.2 Dreaming as imaginative mindwandering

To be charitable to the imagination model, we propose an interpretation that we think is the strongest analogy with dreaming. For Ichikawa, we generally do not believe that imagined objects or events are real although we might imagine believing that they are real. Further, they do not involve percepts, are subject to the will, and they "simulate non-imaginative states; the point of visual imagery is to be able to enter into an experience similar to the experience of visual perception" (Ichikawa, 2009). One weakness of this view is the specification of being subject to the will.

because, as we'll see below, poor dream recall for NREM sleep seems consistent with it being imaginative rather than hallucinatory. Given that, on the one hand, the strongest arguments for dreams being conscious experiences only apply to REM sleep dreaming (Crespin, 2015, 2020) and, on the other hand, muscle atonia is absent during NREM sleep, one might be tempted to explain the absence of NREM dreams behaviour by NREM dreams being unconscious - as neuroscientist and dream researcher Emma Chabani once pointed out (personal correspondence) - or at least much less vivid. According to the dreaming recollection argument we develop here, another possibility would be that NREM consists of imagination while REM involves hallucination.

[6] For an evaluation of these arguments, see Rosen (2021a).

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While it seems clear that dreamers could in theory take control over their dreams, they generally don't feel under our control, and it is unclear to what extent they are even potentially controllable. A way to overcome this unclarity is to specify that dreams are akin to sensory imagination that occurs whilst mindwandering. Mindwandering appears subject to the will in the way Ichikawa describes in that it could *potentially* be controlled, but is generally described as being uncontrolled (Metzinger, 2013). Non-lucid dreams share this feature.

There are many descriptions of mindwandering, for instance, as primarily uncontrolled mental activity (Metzinger, 2013), as thought that is unrelated to a task (Smallwood & Schooler, 2015), as being either intentional or unintentional drifting thoughts (Seli, Risko, & Smilek, 2016; Seli, Risko, Smilek, & Schacter, 2016), as a type of unguided attention (Christoff et al., 2016; Irving, 2016), or as an unfocused variant of daydreaming (Dorsch, 2015). We use "imaginative mindwandering" to refer to the bringing up of imaginative experiences in a mostly uncontrolled, unguided way to distinguish it from propositional mindwandering – thinking thoughts in an unguided way that lack imagery[7]. Thus, imaginative mindwandering is both a subtype of imagination and of mindwandering. It is a type of sensory imagination, so it excludes solely propositional mindwandering, and since it is a form of mindwandering, it excludes imagination that is directed. Because it occurs while mindwandering, the content is usually not controlled.

Mindwandering itself can be considered voluntary, since one can choose to let one's mind wander, just as one can choose to fall asleep[8]. However, the specific content, as with the specific content of a dream, is not intentionally brought about or controlled. If the content *were* intentionally brought about, it would be classed as directed imagination rather than mindwandering. Recall that Ichikawa claims that both dreaming and imagination can be seen as *subject to* the will. We take this to mean that despite imaginative mindwandering being seen as generally uncontrolled, like with dreaming, it is indeed possible to take control of what one is imagining about while mindwandering even if we often fail to do so.

Most of the definitions of mindwandering mentioned above involve the mental state being uncontrolled or unguided, but it can be easy enough to take control, say, to choose to imagine something else. Perhaps once control is taken, however, we are no longer mindwandering. Controlled imagination, such as intentionally doing a mental rotation task, attempting to envision a face in as much detail as possible to draw a portrait or imagining what my coat would look like if it were a different colour, would likely not be classed as mindwandering. This means that

[7] This definition has similarities to daydreaming, another term that is used in a variety of ways in the literature, but summarised by Lawson and Thompson as "spontaneous, immersive imagination in the waking state" (2024). However, we chose to use "imaginative mindwandering" so as not to make assumptions about immersiveness and spontaneity. While, according to Lawson and Thompson, these are key features of daydreaming, they are not defining features of "imaginative mindwandering".

[8] There is, as aforementioned, a debate about whether mindwandering should be defined as unintentional (Irving, 2021; Seli, Risko, Smilek, & Schacter, 2016).

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mindwandering may be "subject to the will" in that we *can* take control, but as soon as we do, we are no longer mindwandering. Tasks like intentional mental rotation, controlling what a face looked like or intentionally changing the colour of my coat *could* occur in a dream, but this would be unusual. There may also be cases in which we try but fail to take control. Dreams should not, then, be classed as *necessarily* mindwandering-like. Rather, this is a claim about the large proportion of dreams, excluding the rare cases in which one has control, during lucidity, for instance[9]. Describing dreaming generally as mindwandering[10] protects the imagination model from the counterargument that dreams appear to often not be controlled, unlike the more controlled intentional imagination.

A reason to not class dreams simply as mindwandering is that mindwandering itself does not necessarily involve sensory imagination. Wandering thoughts can be propositional rather than imagistic. Propositional mindwandering seems disanalogous to dreaming, which typically involves some type of imagery[11]. As previously outlined, "mindwandering", like dreaming, appears to cover a broad set of phenomena and is difficult to define (Irving & Glasser, 2020), so our point here is simply to explain what kind of 'imagination' typical dreams are like under our interpretation of the imagination model: imagination that occurs whilst mindwandering.

Dreaming seems to share several features in common with mindwandering. They are both often less realistic than waking perception, task or environment independent, unintended, and involve reduced executive abilities, especially a reduced ability to sustain attention and control attentional resources. Such features, however, can fall on a scale both in dreaming and mindwandering and should not be seen as all or nothing (Sutton, 2010). Mental states in general could be more or less realistic, task or environment-related, intended or, finally, accessible to metacognitive insight. While mindwandering is usually described as task-independent, less

[9] We should distinguish control from lucidity. Lucidity is the realisation that one is dreaming, whereas control is a separate element that is common but not universal in lucid dreaming. 'Lucid control dreams' involve both (Noreika et al., 2010). Control, as aforementioned, can also occur in non-lucid dreams. However, "lucidity" must refer to something different for Ichikawa and Sosa since, in their view, we *never* really believe we are dreaming. Instead, in non-lucid dreams we "in the dream" believe we are awake, whereas in lucid dreams we "in the dream" believe we are dreaming. Dreams where we are in control, whether lucid or not, appear more akin to intentional imagination than mindwandering.

[10] We allow that *most* but not all dreams are mindwandering-like, whereas imagination, obviously, is a necessary feature in this view. We choose "imaginative mindwandering" as our target because these are the kinds of dreams that are most common and are also less memorable compared to lucid control dreams. Further, the memory research we analyse focuses on the non-lucid variety.

[11] While it is possible to experience propositional mindwandering while asleep, imagination and hallucination theorists alike would most likely not call this kind of mental state on its own dreaming in the normal sense, but a different kind of mentation that occurs in dreamless sleep. For imagination theorists, dreaming involves imagistic experience whereas hallucination theorists obviously require that dreams are hallucinations.

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realistic, unintended, and inaccessible to awareness[12] (Mason et al., 2007; Smallwood & Schooler, 2006), it could involve one or more of these opposing attributes (McVay & Kane, 2010), or have a certain level of these attributes, such as low-level intendedness or be partially task-dependent (Watkins, 2008). This variability is properly captured by the family resemblance view, according to which mind-wandering is defined by an overlapping subset of features instead of necessary or sufficient conditions (Seli et al., 2018). Taking this approach, dreaming could be seen as a type of mindwandering, based on family resemblance, as dreaming also generally has these aforementioned features.

In the following, we shift focus to dream memory. How bad is it really?

# 3 Dream recall: How bad is it?

Dream recall has not, as of yet, been used as part of the broader argument in support of either the hallucination or imagination model. These arguments progress partly by comparing cognitive and phenomenal features to establish if they have the same mental profile, and memory should also be considered as part of this profile. Ceteris paribus, if two token mental states X and Y are of the same type, we would expect them to have similar cognitive features, including recall likelihood and accuracy. Of course, in any state, our memory can be affected by a variety of factors, such as being worsened by alcohol or exhaustion or improved by stimulants, which is why the ceteris paribus clause is important to keep in mind. Further, if there are differences that should affect memory but recall is the same, this indicates either that the two states are not of the same kind or that there is a further, unknown feature that can account for the difference in recall. In this section, we begin by comparing dream memory with memory of perception and hallucination, arguing that evidence supports the view that dream memory is worse than memory of these mental states. In 3.2, we outline the evidence that compares dream memory with mindwandering and imagination. We suggest that imagination that occurs whilst mindwandering also has worse recall than perception, with some preliminary evidence suggesting that it is similar to or even worse than REM dreaming. In 3.3, we argue that our poor recall of REM dreams does not in fact support the imagination model given the state of the dreaming brain. However, in section 3.4, we argue that NREM dream recall aligns better with what the imagination model should predict.

## 3.1 Dream memory, perception, and hallucination

Claims about dream memory being poor are usually based on a comparison with memory of waking events. What indicates good or poor recollection? An obvious

[12] To clarify, Sutton (2010) explains that my mental state would be inaccessible to awareness if I was surprised to realise that my thoughts had been wandering, as opposed to being well aware of my meandering thoughts.

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indicator is absence of recall, the subject is unable to remember what they were experiencing altogether. However, when waking and failing to recall a dream, we can only indirectly infer that a dream was forgotten. Instead, the dream may simply not have occurred. Some periods of sleep are likely unconscious. Similarly, in relaxed wakefulness, subjects may undergo a period in which their mind was blank (Van Den Driessche et al., 2017; Ward & Wegner, 2013), thus poor recall of mindwandering is difficult to distinguish from mind-blanking. We infer a high forgetting rate in dreaming due to the aforementioned relatively high rate of recall in REM and NREM lab awakenings compared to natural awakenings (Schredl & Reinhard, 2008). Another indicator of poor memory is that a remembered experience lacks detail or complexity, or the report is vague. A simple way of measuring this is by measuring the length of the report. A longer report with a higher word count can indicate better memory of the details of the experience. This is also only an indirect indicator of memory, however, as there can be other reasons for a short report, such as the participant choosing not to report much detail or the experience itself involving less detail.

How bad is dream recall compared to normal waking memory? Dream recall is described as terrible, as bad as amnesia. Hobson, reflecting on his recall rate of around one dream a month, quips that "if I were that amnestic in waking, I would be in a mental hospital" (2005). According to estimates, we spend 20% to 50% of our time asleep dreaming (Domhoff, 2003), but on average, people only remember 2 or 3 dreams per week (Schredl, 2004). Some, like Hobson himself (2005), remember one or less per month. One might argue that our recall of waking events is not too good either. We forget most waking experiences. Only a small number of daytime experiences are remembered long-term. In comparison, Highly Superior Autobiographical Memory (HSAM) is a rare form of autobiographical memory in which individuals can remember an extraordinary number of events and the dates in which they occurred (LePort et al., 2017). Those without HSAM may not be able to recall *any* specific events that occurred, for instance, during January two years ago. We need to pay attention to events to be able to recall them spontaneously even a few seconds later (Dehaene, 2001; Gazzaniga et al., 2019) and we only store a few important events in long-term memory[13].

Further to this, memory does not simply lay down experiences that get replayed later when we recall them. Rather, memory involves recreating the initial experience (Sutton, 1998). Considering the nature of memory, perhaps dream recall is not that bad after all. Nonetheless, our focus here is not on the long-term encoding of dream memories, but on what we remember on waking. We appear to have severe amnesia of very recent dream experiences unlike that of waking. Lab awakening studies, where a subject is woken from different sleep stages and asked to report a dream immediately, garner reports from around 90% of REM and 40% of NREM sleep awakenings (Domhoff, 2003). This suggests we have at least 4 hours' worth of dreams per night. If we compare recall of the last eight hours of

[13] Thanks to an anonymous reviewer for this point.

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sleep during which we may have spent 4 hours dreaming with recall of the previous equivalent period of being awake, it is common to be unable to remember *any* dreams whereas failing to remember anything from the previous period of waking it would be considered a type of rare amnesia (Hobson, 2005).

Lab awakenings provide evidence that we are not simply unconscious for most of the night but instead, we forget most of our dreams. Another phenomenon that suggests forgetting instead of unconsciousness is "white dreaming", waking with the feeling of knowing one has just dreamt but with no recall of the content of the dream (Fazekas et al., 2019; see also De Gennaro & Violani, 1989). There is some debate about whether white dreams are normal dreams that we simply fail to remember (Cohen, 1974), contentless sleep stages involving only a minimal form of conscious awareness (Windt, 2015a; Windt et al., 2016), or a combination of highly degraded content, poor encoding, and poor retrieval (Fazekas et al., 2019). However, the common experience of feeling the memory of a dream slide away, the feeling of forgetting, as well as the sense that a vaguely recalled experience was initially vivid suggest that at times, we simply forget the content but remember having dreamt. Individuals also often try not to allow the dream to slide from memory by repeating it to themselves, and the success of this technique suggests that at least some white dreams are forgotten dreams.

The slightest distraction can be enough to make us forget dreams (Cohen & Wolfe, 1973; Parke & Horton, 2009). We even forget bizarre dream occurrences that would usually be highly memorable if they occurred while awake. Trying but failing to remember a funny or interesting dream long enough to tell one's partner is something many of us have experienced. That's not to say that dreams are never remembered in detail. Dreams can leave a strong impression and we can remember dreams we had during childhood. The claim here is simply that we forget the vast majority of them before or as we wake up. If one were to play a virtual reality game, say, set in a saloon, and were asked later in the day "what happened during your game", we would expect them to remember at least the saloon setting[14]. In contrast, any delay between dreaming of being in a saloon and making a report would likely lead to the experience being entirely forgotten.

One might argue that a comparison with waking hallucination, not veridical perception, is more apt under the hallucination model. If we don't remember hallucinations well, then we should expect the same for dreams, ceteris paribus. If it is difficult to remember dreams compared to hallucinations, the hallucination model requires an explanation for the disanalogy. *Prima facie*, it might seem obvious that

[14] Some evidence suggests that changing the environment from virtual to real or vice versa has an adverse effect on our ability to memorise items (Lamers & Lanen, 2021). In a wrote learning task, subjects showed a decrease in recall accuracy by 24% in a virtual reality learning condition in comparison with a reality learning condition. There were, however, no reported cases of forgetting the virtual reality scenario, or for that matter, no subjects forgot having been in a virtual reality. There appeared to be no clear change in memory of the events within the virtual reality other than the wrote learning task. This contrasts with imagining and dreaming in which the subject often forgets what the dream or imagination was about altogether.

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memory of a hallucination should be better than the memory of imagination. Hallucinations have several features that would indeed make them more memorable than imaginative imagery. Like waking perception and in contrast with imagination, hallucinations have a sense of presence – hallucinated objects appear to be located in space and accessible to the viewer (Rosen & Barkasi, 2021). They are usually more vivid and have a greater richness of detail. It is well-established that memory improves as vividness of imagery increases – people are more likely to recall visual images they assess as more vivid (D'Angiulli et al., 2013; Hiscock & Cohen, 1973). Similarly, evidence suggests that dreams of high recallers are more salient than those of poor recallers (Cohen, 1974) and high recallers generally have a greater ability to visualise while awake (Hiscock & Cohen, 1973; Zeman, 2024). For morning reports, we are unsurprisingly biased towards remembering the more vivid, bizarre, or personally salient dream experiences (Trinder & Kramer, 1971), although we are far more likely to remember whatever dream we have just woken from. Hallucinations come unexpectedly and subjects discover their phenomenal features and details by scanning and exploring. We are, in contrast, less likely to be surprised by imagination (Sacks, 2012). Surprise enhances memory by drawing attention to the unexpected event (Ben-Yakov et al., 2022; Ranganath & Rainer, 2003).

We argue that hallucinations are generally remembered better than dreams. Some evidence suggests good recall of hallucinations such as Charles Bonnet syndrome, a disorder in which partial blindness leads to the hallucination of small figures in the blind spot (Menon et al., 2003). People with this disorder do not seem to report dream-like forgetting of their hallucinations. Waters and colleagues (2016) rated hallucinations in Parkinson's, schizophrenia, and Charles Bonnet syndrome as "well recalled" compared to dreams and hypnagogia which were found to be "poorly recalled". Research into ayahuasca hallucinations suggests good memory of immersive hallucinatory experiences (De Araujo et al., 2012) and these hallucinations do not seem to involve the type of forgetting that occurs for dreams, namely, that we forget the entire experience unless we are asked to report it immediately after. Auditory hallucinations also appear well-recalled. In a study of people who heard voices, the experiences made a strong impact on memory, were startling, and provoked anxiety (Romme & Escher, 1989). Further evidence is required to determine exactly how much forgetting occurs in waking hallucinations compared to dreams, and sufficiently detailed comparisons have not been made[15]. Nonetheless, given what we know, it seems that we remember hallucinations better than dreams directly following coming out of each respective mental state. This provides one way in which dreaming is different from hallucinating: dreams are harder to remember.

[15] One can ask whether there is sometimes a 'white hallucination' effect, i.e., that we have a sense that we have hallucinated but cannot remember the content the same way as with white dreams. Also, further evidence is required to determine exactly the ability to recall hallucinations after a delay. Future research is proposed in section 4.

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There is a disanalogy, then, between dream memory and hallucination memory. However, a disanalogy provides a better argument *against* a theory than it provides support for an alternative theory unless the alternative is the only other option. Since the imagination model is not the only other option, memory alone would not sufficiently support that model. Nonetheless, when weighing up evidence for and against the two models, if recall for dreams is similar to that of imagination, this could provide *some* support for the imagination model over the hallucination model, ceteris paribus. A problem that arises, as we discuss in the following section, is that our faculties while asleep and dreaming are *not* equivalent to what we have while awake, so 'ceteris paribus' does not hold. Memory should still, however, play a role in this debate. Given our altered cognitive capacities and brain states, the imagination model should predict our memory of dreams to be much *worse* than that of imagination. Since the evidence does not support this prediction, in our view, we should no longer ask hallucination theorists "why is dream memory so poor?" but instead ask imagination theorists "why do we remember our dreams so well?".

## 3.2 Dream recollection compared to imaginative mindwandering

Here we draw on evidence from both the imagination and mindwandering literature to assess how dream memory compares. We wish to target imaginative mindwandering and not propositional mindwandering or intentional imagination, since, as we have argued, these should not be seen as analogous to dreaming. However, the literature on memory often does not make the same distinctions we make here. Our analysis thus requires drawing on both literatures, focusing on cases that we believe overlap with the target phenomenon, such as "waking fantasising".

Preliminary evidence suggests that dream recall compares quite favourably to imaginative mindwandering recall. On the one hand, we have very little memory – if any – of our recent imaginations or mindwandering activity. Forgetting might be more likely to occur particularly if the contents of one's mindwandering are "irrelevant or uninteresting" (Ward & Wegner, 2013). On the other hand, while it can be difficult to recall what we were dreaming only a few seconds earlier, dreamers can at times report the details of dream scenes that occurred up to three minutes before awakening (Dement & Wolpert, 1958; Koulack, 1969; Koulack & Goodenough, 1976)[16]. It is not obvious that we can do the same for imaginative mindwandering. Although anecdotal, individuals can also have vivid and sudden recall of a dream that occurred the night before, sometimes provoked by an event, sound, or smell

[16] Experimenters in this case could confirm the timing of the details by using a sensory incorporation paradigm in which real stimulus, such as spraying water on the face of the sleeping participant, is experienced in the dream. If, for example, water is sprayed onto the participant's face 3 minutes before waking and in the report, the feeling of water on the face is mentioned, it provides evidence that this experience occurred 3 minutes before waking.

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(Foulkes, 2014). It is not clear that this occurs for imagination. Here we draw on a variety of sources of empirical evidence about memory of imagination and mind-wandering states. While these experiments do not target imaginative mindwandering precisely, they focus on a broader set of states, such as 'relaxed thought' during which imaginative mindwandering commonly occurs. We take this as preliminary evidence and later in section 4 explain how these claims could be strengthened with future research.

Rechtschaffen (1963) claims that when compared to thought, dream recall no longer fairs poorly:

> It is our impression, as yet unsubstantiated by sufficient research, that memory for waking thought is not so great as might be assumed [...]. You may remember what you have seen, heard and tasted, but how well can you remember thoughts you had while brushing your teeth this morning, apart from the visual image of your face in the mirror? (p. 411)

These thoughts may be of the propositional or imagistic kind, but we tend not to remember any of them. Similarly, Gruberger and colleagues (2011) note that "the contents of mindwandering is not always straightforwardly accessible to memory." The empirical research on this matter, although limited, leaves open the possibility that dream recall may be *better* than imaginative mindwandering memory. This argument, however, relies on indirect indicators of memory such as introspective reports, judgments about recall, and report detail.

Siclari and colleagues (Siclari et al., 2013) supply two pieces of evidence to support the claim that memory of mindwandering is not only as bad as dream recall but in fact *poorer*. They interviewed subjects semi-randomly irrespective of sleep stage or wakefulness and compared the reports. Firstly, REM dreams and resting with eyes closed were compared by asking subjects "How far back in time can you specifically recall?". This aimed at assessing the narrative thread and continuity of the conscious experience. They found that the content of REM dreams could be recalled further back than the mental states that occurred while resting with eyes closed. While not targeting imaginative mindwandering in particular, it is plausible that such mental states make up a significant proportion of our resting mind's activity. While dream memory appeared better, the difference was not significant, and a subjective measure was used, since individuals report how long they *think* they can recall back. It may be difficult to accurately report how far back one's memory goes.

A second, perhaps more interesting finding is that when reporting their experiences, dreamers judged that the contents of their REM memories were on average more complex and detailed, and participants also took longer to recount these memories than their memories of quiet waking. They found that on average, REM experiences took 5 minutes to recount while quiet waking experiences took around 3.5 minutes. Although only a 1.5-minute difference on average, a report that is 42%

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longer can contain significantly more detail. Researchers take this as an indirect indicator of memory, although, there are potential alternative explanations to this, such as shorter or less detailed experiences, as we discuss in more detail presently. An earlier study by Stickgold and colleagues (2001) found that the median length of dream reports after waking from REM (94s) was nearly twice as long as reports about mental activity in relaxed wakefulness, collected while resting but not asleep (55s) and slightly longer than reports of active wakefulness, collected during the day at random (78s). Dreams reports also have a richness of detail which seems to far exceed memory for waking imagination (Kerr, 1993; Rechtschaffen & Buchignani, 1992).

It is possible that memory does not explain the longer reporting time of dreams. Describing bizarre images takes longer than describing mundane ones (Hunt et al., 1993) thus if dreams are more bizarre than imagination, this may account for the longer reports. Further, these reports might involve propositional thinking instead of imagery, which may require less time to report. Perhaps propositional mindwandering accounts for the difference since this research doesn't specify when participants were imaginatively or propositionally mindwandering. However, Williams and colleagues' (1992) study provides evidence against the view that the difference is simply due to propositional thinking being less detailed. They studied "waking fantasies" which are "apparently spontaneous mentation of a narrative and/or perceptual nature" (p 173-176). This refers to stories imagined by the subject which may represent perceptual experiences such as faces, scenes, and characters. Waking fantasy appears to be a form of imagination rather than propositional thinking, akin to imaginative mindwandering as we have described it – mindwandering that evokes sensory images. They found these waking fantasies to be nonetheless significantly shorter than spontaneous dream reports. In the following, we assess some limitations of this research.

The aforementioned experiments use a "probe-caught" method, in which subjects are stopped during a task to make a report instead of "self-caught", where the subject chooses when to report their experience. Probe-caught is the common method used in mindwandering research (Weinstein, 2018). One could argue that this disrupts the experiences and alters memory retention. Nonetheless, probe-caught sampling is analogous to lab awakenings – when the experimenter wakes up the subject to collect a dream report, thus the fact that it is disruptive is not a strong criticism against this method. More worrying, however, is the use of report length as an indicator of memory. Assessing report length is less prone to the limitations of introspection (Bak, 2018) since this element is timed by the researchers rather than subjectively judged by the participants themselves. However, there are potential confounds. A long, detailed report might either reflect the quality of the memory or the richness and length of the experience itself. For example, if I report walking down an empty street for 30 seconds, the report might contain less detail than if I were to report watching a circus act for 30 seconds despite memory for both events being equally good. This should, therefore, only be taken as an indi-

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rect indicator of memory quality. If a longer report indicates a richer experience instead of better memory, long dream reports might count as direct support for the hallucination model since hallucinations would likely be experienced as richer and more detailed than imagination.

Finally, Siclari and colleagues' research, which asked how far back participants could recall a particular mental content, does not seem to be subject to the specific biases we have just described. They do, however, have the aforementioned limitation of being based on subjective self-assessment. Although more research is needed, these experiments suggest that participants can recall elements of a REM dream further back in time than when their minds wander. While the participant's judgement is subjective, this view gains credibility when combined with the aforementioned non-trivial fact that dreamers can remember details of a scene that occured, up to 3 minutes before they woke up.

One might still argue that Siclari and colleagues focus on a specific type of imagination of which our memory is particularly poor. Other types of imagination may lead to better recall, such as intentional imagination, doing a mental rotation task, trying to imagine a story when writing a novel, or engaging in fiction.[17] Imagining while engaging in fiction is often very memorable (Fabry & Kukkonen, 2019). However, here we specify that we are comparing dreaming to a particular type of imagination that is most analogous with common dreams: imaginative mindwandering. Engaging in fiction is a type of imagination that is guided by perception – our imagination relates to a film we are watching or a story we are reading or listening to. Mental rotation tasks and intentional mindwandering seem to be different kinds of tasks than imagining while mindwandering and different from non-lucid dreaming. Lucid dreaming, like intentional mindwandering, is indeed more memorable (Kahan & LaBerge, 1994) but is quite rare and our focus here is non-lucid dreaming.

As with dreaming, it is difficult to research memory of mindwandering since there are many confounding factors. Self-caught methods of data collection in particular suggest we can often forget what we were just thinking about (Weinstein, 2018), but forgetting is difficult to distinguish from mind-blanking, a state in which the mind is empty of thought or imagery. Neither forgetting nor mind-blanking leads to a report, thus we have no way of distinguishing the two. Further, Benedetti and colleagues (2015) note that in their study, dreams were harder to recall than "waking fantasies". However, in their studies, morning dream reports were used, meaning that reports were not made directly on waking from a dream, for instance, in a REM sleep awakening laboratory condition. Fantasies were recalled based on a task in which subjects were asked to fantasise about a story which had a beginning, middle, and end. Since this kind of fantasising is directly reported after the task and is intentional, it has relevant differences with imaginative mindwandering or dreaming, making the comparison strongly biased and thus unconvincing.

[17] Thanks to an anonymous reviewer for this example.

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At this stage, it is not possible to assess exactly how good dream memory is compared to imaginative mindwandering memory. Nonetheless, preliminary evidence goes some way towards suggesting that dream memory and imaginative mindwandering memory are both significantly worse than recall of waking events. Further, evidence suggests that dream recall is not worse than recall of imaginative mindwandering. In our view, however, the similarity between imagination and dream recall fails to support the imagination model.

## 3.3 REM dream recall does not support the imagination model

The claim that dream recall compares favourably to imaginative mindwandering recall is, at this stage, a prediction informed by preliminary evidence. However, from what is currently known, we have little reason to think dream recall is worse and some evidence to suggest it could be somewhat *better* than recall of imaginative mindwandering.

We have considered the possibility that, since dreaming and imaginative wandering share a cognitive feature – they are similarly difficult to remember – this could contribute to the argument in support of the imagination model. However, a new issue arises. There is evidence that conditions during sleep are inhospitable to memory retention compared to the conditions during relaxed waking. If dreams are a type of imagination that occurs under these conditions, then it follows that dreams should be *harder* to remember than waking imaginative mindwandering. In sum, if dreams are a type of imagination that occurs in a state which is less hospitable to memory than imagination while awake, the imagination model should predict worse memory for dreaming than for waking imaginative mindwandering.

Evidence that the sleeping brain creates inhospitable conditions for memory can be divided into two types, the neuroactivation along with neurochemical changes to the brain during sleep and the phase shift between conscious stages. Koulack and Goodenough (1976) state that the stabilisation of a dream memory depends on the level of arousal of the brain (see also: Goodenough, 1991; Nemeth, 2023). According to this so-called "arousal-retrieval" hypothesis, the activation level of the sleeping brain is insufficient to allow such stabilisation. Encoding dreams would therefore require waking up while they occur and are still in working memory (Eichenlaub et al., 2014; Goodenough, 1991). Specific neurochemical and neuroactivational changes that occur in sleep are associated with poor memory storage. A simplified description of these changes is that there is a shift from the primarily aminergic modulation of waking to the generally cholinergic modulation of sleep (Hobson et al., 2000; see also Hobson, 1988) and a drop in norepinephrine release (Becchetti & Amadeo, 2016; Murchison et al., 2011). Sleep neurochemistry is far more complex than outlined here, but for our purposes, the important aspect is how it affects memory retention. Regarding neuroactivation, there is a hypothesised blockage of hippocampal outflow during

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REM (Buzsáki, 1996; McClelland et al., 1995) which is necessary for access to memories while awake, and frontal areas of the brain necessary for controlled access to memories such as the dorsolateral prefrontal cortex (DLPFC) show reduced activation during REM and NREM (Kubota et al., 2011). Such deactivation is related to both poor access to memories and poor memory storage (Hobson, 1988; Hobson et al., 2000).

Other authors consider the shift from sleep to waking as part of this inhospitable environment. This "functional-shift hypothesis" (Koukkou & Lehmann, 1983; Lehmann & Koukkou, 2000), according to which memory is lost when shifting between sleep stages, seems to be indirectly validated by the well-established phenomenon of state-dependent learning. Learning accomplished in a certain neurocognitive state may remain perfectly accessible while still in that state, but be unrecoverable in another state - especially if, as is the case for dreams, the initial state in which the information is encoded corresponds to a lower level of brain activation than the state in which the information has to be retrieved (Overton, 1964; Overton, 1991; see also Lehmann & Koukkou, 2000). This functional shift would explain the aforementioned sensation of memory slipping from the mind on waking and perhaps some white dream reports as well.

Lehmann & Koukkou's (2000) "functional-shift hypothesis" is appealing, but it faces serious difficulties. First, while memory seems to rapidly fade on waking, laboratory conditions in which the dreamer is asked to report their dream immediately dramatically improve memory, so it seems it is not the shift alone that prevents recollection. REM lab awakenings, as aforementioned, garner reports over 80% of the time and NREM awakenings do so nearly 40% of the time (Domhoff, 2003). Second, the functional shift hypothesis does not explain why spontaneous microarousals seem to increase morning dream recall (Eichenlaub et al., 2017; Koulack & Goodenough, 1976; Vallat et al., 2017). Nonetheless, as we transition from sleep to waking, any delay before the report is made tends to make us lose track of the dream. The functional distance between the neurocognitive properties of wake and sleep alone may not disrupt memory, but it is hard to resist the idea that the temporal delay along with the state shift between dreaming and reporting do so. One could further assume that the longer the delay, the more likely that the dream will be forgotten. This view is consistent with the amnesia that follows 'night terrors' that occur during NREM since there is a longer delay between dreaming and waking from NREM sleep stages, known as *sleep inertia* (Arnulf, 2014).

Further to this, when we try to remember a dream, we have even fewer external and temporal cues than we do while mindwandering. Chapman and Underwood (2000) argue that external cues greatly aid memory and both dreaming and mindwandering are dissociated from external cues. While researching "task unrelated images and thoughts (TUITs)" they and other researchers (e.g., Giambra, 1995; Singer, 1993) found that a small delay between the TUIT and report greatly decreases the likelihood that the subject will remember what they were thinking

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about. This, they hypothesise, is because there are no retrieval cues or external narratives from the environment that impose on and help recall the content of the TUIT. While waking imagination is internally generated, we still experience other cues from the environment while we imagine, thus we should expect fully dissociated states, as occur in dreaming and fully immersive waking hallucinations, to show bad recall compared to waking experience of the real world.

The aforementioned shift between aminergic modulation of waking and cholinergic modulation of sleep along with the drop in norepinephrine release and reduction in activation of memory-associated areas of the brain suggests poor memory *would* occur were individuals to undergo sleep-like neural changes whilst awake. Memory degradation does occur when individuals are very tired or on drugs which can alter neurochemistry to be more sleep-like (Hobson et al., 2000). While there might be alterations in neurochemistry and activation between imaginative mindwandering and on-task mentation in that imaginative mindwandering is modulated by the default mode network (Smallwood & Schooler, 2015) we do not have as extreme a neuro-functional shift compared to the sleep-to-wake shift. Thus, if dreams are imaginations that occurs whilst the brain is modulated in a way that degrades memory capacity and in which there are no external cues, we should expect the memory of dreams to be far worse than the memory of imagination. What should be made of this? Poor REM dream memory does not support the imagination model. Nonetheless, dream recall that is as good as or better than imagination may not be evidence that dreams are hallucinations either. Dreams might simply be another type of mental state, neither hallucination nor imagination (Windt, 2015b).

Alternatively, REM dreams could be very intense imaginations. For Hobson and colleagues, dreams are inherently more memorable than mindwandering because they completely capture our attention, whereas mindwandering "is a background mental state which has to compete with foreground input-output processing" (Hobson et al., 2000, p. 1021). While Hobson himself thinks dreams are hallucinations, if they were indeed simply intense imaginations, it could be their "single-mindedness" (Rechtschaffen, 1978) that allows them to overcome sleep and state-change related memory deficits (Hobson et al., 2000). Further, the isolation of the sleeper's mind from external input and processing could increase the vividness of their mental state, as suggested by experiments on sensory deprivation (Zubek et al., 1961, pp. 88–89; see also McGinn, 2006; and Sacks, 2012, p. 37). If dreams are a type of imagination with increased bizarreness and emotional content[18], this might also explain the increased memorability.

Another interpretation is that there might be a continuum between imagination and hallucination. In one experiment, some individuals who were left to mindwander in a darkened room could not distinguish between hallucinating and imag-

[18] Note, however, that the thesis that dreams are more emotional than mindwandering has recently been challenged by Windt (2021, p. 9) and Domhoff (2022), the latter further arguing that the amygdala, which is associated with emotions, is not part of the default network that is specifically activated during dreaming.

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ining (Foulkes & Fleisher, 1975; Klinger & Cox, 1987, pp. 122–124; see also William Domhoff, 2011). We might conclude that a very vivid mental image that occurs during the sensory blockade specific to sleep and occupies all our attentional resources will tend to be more hallucinatory than imagistic.

A final discussion is that dreams in different sleep stages appear to have different memory capacities. While here we have focused on the relatively good memory of REM dreams, NREM dream recall is not as good.

## 3.4 NREM dreams are consistent with the imagination model

We have argued that imagination model theorists should predict dream recall to be worse than imaginative mindwandering recall due to the conditions of the sleeping brain, but there is no evidence for this in REM dreams. It is likely, however, that NREM dreams involve worse memory than REM dreams. The recall of these dreams is less detailed than recall of either REM dreams or mindwandering. The memory arguments against the imagination model of dreaming thus may not apply to NREM dreams.

Siclari and colleagues (2013) rated the duration of REM dreams, sleep onset (NREM stage 1), and memory of quiet waking with eyes closed all as "high" in contrast with recall of NREM sleep stages 2 and 3 which were rated as "low". For the richness of the experience, REM memory was rated as "high", quiet waking as "intermediate", and all other stages, NREM 1, 2 and 3 as "low". Stickgold and colleagues (2001) found similar results. One might argue, then, that we should limit our claim about the surprisingly good memory of dreams to REM dreams. Could NREM dreams be imagination while REM dreams are hallucination?

For Hobson, the lower rate NREM recall compared to REM comes mainly from the fact that NREM dreams are rarer, less intense, and more thought-like than REM dreams (1992). This is consistent with an imagination model for NREM dreams. Other authors, however, maintain that rather than a change in dreaming, the storage conditions are even more unfavourable in NREM sleep than in REM, mainly due to a lower level of brain arousal (Conduit et al., 2004), although there is disagreement here. While the conditions of the brain being unsuitable for memory in sleep are undisputed, it is unclear if there are specific brain changes that make NREM dreams harder to remember than REM dreams.

Another alternative is that NREM dreams should not be classed as dreams at all but instead as a different type of mentation that occurs in dreamless sleep (Alcaraz-Sanchez, 2023). We find this approach implausible because it becomes too hard to draw the line between dreaming and dreamless sleep. There doesn't seem to be a clear distinction between REM and NREM dreams such that all REM dreams are hallucinations and all NREM dreams are imaginations. Rather the boundaries between the two types of dreaming are unclear (Rosen, 2024). While there are some average cognitive and phenomenological differences between the kinds of reports

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subjects make from each stage, evidence suggests that a spectrum of experiences occur, including more vivid mentation during NREM sleep (Scarpelli et al., 2022), especially NREM that occurs closer to waking up in the morning (Antrobus et al., 1995; Cicogna et al., 1998). We would not want to assume that dreams only occur during REM sleep as earlier theorists did (Aserinsky, 1996; Dement & Kleitman, 1957; Jouvet, 1999). The distinction between dreaming and dreamless sleep might turn out to be quite arbitrary, such that the mental state must pass a vividness threshold and be deemed hallucinatory. This is especially problematic if there is no clear distinction between imagination and hallucination (Nanay, 2016). However, even lacking a clear distinction, NREM dreams have been described as sharing on average more phenomenal features with imaginative mindwandering, such as reduced sense of presence, clarity, and vividness, while REM dreams generally share more in common with hallucination (see Rosen, 2024). The evidence for poorer NREM recall is consistent with this. This is not sufficient evidence to conclude that NREM dreams are imaginative, however. The fact that we appear to have poorer recall of NREM than REM sleep is just one piece of evidence to add to the debate.

Dream recall should be considered as part of our argument about the nature of dreams. More empirical evidence, however, is required to come to any firm conclusions regarding the relative recall capacity of NREM and REM dreams, imaginative mindwandering, and hallucination.

## 4 Future research

While significant work has been done on recall of dreams and waking events, less is known about recall of hallucinations, imagination, and mindwandering. Further research on the difference in memory encoding for each state is required.

With current technology, we can only analyse the details of dreams, hallucinations or imaginations that are remembered. This will remain so unless future technologies allow us to read mental content directly from brain imagining. The lower reporting rate of NREM than REM may be because of poor memory but it could also be because conscious experience is less common in NREM (Carruthers et al., 2019). This problem is difficult to overcome. Future research could compare white dreaming with mind-blanking. This would target cases in which we have some evidence of a conscious experience occurring – the report of remembering *some* unspecified experience, as well as evidence of forgetting – the fact that the details can't be remembered. Although there are other potential explanations for white dreams, as aforementioned, we have reason to think that we at times remember having dreamt but forget the specific content. Perhaps some reports of mind-blanking involve "white imagination", and perhaps even "white hallucination" occurs.

Unfortunately, it is still possible that such reports involve a false sense of having dreamt, imagined, or hallucinated, and this cannot be tested unless a reliable method of measuring conscious states independent of reports is devised. Despite

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some advances made in this field, such as using fMRI to predict some of the content of dreams before a report is made (Horikawa et al., 2013), the techniques and technology required to distinguish conscious from unconscious neural processing may be a long way off. Neuroscientists are not yet even able to reliably predict whether a dream will be recalled (Ruby, 2020) and there are strong epistemological reasons to believe that the ability to report one's mental content is, in principle, the only reliable indicator of conscious experience (Kouider, 2009; Kouider et al., 2012).

To overcome the aforementioned problems regarding the relationship between report length and memory, one could better control for the length of imaginative sessions. Instead of collecting reports at semi-random periods as Siclari and colleagues (2013) did, one could track the length of the imagining and REM sessions. Researchers could choose to compare, for example, a 30-second REM session with 30 seconds of relaxed imagining. There are still limitations since a dream may not start at the beginning of the REM session. One method to further control for dream length is to use sensory incorporation. A stimulus applied to a sleeping participant, such as a gentle sound, can be incorporated into the dream and used as a temporal marker if the dreamer reports hearing the sound during the dream (see Dement & Wolpert, 1958). A similar method could be used during an imaginative episode. This sound might later be reported as part of the imagined narrative. It might be difficult, however, to determine what is the right level of stimulation that would not distract the participant from their imaginative session.

To study memory retention over time, researchers could also compare recall of previously reported dreaming and use the same protocol for an imagination episode. For example, in the dream case, the participant makes a report during a REM or NREM sleep awakening and then later reports the same dream a second time upon waking normally in the morning. For the imagination case, the participant makes a probe-caught report of their imagination and then another report after a similar amount of time has elapsed as with the second dream report. The same can be done for hallucinations. Montangero and colleagues (2003) used a similar method but instead compared dream recall and recall of a film. This was successfully used to show the efficiency and accuracy of a complementary morning report of dreaming after a previous report was collected during the night. This could test whether there is any difference in recall between REM dreams, NREM dreams, imagination, and hallucination in terms of forgetting the entire report between the first and second reporting sessions. As discussed previously, we cannot gain any information about an experience that is entirely forgotten without a report being made, but we could possibly test how much forgetting occurs between two reports. If, as we have hypothesised, dreams do involve some imagined and some hallucinated elements, it might also be possible to compare whether these elements have different recall capacities. For instance, if an individual reports imagining their grandmother's face while dreaming, would this be as memorable as 'seeing' their face? One limitation, however, is that the report can be remembered rather than

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the initial experience, and we should expect the act of waking an individual during a dream and getting them to make a report to greatly increase retention.

Finally, a questionnaire could probe subjects on the number and vividness of imagined episodes versus dream episodes from the previous day, or within a week. For our purposes, comparing waking experiences, virtual reality, or hallucinations would further determine exactly the relative memory capacities of each state. One problem with morning reports is that the sleep stage in which the dream occurred cannot be determined, so perhaps restricting the reports to probe-caught imaginations and lab-awakened dreams is the most appropriate comparison.

# 5 Conclusion

Here we have argued that dream recall has interesting implications for the debate on the nature of dreams. Since, all things being equal, we would expect a similar memory capacity for similar mental states, our memory of dream experiences deserves further analysis in relation to the debate about their nature. The strongest application of this memory argument would be a disanalogy between dreams and the target wake state. However, it is not the case that all things *are* equal. The mind undergoes neural and cognitive changes while asleep, thus requiring nuance.

Although dream recall has long been considered very poor compared to waking memory, evidence suggests that dream recall is not so poor compared to recall of mental states such as mindwandering and imagination. Our memory of imagination that occurs during mindwandering, which we refer to as imaginative mindwandering, is also far worse than our memory of waking perception. At first blush, this seems a commonality shared between dreaming and imagining. However, we have outlined preliminary evidence suggesting that REM dream recall might be equivalent, if not superior, to that of imaginative mindwandering and we used this as a tentative argument *against* the imagination model. If the imagination model is correct, dream recall should be much worse than waking recall of imaginative mindwandering given the many neural changes undergone in sleep. The brain activation and neurochemistry of dreaming are associated with poor memory. The delay between sleeping and waking further provides reason as to why imaginative mindwandering that occurs during sleep should involve worse recall than waking imaginative mindwandering. There is a period in which the dream slips away from memory during this delay, an experience commonly reported on waking, making memories hard to retain. Further, since dreams are decoupled from waking contexts, there are no external cues to aid our memory. Nonetheless, dream recall is not equally good across sleep stages, opening the possibility of a memory-based argument for imagination during NREM sleep.

Recall of conscious experiences from NREM sleep appears to be far worse than REM dreaming recall. This means that the memory argument against REM experiences being imagination may not be applicable to NREM dreams. Currently, the evidence from memory does not suffice to make a strong argument in favour of one

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theory of dreams over another. However, if future research provides better comparisons between dream and imaginative mindwandering memory, this research should be taken as a piece of the broader landscape of abductive reasoning in the debate on the nature of dreaming.

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