

Opinion piece



Cite this article: Windt JM. 2021 How deep is the rift between conscious states in sleep and wakefulness? Spontaneous experience over the sleep–wake cycle. *Phil. Trans. R. Soc. B* **376**: 20190696.
<http://dx.doi.org/10.1098/rstb.2019.0696>

Accepted: 12 October 2020

One contribution of 16 to a theme issue ‘Offline perception: voluntary and spontaneous perceptual experiences without matching external stimulation’.

Subject Areas:
cognition

Keywords:
spontaneous thought, mind wandering, sleep, dreams, dreamless sleep

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How deep is the rift between conscious states in sleep and wakefulness? Spontaneous experience over the sleep–wake cycle

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Whether we are awake or asleep is believed to mark a sharp divide between the types of conscious states we undergo in either behavioural state. Consciousness in sleep is often equated with dreaming and thought to be characteristically different from waking consciousness. Conversely, recent research shows that we spend a substantial amount of our waking lives mind wandering, or lost in spontaneous thoughts. Dreaming has been described as intensified mind wandering, suggesting that there is a continuum of spontaneous experience that reaches from waking into sleep. This challenges how we conceive of the behavioural states of sleep and wakefulness in relation to conscious states. I propose a conceptual framework that distinguishes different subtypes of spontaneous thoughts and experiences independently of their occurrence in sleep or waking. I apply this framework to selected findings from dream and mind-wandering research. I argue that to assess the relationship between spontaneous thoughts and experiences and the behavioural states of sleep and wakefulness, we need to look beyond dreams to consider kinds of sleep-related experience that qualify as dreamless. I conclude that if we consider the entire range of spontaneous thoughts and experiences, there appears to be variation in subtypes both within as well as across behavioural states. Whether we are sleeping or waking does not appear to strongly constrain which subtypes of spontaneous thoughts and experiences we undergo in those states. This challenges the conventional and coarse-grained distinction between sleep and waking and their putative relation to conscious states.

This article is part of the theme issue ‘Offline perception: voluntary and spontaneous perceptual experiences without matching external stimulation’.

1. Introduction

Whether we are awake or asleep is often thought to make a difference not just to behaviour, but also to our conscious mental states. More specifically, which behavioural state a person is in at a particular time is believed to constrain which conscious state a person is in at that time and whether they are conscious at all. Both in folk-psychology and in prominent dream theories, conscious experience in sleep, in the form of dreaming, is thought to differ in characteristic ways from waking thought and experience [1]. In this view, there is a deep rift between the types of conscious states experienced in sleep and wakefulness.

Others reject the idea that differences in conscious states map onto differences in behavioural states. Often, this is framed as the idea that there is continuity between dreaming and waking. This continuity can refer to the fact that we tend to dream of things we experience, think, or worry about in waking [2–4]. Or it can mean that dreams are the same type of mental state as waking imagination and daydreams and both are distinct from perception [5]. More recently, dreaming has been described as an intensified form of waking mind wandering existing on a continuum of spontaneous experiences

that ranges from creative thought and mind wandering in waking to dreaming in sleep [6–8].

Assessing these opposing positions on the relation between conscious states and behavioural states—I call this the state-dependence question—is complicated by the fact that there is no common terminology for describing spontaneous thoughts and experiences. Mind wandering [9,10] and dream research [11,12] have both been fraught by competing definitions. In recent years, there has been growing consensus on the definition of dreaming [13–15]. However, the terminology used for dreaming operates on a different level of description from that used for the definition of mind wandering. This, in turn, hampers comparisons between these states as well as their joint empirical investigation.

Another problem is that existing attempts to model spontaneous thoughts in waking and sleep along a continuum [6–8] have focused on the relationship between dreaming and waking mind wandering. However, there are theoretical and empirical reasons for saying that there exist kinds of sleep-related experiences that are distinct from dreaming [16–20]. To fully assess the state-dependence of spontaneous thoughts and experiences, the entire range of sleep-related experience needs to be taken into account.

Here I aim to fill this gap by proposing a conceptual framework that distinguishes different kinds of spontaneous thoughts and experiences independently of their occurrence in sleep or wakefulness. This framework draws from three main sources: one, the dynamic framework of spontaneous thought [6,21]; two, simulation theories of dreaming [13–15], and three, a taxonomy of dreamless sleep experience that was derived from simulation theories of dreaming [19,20].

I then apply this framework to findings from sleep, dream, and mind-wandering research to reach a preliminary assessment of the state-dependence question. In particular, I investigate whether the subtypes of spontaneous thoughts and experiences that are distinguished through the proposed framework occur equally in sleep and waking. I argue that overall there are good reasons to think that they do: different subtypes of spontaneous thoughts and experiences appear to vary independently of behavioural states. A possible exception is the subgroup of immersive imagistic spontaneous experiences: their occurrence might well be restricted to sleep dreams, and the occurrence of immersive daydreams is an open question. This conclusion has broader consequences for our taxonomy of conscious states as well as our understanding of what it means to be awake and asleep: at least insofar as spontaneous thoughts and experiences are concerned, the alleged rift between sleeping and waking appears to be much smaller than often assumed.

Before I begin, I wish to introduce some caveats. First, my defence of the independence of subtypes of spontaneous thoughts and experiences on behavioural states is preliminary. While the proposed framework is more comprehensive than existing taxonomies in that it specifically aims to integrate findings on waking mind wandering, dreams, and dreamless sleep experiences, it is open to future refinements. Such refinements—especially if they were advanced in tandem with refined criteria for scoring (sub-)stages of sleep and wakefulness—might well lead to a reinstatement of state-dependence. My main aim here, by contrast, is to cast doubt on the dependence of spontaneous thoughts on coarse-grained and conventionally defined behavioural states. My rejection of the state-dependence thesis is therefore largely programmatic: I

believe it is a useful starting point that can help reset empirical and theoretical research, but it is not my anticipated endpoint.¹

Second, for reasons of space, my discussion of empirical findings is selective. In particular, I do not attempt to provide a comprehensive literature review of dreaming and mind wandering. Given the range of topics and disciplines discussed here—the philosophy and science of mind wandering, dreaming and dreamless sleep experience, both individually and together—a comprehensive discussion would be far beyond the scope of this paper. Instead, I attempt a birds' eye perspective that aims to integrate existing approaches in a new way. I focus on selected examples that I take to be particularly useful, but this also means there are important gaps both in the topics I cover and in the literature I cite.

Third, I do not attempt to offer a conclusive defence either of the dynamic framework of mind wandering or of the simulation view of dreaming, which are the two main sources of inspiration for the framework I propose here. I also do not attempt to offer a conclusive critique or discussion of alternative views.² Readers who do not share my enthusiasm for the frameworks of mind wandering and dreaming I have chosen are free to read this paper as endorsing a conditional claim: if we assume the dynamic view of mind wandering and the simulation view of dreaming, as well as the framework of dreamless sleep experience derived from it, their integration into a unified framework of the type I present here is promising. I hope that the usefulness of this framework will, in fact, further highlight the attractiveness of the positions that have inspired it. Yet my main aim, here, is not to resolve conceptual issues for the fields of dreaming and mind wandering individually; rather, I wish to identify points of contact between them and sketch a path towards their further integration.

In sum, my main aim is to make a conceptual contribution: I believe that to assess the state-dependence question, we need a new way to think about conscious states and their relation to behavioural states. In particular, I believe it is crucial to integrate efforts across sleep, dream and mind-wandering research to achieve this goal. The framework I present here is intended as a constructive and potentially research-generating, but also preliminary step in this direction.

2. The state-dependence question: narrowing the target to spontaneous thoughts and experiences in relation to sleep and wakefulness

In its most general form, the state-dependence question asks whether the behavioural state a person is in at a given time determines their conscious state at that time. Traditionally, its starkest reading has been that whether a person is sleeping or waking at a given time determines whether or not they are conscious at that time. This idea is implicit in the traditional characterization of sleep and wakefulness as opposites, with sleep being defined as the absence of waking, perception and consciousness [25]. A more differentiated reading underlies the common contrast between dreamful rapid eye movement (REM) sleep and dreamless non-rapid eye movement (NREM) sleep, where dreamless sleep is (again often implicitly) equated with a loss of consciousness [29,30]. Reasons for doubting these dichotomies between conscious wakefulness and unconscious sleep, as well as between conscious and unconscious sleep

stages are familiar [11,18,20,31] and I will not repeat them here. In particular, even the deepest stages of NREM sleep have been shown to support both conscious experience and a loss of consciousness [11,32]. The notion of consciousness in dreamless sleep can be traced all the way back to classical Indian philosophy [16,17].

Another reading of the state-dependence question is that which behavioural state a person is in at a given time determines the quality of consciousness at that time (i.e. their conscious state, global state or mode of consciousness; [33,34]). An example is the idea that dreams occurring in REM sleep differ in characteristic ways from both NREM sleep mentation and waking experience. This idea underlies the influential AIM model, in which the phenomenological, cognitive and behavioural characteristics of dreaming align with REM sleep neurophysiology, and REM sleep differs from both NREM sleep and waking in all of these respects [1]. While there are indeed some differences between REM and NREM mentation [35], it is not clear that these differences are sufficient to uphold a sharp distinction between kinds of conscious states; rather, they appear to point towards statistical differences in types of dreaming. Indeed, there is increasing consensus that dreams occur in all stages of sleep. Conceptually, this is supported by simulation views of dreaming [13]. Empirically, recent evidence suggests that the neural correlates of dreaming are independent of sleep stages [32]. Views that confine dreaming to REM sleep therefore appear too narrow.

Because the sleep-stage correlates of dreaming and more generally of consciousness in sleep remain elusive, I will set aside, for now, differences between sleep stages and focus on the coarse-grained distinction between sleep and wakefulness. This is not to deny that state-dependence could be re-established under a more nuanced reading of behavioural states and/or sleep stages. In fact, I think this is exactly the way things will optimally develop [18,20]. Here, I have three main reasons for focusing on a more coarse-grained view of behavioural states. One, the most widely discussed alternative, which attempts to relate dreams to conventionally defined sleep stages, has failed, and in fact, the search for the neural correlates of consciousness in sleep is now increasingly focused on differences in neural activity within NREM sleep [32]. Two, a coarse-grained focus on sleep and wakefulness seems best suited to the comparison between (dreamful and dreamless) sleep-related experiences and waking mind wandering. Three, this also seems appropriate given there is no corresponding partition between stages of wakefulness.³ Recent research on mind wandering promises new perspectives on the state-dependence question. Mind wandering, in which thoughts and attention drift away from what we are doing and unfold freely and associatively, takes up a significant proportion of our waking lives [27]. According to some estimates, we spend up to 50% of waking life mind wandering [27,43]. The frequency of mind wandering has been shown to vary quite dramatically dependent on how it is operationalized in a given experiment [43]; but either way, mind wandering is frequent. If we add to this the fact that the vast majority of (if not all) sleep-related experiences are spontaneous, spontaneous experience seems to be the predominant mode of experience in waking and sleep [44].

Mind wandering is thought to involve a change not just in what we think about, or the contents of thought, but also in how we think and experience, or the quality of experience. Specifically, a majority of mind wandering is thought to unfold

outside of our awareness and control, whereas when not mind wandering and awake, we are supposed to be aware and in control of our conscious thoughts and attention as well as focused on ongoing tasks and environmental demands [44]. The ubiquity of mind wandering therefore forces us to reconsider the nature of waking consciousness, making it seem heterogeneous and suggesting that awareness and agency may not be the hallmarks of waking thought that we took them to be.

Aside from the rapid expansion of mind wandering research, there is also increasing interest in comparing and jointly investigating spontaneous thought in waking and sleep.⁴ Spontaneous thought has been proposed to exist along a spectrum, with dreaming possibly occupying the extreme end and being described as an intensified form of waking mind wandering [6–8,21]. These recent proposals, alongside research findings on mind wandering, suggest a profound shift in how we conceive of conscious states in relation to behavioural states. If the spectrum of spontaneous thought reaches from waking into sleep, the borders between behavioural states become porous. There may still be state-dependent differences, such that one end of the spectrum of spontaneous thought (i.e. dreaming) may be associated with sleep and the other with waking. However, any differences between behavioural states will now be located within the spectrum of spontaneous thought. The difference between sleeping and waking will then have to be drawn between different subtypes of spontaneous thought, rather than between broad categories of conscious states.

Spontaneous thoughts and experiences in sleep and wakefulness also seem well suited to the investigation of the state-dependence question because, by definition, they arise naturally, allowing waking mind wandering and sleep-related experiences to be compared on an equal footing. The prospects for experimentally inducing mind wandering episodes are limited [37,39,46–49]. Experimental manipulations are available; for example, boring tasks, alcohol or nicotine withdrawal increase the frequency of mind wandering and decrease task performance [27]. Yet these means of induction are indirect and leave much room for variability. This stands in contrast to large parts of psychology and cognitive neuroscience, which use behavioural performance in response to experimental tasks administered under carefully controlled conditions to measure and induce specific cognitive functions. The experimental induction of specific experiences is also notoriously difficult in sleep. There are some exceptions, such as sensory or direct brain stimulation, which can induce changes in dream content [50], as well as various lucid dream induction techniques [51]. The precise extent to which both dreaming and waking mind wandering are open to task-based manipulations is debatable (e.g. [14,15,52]); however, on the whole, it seems safe to say that sleep-related experiences are hard to control both by external means and through deliberate intention.

Furthermore, the investigation of spontaneous thought is largely limited to retrospective report. A counterexample may be certain lucid control dreams, where eye movement signals can be regarded as a limited form of concurrent report [51,53]. Concurrent reports might also be possible for aware and intentional mind wandering [54–56]. Both proposals raise conceptual questions about the classification of experiences that are to some extent deliberately controlled as spontaneous [57,58]. But irrespective of this issue, it seems clear that for the majority of spontaneous experiences in waking and sleep, only retrospective reports are available, and often even these require prompting the participant to give a report (as in

experimental awakenings in the sleep laboratory and probe-caught methods in mind-wandering research [27]).

The analysis of spontaneous thought is also attractive from a broader consciousness perspective. Dreaming has been described as consciousness in its purest form because, in sleep, consciousness is largely independent of behavioural output and sensory input, making wakefulness appear as a kind of online dreaming [59]. Dreaming has even been proposed as a metaphor and model system of consciousness [59], leading to a view in which conscious experience is at core internal and simulation [60,61]. Dreaming has also been proposed as a promising target for identifying the neural correlates of consciousness [32,62]. Whether dreaming can be appropriately characterized as an offline state, comparable to a brain in a cranial vat—and whether this is relevant to the contrast between internalism and externalism about conscious experience—is debatable [63,64]. But at the very least, it seems safe to say that dreaming is much more weakly constrained by external and bodily stimuli than standard waking perception, and that this feature renders it similar to mind wandering.⁵ The ability to detach from the environment and simulate counterfactual possibilities—of which spontaneous thought is an example—may even lie at the root of biological cognition itself [67]. Generally, the analysis of spontaneous thought may therefore offer a window on the sources and mechanisms of conscious thought operating on their own, comparatively free of the constraints imposed by environmental demands, deliberate control and ongoing tasks. Bringing these into full view requires an integrated analysis of spontaneous experience in sleep and wakefulness.

3. What are spontaneous thoughts and experiences? A multi-level framework

To move forward, we need a conceptual framework that can apply equally to spontaneous thoughts and experiences in waking and in sleep. This requires integrating definitions of mind wandering, dreaming and other sleep-related experiences—a task that is made more challenging because current definitions operate on different levels of description. Where dreams, according to a leading conception, are defined through their phenomenological structure [13], waking mind wandering tends to be defined by its content, the degree to which it is constrained by ongoing tasks and deliberate intentions, and/or the dynamics of its occurrence [10]. My approach draws, on the one hand, from the dynamic framework [6,21] and on the other hand from simulation theory of dreaming [13]. I use these approaches to define spontaneous thoughts and experiences and distinguish them from focused and deliberate kinds of thought, as well as to distinguish different subtypes of spontaneous thoughts and experiences. Such an integrated framework can guide an assessment of the state-dependence question and lay the groundwork for further research.

In this section, I largely leave empirical findings to the side. This allows me to focus on theoretical–conceptual issues and sharpen my conceptual toolkit, which in turn helps organize my discussion of empirical findings in the next section.

(a) Content-based approaches

Until fairly recently, research on what is now commonly referred to as mind wandering was conducted under different headings,

such as task-unrelated, stimulus-independent, unconstrained, spontaneous, unguided or freely moving thought [10], day-dreaming and fantasy [68]. The term mind wandering was introduced with the programmatic aim of unifying these different lines of research under a single familiar, folk-psychological heading [69]. This was successful, leading to an enormous increase in publications on mind wandering [49,68].

At the same time, competing terms are still used and mind wandering itself is defined and measured in different ways [9,10]. The most widespread definition is mind wandering as task-unrelated and/or stimulus-independent thought [27]. This definition offers a straightforward way to define mind wandering and can readily be operationalized in laboratory studies by measuring changes in task performance and externally focused attention. However, defining mind wandering as task-unrelated thought seems to artificially restrict mind wandering to cases where people are engaged in a primary external task [10,49,70]. If we take the metaphor of mind wandering seriously (see also [71]), it refers to the movement of thoughts in no particular direction; but this is at odds with the notion of task-unrelated thought, which implies thoughts that are directed away from an occurrent, primary (and typically experimenter-defined) task. The definition also seems too narrow to accommodate the full spectrum of spontaneous thoughts, especially under naturalistic conditions [49]. For example, thoughts occurring outside the context of a particular task—such as spontaneous daydreams or meandering thoughts while sitting on a bus and looking out the window—intuitively count as mind wandering, but are not covered by the definition of mind wandering as task-unrelated thought. A viable option might be to consider task-unrelated thoughts as distinct from mind wandering, though there will likely be some degree of overlap [49].

Here, my main motivation for looking beyond task-unrelatedness as a defining criterion of mind wandering concerns its applicability to sleep. If we focus on occurrent and externally focused tasks of the type that are central to the investigation of task-unrelated thoughts [49], such cases are largely irrelevant in sleep. By contrast, if we consider task-relatedness as referring to any kind of task or project [14,15], dreams can be task-related in various ways, but we now need a novel task conception and lose the comparability to more narrowly defined task-unrelated thoughts.

Similar problems are raised by defining mind wandering as stimulus-independent thought. It seems plausible that mind wandering can be prompted and shaped by something one sees or hears [72,73]. Stimulus-independence therefore seems to artificially restrict the causes and content of mind wandering (for a similar argument with regard to dreaming, see [64]). A final issue is that both task-unrelatedness and stimulus-independence emphasize only what mind wandering lacks, whereas a definition pointing to its positive characteristics would be preferable.

At the same time, both mind wandering and dream research have produced enormously valuable evidence on different types of content. Content analysis [2,74], which investigates the occurrence of a wide range of dream contents in dream reports, continues to dominate large parts of dream research. In mind wandering research, classical work led to content-based distinctions between different styles of daydreaming [75], and a range of contents of mind wandering including self-relatedness personal relevance, temporal orientation and affective content have been investigated [76]. There have also been

attempts to compare the content of dreaming and mind wandering directly, such as their orientation towards goals [77]. On the whole, these approaches have a very different aim from content-based definitions of mind wandering, which seek to distinguish spontaneous experiences from more focused, task- or stimulus-directed kinds of thought and attention. Because the first challenge is to delineate the broad category of spontaneous thought, I leave content analysis of dreaming and mind wandering to the side here.

(b) The dynamic framework

The dynamic framework [6,21] offers an attractive alternative.⁶ In this framework, thoughts are spontaneous when their contents and/or the transition between different thoughts are weakly constrained by affective or sensory salience on the one hand and deliberate cognitive control on the other hand. Different subtypes of spontaneous thought can be distinguished by varying degrees of constraint, with mind wandering occupying an intermediate position, in terms of the degree of deliberate constraint, between dreaming on one hand and goal-directed (non-spontaneous) thought on the other hand.

The dynamic framework captures the intuitive characterization of mind wandering as involving mental movement and the succession of thoughts rather than rest. While it does not consider task-unrelatedness as a defining feature of mind wandering or include it among its dimensions, it does allow that mind wandering can relate to tasks to different degrees. By acknowledging overlap between spontaneous and task-unrelated thought, the dynamic framework also allows that insights from task-based paradigms may still be applicable to at least a subset of spontaneous thoughts.⁷

Here, I will adopt the dynamic framework to define the broad category of spontaneous thought, but will refrain from adopting some of its more specific commitments. The framework I offer draws a phenomenological distinction between different subtypes of spontaneous thought, but these subtypes do not necessarily track the varying degrees of constraint that are foregrounded in the dynamic framework. This is mostly due to a difference in interest: while the dynamic framework foregrounds different kinds and degrees of constraint, I am interested in the qualitative characteristics of spontaneous experiences (such as whether they are imagistic or thought-like, or whether imagery is organized into a scene). For now, we should remain open to the possibility that spontaneous thoughts with the same phenomenological characteristics show differences in terms of the kind and degree of constraint, and that spontaneous thoughts with different phenomenological characteristics are located at the same points of the dimensions of constraint. In other words, even if we grant that dreaming is an intensified form of waking mind wandering on measures of deliberate constraint, this does not mean the same applies to its phenomenological characteristics (but see [8]). Finally, I prefer to speak of spontaneous thoughts and experiences. As I explain in the next section, my main motivation for this is, again, phenomenological.

(c) The format of spontaneous experience

How we think about spontaneous thought is closely linked to the terminology used for its description. Interpreted as a phenomenological notion, thought is ambiguous. In its broadest sense, it can refer to all self-generated conscious mental states

(as opposed to perceptual experiences or bodily sensations). More narrowly, thought can also refer to a subgroup of self-generated mental states characterized by conceptual and quasi-linguistic content (as opposed to quasi-sensory imagery in different modalities). For example, while dreaming can be described as thinking in the broader sense [81], in the narrower sense, thought would refer only to cases in which the dream self engages in quasi-linguistic thoughts and musings about the ongoing dream [58]. I prefer to speak of spontaneous thoughts and experiences to emphasize that this a phenomenologically diverse category that comprises both conceptually mediated thoughts (or thoughts in the narrow phenomenological sense) and more imagistic types of experience.

A similar contrast is often drawn between propositional and sensory imagination [82].⁸ Again, this distinction is largely orthogonal to content: it refers to different ways of imagining the same thing. To give an example, on the day before an important conference presentation, you might be struck by the thought, 'If I forget to pack my adapter, I will have to speak freely without my slides!' Or you might suddenly be overwhelmed by a vivid fantasy involving visual and auditory imagery of standing at the lectern in front of the audience without slides and you might even feel the clench of anxiety in your stomach. While both imaginings can have roughly the same content and behavioural consequences (leading you to check if you packed your adapter), they have different formats: the former is propositional and quasi-linguistic, involving conceptually mediated thought, whereas the latter is imagistic, involving quasi-visual or auditory experience. They also feel different and likely have different neural correlates [84].⁹

We should tread carefully here as the overlap between imagination and spontaneous experience is only partial: some instances of imagining can be quite focused and deliberate [86],¹⁰ and not all spontaneous experiences can be described as imaginative (such as feeling overcome by a vivid episodic memory of a significant personal event or engaging in future planning, which makes up a significant proportion of mind wandering) [27,88]. As long as we are clear about this difference, the distinction between different phenomenological formats can nonetheless be used to differentiate subtypes of spontaneous thoughts and experiences. This distinction is also methodologically important. If participants in a mind wandering experiment understand the term 'thought' narrowly, they might focus on propositional instances and fail to report more sensory and imagistic ones.

That said, we should expect real-world cases to be more complex. For example, thinking in words or sentences can take the form of inner speech and may even have a voice-like quality [89], suggesting a mixture of formats, whereas in other cases, such an auditory quality might be lacking. Within spontaneous imagery, further subtypes such as voices versus other sounds, or visual imagery of objects versus persons, can be distinguished. Spontaneous imagery can also occur in just one modality or have a multimodal quality (as is often the case for dreams; [1, p. 200; 90]).

Different formats may also be associated with different contents. For instance, future-oriented mind wandering is more likely to involve inner speech than visual imagery and tends to be more personally relevant, realistic and integrated into structured thought sequences [91].

Distinguishing spontaneous experiences by their format leaves much room for future refinement. It identifies a point of contact between research on spontaneous experience and

the cognitive neuroscience of imagination. Because this type of approach has been used in both mind-wandering [91] and dream research [1], including the neural correlates of dream imagery [92], it also facilitates the comparison of spontaneous thoughts and experiences across sleep and waking.

(d) The structure of spontaneous experiences

Within spontaneous imagistic experience, we can draw a further distinction in terms of structure. Here, it is useful to consider so-called simulation views of dreaming [13]. Their key claim is that dreams are immersive mental simulations [14,15]. Dreams are *here-and-now* experiences; they have the structure of a self-in-a-world. Subjectively, we feel present in our dreams, much as we do in waking life. We feel that we can perceive objects, interact with other people, and move through the dream world. But unlike waking perception, which has a tight external stimulus correlation, the people and objects we seem to perceive in dreams typically diverge from our actual surroundings. Like all mental simulations, dreams are not in the business of representing how things are, but how they could be. And unlike immersive virtual reality, this experience comes about spontaneously rather than through external stimulation and technological means.

Simulation views focus on different aspects of dreaming, such as self-experience [14,15] or social interactions with other dream characters [13]. They can also have different targets, such as characterizing the typical phenomenology of a majority of dreams [93] versus aiming at the simplest characterization of dreaming (or the minimal conditions for dreaming to arise) [18]. Because these different versions converge on the idea that dreams are *here-and-now* experiences, they are largely complementary. Importantly, simulation views offer a common framework for defining dreams independently of sleep stages; in view of the failure of conventional sleep stages to align with dreaming and increasing interest in comparisons within the same sleep stage, this is considerable progress.

Simulation views also form a starting point for defining kinds of sleep experiences that are non-immersive and hence dreamless [20]. The current discussion of dreamless sleep experience (see also [94,95]) was inspired by Thompson's [16,17] analysis of a classical Indian debate. Criticizing attempts to define consciousness as what disappears in dreamless sleep and reappears in waking, Thompson argues that dreamless sleep cannot be identified with a loss of consciousness.

Simulation views of dreaming seem to offer an ideal starting point for developing a conception of dreamless sleep experience because they minimally define dreaming as immersive *here-and-now* experience [14,15,18]. Consequently, sleep experiences that lack the phenomenology of temporal or spatial self-location count as dreamless. Such non-immersive, dreamless sleep experiences have been discussed in the context of minimal phenomenal and possibly selfless experience [19,20,94–97]; but in the context of this paper, it is more important to note that many and perhaps the majority of experiences falling into this category are in fact richer and more complex. Examples include sleep thinking and isolated imagery or sensory experiences that occur independently of a broader imagistic context and are not centred on an internal first-person perspective. While in sleep, such experiences qualify as dreamless, a significant proportion (and possibly the majority) of spontaneous imagistic experiences occurring in waking probably also qualify as non-immersive. We could then say that the subtype of

non-immersive and imagistic spontaneous experience occurs equally in sleep and in wakefulness.

Before I assess empirical findings in light of this distinction, I will offer further clarification of the concept of immersion. First, immersion should not be confused with subjective realism, or the feeling that the environment in which one feels present is real or that the events occurring in it are really happening. In lucid dreams, dreamers realize they are dreaming and often have some level of dream control, allowing them to change the course of the unfolding dream [51,53]. Yet these are still *here-and-now* experiences, which in some cases take on a distinctively dreamlike character: the dreamer feels present in a world that is experienced as a dream [90]. This means lucidity is not just a matter of intellectual insight or disbelief in the reality of experienced events, but can involve the sense of being present in what is now realized to be and experienced as a dream environment.

Conversely, certain non-immersive experiences can feel like they are really happening. In the borderland between sleep and waking, a range of thoughts and experiences can occur. Drifting off to sleep, one might hear footsteps or a voice, or one might see (or feel) that someone is present in the room [98–100]. These experiences can feel very realistic, and people may feel that there really was someone there, which can be a cause of concern even after the episode has ended. In some of these cases, the imagistic element—say, of hearing footsteps—may occur before the background of otherwise largely perceptual and veridical experiences of the bedroom and one's own body. Here, the sense of presence would be relative to the perceptual environment. By contrast, if the majority of experiences at a time were made up of spontaneous imagery, we would speak of an immersive mental simulation. This difference may or may not be available on the level of subjective experience; my main point here is that we can conceive of cases that do not involve immersive imagery but are yet experienced as real.

Second, immersion is not simply a function of the overall complexity of experience at a given time; that is, it does not simply depend on the amount or kinds of imagery that make up experience. Instead, immersion is a structural feature of the organization of experience. A technological metaphor is the difference between watching a film on a cinema-screen and having an immersive and interactive virtual reality experience. In the former case, even if you are gripped by the movie, you do not become part of it; even if bodily sensations temporarily recede into the background, you are still viewing the film from an external perspective. By contrast, in immersive virtual reality, you (or the avatar you identify with) are the centre of the virtual environment and feel present in it [22]. This environment may have some limitations, but within these confines, you can move around and potentially even interact with virtual characters. An immersive experience depicts not just an object or even an integrated scene, but a world, and it places you at its centre.

Immersive experience can lack complexity, and in describing this as world-experience, we should not assume that it is a world in the same rich, multisensory way in which we experience the real world in standard waking perception. Certain lucid dreams involve the sensation of floating in a void, where there is no visual or auditory imagery; the dream self is present as a disembodied entity or unextended point in space [101]. Such cases approach the simplest forms of immersive mental simulation and possibly of minimal dreaming

[19,90]. Modality-specific imagery may be lacking entirely; instead, world- and self-experience are reduced to pure *here-and-now* experience associated with amodal spatial and temporal imagery. This shows that even a state in which there is no modality-specific imagery can still be immersive.

In sum, immersion is a structural feature of experience that is distinct from intellectual insight, the feeling of reality (e.g. of dream events), as well as multimodal complexity. These features are in fact often associated with immersion and so may still be pragmatically valuable in that they can guide more detailed phenomenological questions. For instance, for the question of whether spontaneous thoughts and experiences in waking can approximate the immersive quality of dreams, these factors might give a first, rough indication of where to look. But we should not take them to be strictly necessary for immersion.

(e) Summary and open questions

I use spontaneous thoughts and experiences, in line with the dynamic framework [6], to refer to a train of thoughts and imagery that are strung together loosely and associatively and are only weakly constrained by concurrent sensory stimuli, environmental demands, or deliberate control. These thoughts and experiences lack direct and sustained focus on any occurrent, external task, but may relate to externally defined tasks, personal projects, goals or concerns in various ways. Typically, different thought contents follow each other in quick succession, implying that the relationship between individual thoughts or images on the one hand and tasks or goals on the other hand can fluctuate both between and within individual trains of thoughts and experiences. I take this to be consistent with the intuitive characterization of mind wandering as involving the movement of thought without regard for any particular project or goal. When this movement is interrupted, for instance when there is sustained focus on a particular task, thought content, event or object, mind wandering gives way to focused thought and attention.

Generally, I use spontaneous thought and experience as an umbrella term comprising cases from waking and sleep, whereas I use mind wandering to refer to spontaneous experiences occurring in waking. Whether and how these differ from immersive dreaming and non-immersive sleep-related experiences is a separate question, which I address in the next section.

While spontaneous thought is the more common term, the slightly more inclusive ‘spontaneous thoughts and experiences’ can better accommodate the phenomenological diversity of the target phenomenon. Here, I focus on two subtypes of spontaneous thoughts and experiences, namely quasi-linguistic, propositional thoughts as well as imagery. I further distinguish spontaneous imagery by its structure, which I use in the specific sense of immersive versus non-immersive experience. These dimensions draw from mind wandering and dream research, as well as from the philosophy and cognitive neuroscience of imagination and imagery. Bringing them together in a single framework enables us to compare spontaneous experiences occurring in sleep and waking on an equal footing. This, in turn, is crucial for assessing the state-dependence question.

Before I move on, I want to take up some loose ends. Because spontaneous thoughts and experiences are distinguished from focused thoughts, in part, through the succession of thought and attention over time, an important question is how long a

period of focus has to be to count as sustained, and at what point a shift in thought and attention counts as spontaneous.¹¹ One might be tempted to put a precise measure on this, but I do not think defining a particular number of seconds or minutes realistically captures how we conceive of mind wandering or use the term. My sense is that, at the limit, we are speaking of periods spanning several seconds rather than minutes. It seems one can say one’s attention wandered for a few seconds before returning to the book one was reading, only to wander again.

This is consistent with experimental work on mind wandering. It has been proposed that the optimal frequency for interrupting participants from a task to probe whether they were mind wandering or attending to the task is around 1 min [104]. Assuming they initially return to the task with focus after the interruption, this means less than a minute of task focus often gives way to mind wandering. Moreover, having a very short timeframe will be useful to pinpoint the behavioural and neural correlates of attentional shifts: the shorter the timeframe, the more precisely one can localize the moment at which attention switched from an experimental task or sustained focus to a period of mind wandering. This, in turn, will aid with identifying the behavioural and physiological correlates of both attentional shifts and different types of spontaneous versus non-spontaneous states. By contrast, at a larger timeframe, the subtle and often short-lived fluctuations between spontaneous and non-spontaneous states may be obscured.

This definition of a short timeframe is also consistent with a looser, more colloquial manner of speaking in which one might say one was (largely) attentive over a longer period, say of an hour, even though deliberate and sustained focus may have repeatedly been punctuated by distraction, only to be brought back again. It is also plausible that a significant proportion of mind wandering never reaches awareness in the first place and that the true frequency of mind wandering is only revealed by interrupting participants and prompting them to report their state of mind [27].¹² Similarly, one might describe one’s state over a longer period as distracted even though there were moments of focus. When considering a longer period, it seems plausible to speak of mind wandering where the movement of attention and succession of thoughts overall predominate over rest and attentional focus, and of focused thought and attention where the opposite is the case.

It is also important to acknowledge that subtypes and dimensions of spontaneous thought and experience exist that are not captured by the proposed framework. For example, emotions and moods can also arise spontaneously, and indeed many spontaneous thoughts and experiences have an emotional quality. Another important step towards refinement—and admittedly a glaring omission in this paper—is to consider content-based approaches insofar as they are used to distinguish types of mind wandering, daydreaming and dreams. Whereas I focus on phenomenological questions, or what it is like to undergo spontaneous thoughts and experiences, content analysis has traditionally focused on what we dream or daydream about [2,27,74,76], whether we dream about the same things we think about or experience in waking (the continuity hypothesis) [2,4], and how this relates to emotional ill- or well-being [105]. Continuities in content between waking mind wandering and dreaming or sleep-onset experiences have also been investigated [77,106]. These

questions are invaluable for psychology; however, the phenomenological approach I have chosen here is more pressing from a consciousness science perspective because it focuses on the quality and kinds of experiences occurring in waking and sleep. Discerning these, in turn, might help identify the neural correlates of different kinds of spontaneous thoughts and experiences. Also, different kinds of content categories likely cut across distinctions in terms of format and structure. Ultimately, I believe that integrating both lines of research is an important next step and would bring on board a wealth of research results from both dream and mind-wandering research. However, I cannot begin to do justice to this literature here, and so I largely leave it to the side.¹³

A phenomenon at the limit of spontaneous thought and experience is mind blanking. Whereas mind wandering involves the spontaneous flow of thoughts and experiences, mind blanking occurs when the stream of thoughts and experiences temporarily stops. Phenomenologically, mind blanking is described as an empty mind and the cessation of thought. Mind blanking is also behaviourally distinct from mind wandering [107–109]. Conceptually, mind blanking is related to spontaneous thoughts and experiences in that both are attentional lapses whose onset and termination tend to be spontaneous. Yet they are distinct in that we cannot meaningfully describe mind blanking as involving spontaneous thought contents or images, or changes between them. In particular, because it is defined by the absence of contents, we cannot meaningfully apply to mind blanking the distinctions of format and structure I suggest for spontaneous thoughts and experiences. Investigating the relationship between spontaneous thoughts and experiences and their cessation in mind blanking would be a fascinating next step. We could also ask whether possible equivalents exist in sleep, for instance in the form of sleep experiences that lack specific thought contents and imagery [20]. But here, again for reasons of scope, I will focus on the core phenomena of spontaneous thoughts and experiences.

4. Are spontaneous experiences dependent on behavioural states?

Despite increasing efforts towards their integration, dream and mind-wandering research remain largely separate.¹⁴ Here, I give examples of how the proposed framework applies to specific instances of spontaneous thoughts and experiences and consider what this tells us about the state-dependence question. For reasons of space, my discussion is selective and my assessment of the state-dependence question is preliminary. Yet it hopefully demonstrates how the format/structure distinction can be used to organize existing findings on spontaneous states in sleep and waking and lead to new questions and hypotheses for future research.

(a) Dreaming and waking mind wandering

On the side of dreaming, phenomenological questions stand at the forefront of formal analysis [1,111], which focuses on imagery in different sensory modalities, emotions, bizarreness, cognition, metacognition and memory. Dreams are widely accepted to involve vivid and intense forms of multimodal imagery; these are often described as hallucinatory or even perceptual ([1,92]; but see [26]). Visual imagery, followed by

auditory imagery and movement sensations, are the predominant forms of imagery, whereas thermal, tactile, pain, nausea, ticklish, and proprioceptive sensations are described in only 1–4% of laboratory reports [111, p. 198; 112]. Dreams are also commonly characterized as bizarre and emotional and marked by cognitive deficits involving deficient reasoning and short- and long-term memory as well as a lack of metacognitive insight into the fact that one is now dreaming. These characteristics are particularly pronounced for REM sleep dreams and dreams from the second half of the night [35]. They have also been linked to changes in regional patterns of brain activation during REM sleep, giving rise to hypotheses about their neural correlates [92].

Overall, these findings suggest that in dreams, imagery dominates over thinking. However, this should not be taken to imply that thinking or even instances of metacognition are uniformly absent in dreams. Lucid dreams, in which dreamers realize they are dreaming and often have some degree of control over the unfolding events, are a good example [51,53]; but even in non-lucid dreams, various types of thinking, speech and even metacognition occur, often in response to dream events [113].

The phenomenology of mind wandering has been less well explored, likely owing to the fact that this is a younger field. Overall, visual imagery and inner speech seem to be the most common formats, whereas other modalities such as (non-speech) auditory, tactile or gustatory imagery are comparatively rare [76]. Some evidence suggests that individual mind wandering episodes tend to involve imagery in just one format and modality rather than more complex combinations [76].

Mind wandering also appears to be diverse in terms of thoughts, metacognition and control [76]. Thought-like instances of mind wandering can be sequential, as in longer lines of reasoning, or fragmented. Repetition, especially of personally relevant content, is frequent. While most mind wandering likely happens outside of our awareness and control, we can become aware that our thoughts and attention are wandering [27] as well as initiate mind wandering intentionally ([55], but see [57]), as when we allow our minds to wander during a boring meeting. A promising approach could be to compare meta-awareness and control of mind wandering with lucid control dreams [58].

A meta-analysis of studies of dreaming and mind wandering, as well as of imaging studies of the default mode network (DMN) and REM sleep [8], suggested that overall, the intensity of audiovisual imagery and the frequency of bizarreness is increased in REM dreams as compared with mind wandering. Dream reports were also longer, narratively more complex, and more immersive, leading to the description of dreaming as an intensified form of waking mind wandering. This was paralleled by increased activity in the DMN as well as decreased activity in prefrontal areas associated with executive control and goal-directed thought. In keeping with this, Occhionero & Cicogna [114] propose that whereas dreams are characterized by impaired reality testing and hallucinatory imagery, mind wandering is more thought-like and reality testing is preserved. They also propose that mind wandering can occur during sleep onset.

If we take these comparative claims at face value, the idea that dreaming and mind wandering are placed on a continuum casts doubt on a dichotomous view of sleep and waking as opposites associated with different kinds of mental states. The difference between sleep and waking would now have to

be drawn within the broad category of spontaneous thought rather than between spontaneous and non-spontaneous states. This requires the alleged dependence of conscious states on behavioural states to be adjusted but preserves the basic idea of state-dependence. Here, I want to suggest that even this adjusted notion of state-dependence is questionable.

Importantly, such comparative claims are hampered by the methodological diversity that exists both within mind wandering and dream research and between them. Methods used for dream research include spontaneous dream recall at home, laboratory studies in which reports are prompted following awakenings from different sleep stages, questionnaires targeting dreams in general or particular dreams and used in combination with or without dream reports, and descriptions of most recently recalled dreams [2,115]. Mind wandering can be assessed in the laboratory, during task performance or in participants' everyday lives, in response to prompts or spontaneously, when participants notice that their minds have wandered (as in probe-caught versus self-caught paradigms), through questionnaires or reports [27]. The need for reducing the disruption caused by experience sampling probes has favoured short questionnaires over ones that are longer and more phenomenologically detailed [76].

This diversity of methods both within and between dream and mind-wandering research illuminates different facets and in some ways leads to a more nuanced picture, but also casts doubt on the comparability of results. In dream research alone, methodological differences have been associated with significant shifts in scientific opinion about the frequency and kind of dream emotions [116,117], about whether we dream in colour or in black and white [118], and about the frequency of auditory imagery in dreams [28].

Just a handful of studies have compared dreams and waking mind wandering in the same participants. A classical attempt is the Imaginal Process Inventory (IPI) [119]. Consisting of 344 items, it is still one of the most elaborate instruments for assessing daydreams (defined as task-unrelated thought) and sleep dreams. Rather than focusing on particular dream and daydream experiences, it asks participants for a general assessment of their daydreams and dreams on a range of topics including their frequency, contents and relation to everyday life, emotions, temporal orientation, visual/auditory quality, boredom proneness and distractibility. The IPI and its short version, SIPI [120], have been used in numerous studies [76], which together highlight the ubiquity of daydreaming as well as its multi-faceted nature and different styles.

A few studies have collected dream and reports from the same subjects. One study investigated bizarreness, positive and negative emotions, and sensory vividness in nap dreams and daydreams [121]. Bizarreness was similar in NREM nap dreams and daydreams but significantly higher in REM dreams; REM dreams were not significantly different from daydreams in emotions, but NREM dreams were less emotional than both; REM dreams received the highest ratings in sensory vividness and NREM dreams the lowest, leaving daydreams in an intermediate position. The results are intriguing because they suggest that no simple ordering between dreams from different sleep stages and daydreams is possible; it is particularly noteworthy that, overall, daydreams took an intermediate position, being more similar to NREM dreams on some and to REM dreams on other measures. It is also

noteworthy that in this study, daydreaming occurred under specific conditions: participants were asked to sit for 3 min with their eyes closed and think or daydream about anything that came to mind. While the closed-eyes condition is likely quite different from daydreaming with open eyes while going about one's business, the study enhanced the comparability of dreams and daydreams by minimizing outward activity and visual perception during wakefulness. The results therefore indicate that even when external differences are minimized, the difference between waking and sleeping does not necessarily differentiate spontaneous thoughts and experiences occurring in either state.

A similar protocol was used to compare the dreams and daydreams of frequent nightmare sufferers and controls [122] on measures of positive and negative emotions, bizarreness and bodily sensations. The daydreams of nightmare sufferers showed similar levels of negative emotions but contained more bodily sensations, bizarreness and positive emotions than those of controls. For nap dreams, the only significant difference between groups was for bodily sensations, whose frequency was heightened in nightmare sufferers. These findings suggest that, overall, the daydreams and nap dreams of nightmare sufferers are more vivid and intense than those of controls. It also suggests that to fully understand the profile of specific types of dreams (such as nightmares), it is useful to look beyond their specific occurrences and even beyond sleep itself to spontaneous thoughts and experiences in waking.

While these direct comparisons between sleep dreams and daydreams constitute important progress, they are informative only about a subset of spontaneous experiences, namely immersive dreams on the one hand and daydreams occurring under particular conditions on the other hand. This precise focus strengthens the findings of these studies; but it also suggests that a nuanced approach distinguishing subtypes of mind wandering and dreams is required. The next step is to further broaden the comparison between spontaneous thought in waking and sleep by taking non-immersive and hence dreamless kinds of sleep experience into account.

(b) Beyond dreams? Dreamless sleep experiences

The possibility of non-immersive and hence dreamless sleep experiences is addressed by studies investigating reports from all sleep stages. The most important methodological innovation, which enables comparing reports from the same sleep stages, are serial awakening paradigms, in which participants are awakened at short time intervals (e.g. every 15–30 min) and asked for experience reports [123,124]. This vastly increases the amount of reports that can be gathered per experimental night. Because this method allows for frequent experience reports following NREM sleep in particular, it enhances the likelihood of reports of non-immersive sleep experiences.

Noreika *et al.* [123] used this method to investigate early-night NREM sleep mentation. Subjective reports ranged from simple (involving a single fragment) to complex (involving a progression of events or even scene changes). These categories speak to the organization of NREM experiences over time, but not to their format or structure at a time. Complexity of experience reports did not differ by NREM stages or by timing (first versus second half of the awakening period, where both were within the first 3 h of sleep). Overall, there were roughly equal proportions of experiences, reports of unconscious sleep, and so-called white dreams, in which participants had

the impression of having dreamt but were unable to describe any details. If we take such reports at face value, the inability to describe any detailed experiences (including thoughts or imagery) might reflect the absence of such thoughts or imagery in the preceding sleep period. Because participants nonetheless awoken with the impression of having had experiences, such cases might involve a minimal kind of dreamless sleep experience involving an intermediate state in which conscious experience is present but specific thought contents or imagery are missing [19,20]. Alternatively, imagery might be present but too degraded to enable report [125], or complex dreams might have occurred and been forgotten. It is also possible that different types of white dreams exist. Targeted questionnaires or training participants might allow researchers to tease apart these possibilities and determine whether minimal or degraded imagery and/or thought contents were indeed present and whether these experiences were immersive.¹⁵

Siclari *et al.* [32,124] used a similar paradigm to awaken participants from all sleep stages. A small percentage of reports were also elicited when participants were still awake. As in the Noreika study, similar proportions of conscious experiences, unconscious sleep, and white dreams/conscious experience without recall were reported following awakenings from N3, the deepest stage of NREM sleep.

Participants were also asked to classify the thought-like versus perceptual quality of their experiences. Thoughts were highest in waking, lowest in REM sleep and intermediate at sleep onset. This is consistent with earlier work charting the occurrence of thoughts versus hallucinations across sleep stages. For example, Fosse *et al.* [126] found that directed thought (defined as involving mental effort or occupation with a particular theme) was higher in NREM than in REM sleep, whereas hallucinations (defined as percept-like imagery) were highest in REM sleep, suggesting a reciprocal relationship between thinking and hallucinating in sleep. Focused thought also decreased in NREM sleep in the second half of the night, when NREM experiences became more hallucinatory.

One fascinating study [36] compared the occurrence and neural correlates of thought in reports from all sleep stages and quiet rest in waking. Following randomly timed prompts in sleep and waking, participants were asked to rate how thought-like and effortful their experience was. The free reports were additionally analysed by independent raters for metacognition, social focus, positive and negative emotions, temporal focus (past, present, future) and bizarreness. Thoughts occurring in N2 were rated as significantly lower in metacognition than waking thoughts. Compared with waking thoughts, REM thoughts were also less metacognitive but higher in positive emotions, social focus, and effort. Compared with N2, REM thoughts were more effortful, longer, more complex and easier to recall. Yet it is noteworthy that the only feature that distinguished waking and sleep independently of sleep stage was metacognition, which was consistently higher in waking. All other features either were broadly similar or required a more differentiated analysis of mentation occurring in different sleep stages. Also, in all three states, thought appeared to depend on activity in the midcingulate region, suggesting a common neural correlate.

Owing to differences in methodology and subjective reports, it is hard to determine how to compare results on sleep-related thoughts from different studies. In view of the comparison with mind wandering, it would be particularly

interesting to investigate more systematically the occurrence of thoughts in sleep (and especially in NREM sleep) in isolation from imagery, as well as the extent to which imagery occurs in a single or in multiple modalities, whether or not imagery is isolated or organized into a quasi-perceptual scene, and if the latter, whether it is immersive in the sense of placing the dream self at its centre.

The latter question has not been directly investigated, but the evidence is suggestive. Anecdotally, it does seem that thoughts, isolated imagery, and sometimes even perceptions or bodily sensations can occur in sleep independently of a broader hallucinatory scene and without necessarily being centred on a self or even being experienced from an internal first-person perspective [11,18–20].

The Siclari *et al.* [32] study asked participants to rate the degree to which their experiences were self- versus environment-related. They found that, overall, there was more self-related mentation in waking and more environment-related mentation in sleep, independently of sleep stage. This is not quite the same as asking about immersion, however: dream reports rarely describe self-related features, but focus on the environment, events and other dream characters [127]. The dream self is structurally placed at the centre of events even though it remains in the background of dream reports. But at least a subset of reports of environment-related experiences might also be non-immersive.

We can also look to research on visual perspectives in dreams, where it is common to distinguish between active participation and passive observation [128]. In the majority of REM dreams, the self tends to be present as an active participant; more rarely is it a passive observer. A majority of NREM dreams also involve active participation, but compared with REM sleep, the percentage of passive observer experiences is much higher and there is generally a broader range of different types of self-representation, including cases where the self is not represented at all.

Passive observer experiences are of interest for immersion because a subset might involve location within the experienced scene—i.e. be dreamful—whereas in other cases, self-location might be external to the experienced scene and hence dreamless. The contrast, here, is between being a silent onlooker in an immersive virtual environment, where one observes (but does not participate in) events unfolding in one's surroundings, and feeling external to an image or scene, as in watching a film in a conventional movie theatre. More detailed questions or training might help disentangle these phenomenological differences.

In sum, there is evidence that especially NREM sleep supports diverse types of experience, including sleep experiences in different formats, immersive and non-immersive experiences, as well as a loss of consciousness. Thought-like activity, either in combination with imagery or on its own, appears to occur both in sleep and in waking as well as in all stages of sleep; the same appears to be true for spontaneous imagery. While behavioural state differences seem to be most pronounced for metacognition, exceptions exist in the form of lucid dreaming and metacognition in non-lucid dreams. Even metacognition therefore does not appear to be strictly dependent on waking.

It is also worth considering whether the apparent asymmetry in metacognition between sleep and waking might be eschewed by an inaccurate view of waking thought. The ubiquity of mind wandering is surprising in part because it suggests that for much of our waking lives, we are neither

aware nor in control of our conscious thought processes [44]. This softens the distinction between wake- and sleep-related experiences. Especially if we focus on spontaneous thoughts and experiences, it seems that regardless of whether we are waking or sleeping, these largely occur without awareness and control. Even if metacognitive awareness turns out to be even more compromised in sleep than in waking [36,114], it might still characterize just a small proportion of waking mind wandering [27].

(c) Do immersive daydreams exist?

Even if we acknowledge the possibility of non-immersive and hence dreamless sleep experiences, it still seems that immersion constitutes a key difference between dreaming and waking spontaneous thought [8]. The next question to ask is whether immersion really is a unique feature of spontaneous experiences occurring in sleep, or whether immersive episodes of mind wandering exist. At the current stage of research, I think the possibility of immersive waking mind wandering is speculative and no more than a theoretical possibility. Still, for the sake of argument and to highlight the possible proximity of such experiences to dreams, I will call the most immersive types of mind wandering daydreams. In this section, I identify some possible avenues for their investigation, but leave open whether or not they are immersive in the same sense as dreams.

One possibility is that daydreams as a subset of waking mind wandering are immersive in the same sense as dreaming; another is that mind wandering generally falls short of the immersive quality of dreams; in this case, daydreams could not be properly described as immersive at all. A third possibility is that immersion is a complex, graded construct and that daydreams fall short of dream immersion in some but not all respects.¹⁶ The second and third possibilities would indicate that at least in relation to spontaneous experience, either immersiveness in general or some aspect of immersiveness is state-dependent.

As is the case for dreamless sleep experience, a first question to ask is whether waking mind wandering tends to be centred on the self; however, we already know that a majority of waking mind wandering is self-centred in the sense of revolving around self-related concerns [76]. This seems to tell us more, however, about the content than about the format or structure of mind wandering and thus is not very useful in assessing the immersiveness of waking mind wandering.

Another question, much as I argued in relation to dreamless sleep experience, concerns the perspective from which imagistic mind wandering is experienced. In mind wandering research, it is common to distinguish between the visual first- and third-person perspectives [130,131].¹⁷ While the first-person perspective implies observing events as if through the eyes of an imaginary, remembered (or dream) self, the third-person perspective involves seeing oneself or the world from the outside.

This distinction can be used as a proxy for thinking about immersion, though it is an imperfect indicator. Firstly, much as is the case for observer dreams, seeing oneself from the outside is consistent with a point of view that is internal or external to the imagined or remembered scene. Without further clarification, it is therefore unclear how to interpret reports of a third-person perspective with regard to the locus of self-location and the immersive versus non-immersive structure

of the experience. However, the same ambiguity does not arise where the experience is centred on an internal first-person experience. Focusing on such cases might therefore be a promising starting point for determining the possibility of immersive daydreams.

Secondly, these distinctions in terms of perspective are typically given a visual reading, implying that visual imagery is centred on a particular point of view. By contrast, immersion, as I have defined it, refers to spatio-temporal self-location. This is known to align imperfectly with the origin of the visual first-person perspective. Where you feel yourself to be can be different from where you see yourself to be [134,135]. As noted earlier, there are also cases of immersive dreams that do not involve visual imagery (or a visual perspective) at all, but take the form of amodal *here-and-now* experience, for example, of being a disembodied entity in a void [20,90]. For the possibility of immersive daydreams, this means that, ultimately, it would be prudent to look beyond visual imagery.

Thirdly, the feeling of embodiment—either relative to the physical body or relative to the dreamed or imagined body—while not necessary for spatio-temporal self-location, may nonetheless be an important factor. In particular, it seems plausible that in waking, the persistent flow of own-body experience could counteract the feeling of presence in an imaginary environment, whereas in sleep, as own-body experience changes and often recedes into the background, there might be less ongoing sensory and proprioceptive information to contradict the feeling of presence. In some dreams, bodily and movement sensations (such as flying or falling) might even enhance the feeling of presence [64,90]. This appears to be the case in dreams of flying, falling, or having incomplete control over one's body while trying to flee from a pursuer, which are all intense kinds of dreams [23]. Investigating own-body perception in relation to immersive daydreams could therefore be an interesting perspective.

Keeping these issues in mind, findings on (visual) perspectives in mind wandering might nonetheless help identify cases that would be promising for further, more detailed analysis. The majority of mind wandering episodes indeed seem to be rated as having a first-person perspective, whereas around one-fifth have a different perspective and around 17% have no particular visual perspective at all [130]. This effect may be culturally dependent, with participants from Western cultures reporting a predominance of the first-person perspective and participants from Eastern cultures reporting a predominance of the third-person perspective [131]. While waking mind wandering generally shows a predominance of visual imagery over other modalities, the first-person perspective in particular seems linked to greater vividness and the third-person perspective to a stronger orientation towards the future. To further investigate the possibility of immersive daydreaming, the subset of mind wandering episodes experienced from the first-person perspective would be an excellent starting point.

Methodologically, it seems particularly promising to look to studies that investigate mind wandering under conditions that approximate sleep by minimizing the flow of external sensory input and overt behaviour, for example, by asking participants to engage in mind wandering while in a calm position and with their eyes closed. One older study [137] explicitly used methods from dream research to investigate mind wandering. Participants were asked to lie down in a dimly lit room and to relax

but stay awake. At 1–9 min intervals, they were asked to describe their experiences. Most participants described their mental state as fully awake and relaxed rather than drowsy. Visual imagery was much more frequent than auditory imagery and in most cases, participants described just one modality rather than both. Notably, 24% of cases were rated as hallucinatory in the sense that the imagined events felt as if they were really happening. Participants also rated the degree to which reality contact (defined as control over thoughts, awareness of being in the laboratory, and non-hallucinatory thoughts and imagery) was maintained; this was the case in roughly 40% of episodes. Roughly 20% were classified as mind wandering (where control over thoughts was lost) and in another 20%, participants additionally lost awareness of being in the laboratory; 15% lacked all three features of reality contact, meaning there was no control over thoughts, no awareness of being in the laboratory, and imagined events felt as if they were really happening. The remainder of cases could not be clearly classified.

Because the features indicating a loss of reality contact in this study are reminiscent of a majority of non-lucid dreams, they might help identify candidates for immersive daydreams. Again, they should be treated with caution: as discussed earlier, lucid control dreams show, for example, that immersion is distinct from control and metacognitive insight. But at least initially, the characteristics of non-lucid dreams might still be a good starting point.

Finally, rather than assuming that immersion is a simple, on–off property, a more nuanced, multi-dimensional view might be better suited to comparing the *here-and-now* quality of dreams and daydreams. We can get a stronger grip on immersion and its relation to factors such as visual perspective and bodily experience by looking to sleep onset. The border between sleeping and waking is phenomenologically diverse, offering an ideal opportunity to study the transition between non-immersive (or dreamless) and immersive, dreamful experience [90]. Elsewhere, I have argued that sleep onset can involve both non-immersive and immersive, dreamful experiences, often following a progression from the former to the latter [90,137]. Sleep onset is also electrophysiologically diverse. Within the period reaching from drowsy wakefulness into early, stage 2 NREM sleep, nine substages can be distinguished [24,138], which in turn may align with characteristic changes in experience.

Of relevance for the state-dependence question, sleep onset casts doubt on the idea that there is a correspondence between conventionally defined behavioural or sleep states and conscious state changes, and indeed on the sleep–wake dichotomy itself [18]. While the investigation of sleep onset experience and its neural correlates might plausibly lead to a reinstatement of the state-dependence thesis, this would require a significant departure from the way behavioural states and sleep stages are currently defined and operationalized. As noted in the Introduction, I think this would be an extremely promising and fruitful development.

In a groundbreaking article and dazzlingly rich survey, Nielsen [139] calls sleep-onset experiences microdreams and suggests that their analysis can shed light on the factors underlying the formation of more complex dreams. Here, I would like to extend this idea by proposing that the analysis of sleep-onset experiences can also inform the investigation of spontaneous thoughts and experiences in waking. Sleep onset experiences are ideally suited to this task because they

allow us to draw connections in both directions, to full-fledged dreams and other sleep-related experiences, but also to mind wandering and daydreams.

This type of approach involving a comparison between reports from waking, sleep onset and/or REM sleep has already been used to investigate differences in passive versus active participation, future versus past oriented thought, auditory verbal experience and the transition from reflective to hallucinatory thought [140–142]. There is also evidence that if one tries to suppress thoughts about a particular topic or person in waking, those thoughts are more likely to reappear as cognitive control loosens during sleep onset [106].

The analysis of sleep-onset experience might also help disentangle different dimensions that contribute to the feeling of presence and immersion. Sleep onset suggests that immersion is complex and comprises distinct dimensions, each of which varies gradually [90]. At the very least, we can distinguish: (1) the gradual emergence of an integrated visuo-spatial scene, beginning with isolated imagery and building up to an integrated scene or environment; (2) changes in bodily experiences, such that bodily sensations gradually recede into the background; there may also be the feeling of moving outside of one's physical body. At the same time, relative to sleep-onset imagery, there is often a progression from passive observation to active participation, which may involve the experience of embodiment in a 'dream' body; (3) the emergence of an alternative temporal reference frame, ranging from brief and isolated, snapshot-like images to prolonged and narratively organized episodes. In this process, the sense of *here* and *now* and the feeling of embodiment appear to shift from one's actual environment and body to a dreamlike environment and body, though awareness of this fact is often lost. Later-stage sleep onset imagery, which tends to be more fully formed, also tends to draw from more temporally remote and diverse memory sources and may be easier to recall and describe in detail. Another central factor seems to be the sense of dynamism and movement, relating either to oneself or to observed movement [139].

It would be fascinating to probe examples of seemingly immersive daydreams in more detail with respect to these dimensions. One possibility is that there are different pathways to immersion, with some dimensions being more likely to occur in waking or at sleep onset and others being more prevalent in sleep [138]. For instance, immersive sleep onset imagery appears to be highly dynamic and closely tied to kinetic imagery, whereas in deep sleep, static yet immersive dreams can occur [123]. Immersive daydreams could also be more fragile and short-lived than sleep dreams—much as is the case for the rapid progression in experience during sleep onset. Indeed, Foulkes & Fleisher [136] remark that, overall, reports from quiet waking indicated a rapid alternation in conscious states. For example, a participant who described her experience just before the prompt as non-hallucinatory added that this, in turn, was preceded by the seemingly hallucinatory experience of being in a refrigerator and looking down at a sandwich.

Specifically for daydreams, it might also make sense to consider whether some cases involve a sense of dual self-location, in which one feels present both in the imaginary and in the actual environment or rapidly switches between them. Such cases of dual or alternating self-location are familiar from full-body illusions [143,144] as well as from certain lucid dreams, where there can even be a sense of moving back

and forth between the physical body and the dream body [145]. Progress on these questions could be made by applying the terminology and methods used for research on full-body illusions and lucid dreams to daydreaming and mind wandering. Either way, analysing and comparing such cases in more detail might help distinguish different dimensions of immersion that are more or less likely to occur under different conditions and perhaps in different states.

Incidentally, the investigation of immersion might lead to a partial reinstatement of the idea of state-dependence. Full-fledged immersion might turn out to be unique to sleep dreams and mark a sharp distinction from even the most vivid daydreams. Alternatively, all or at least some aspects of immersion might be present in at least a subgroup of maximally immersive daydreams, which would increase pressure on the state-dependence thesis. But even if it turns out that there are robust differences between dreams and daydreams in their immersive quality, we have still, overall, made a sizeable dent in the state-dependence thesis: we have seen that immersion likely just characterizes a subset of sleep experiences. This is consistent with saying that for the subgroup of non-immersive spontaneous experiences, which behavioural state one is in may be largely irrelevant. At the very least, the issue of state-dependence can be narrowed to the question of whether immersive daydreams exist, and at present this should be considered an open question.

5. Conclusion

To conclude, it seems that if we carve up spontaneous thoughts and experiences in the way I have proposed here and consider the full range of sleep-related experiences, there is no strong dependence of conscious states on behavioural states: at the very least, the difference between sleeping and waking does not draw a sharp line between coarse-grained categories of conscious states. Spontaneous thoughts and experiences abound in sleep and wakefulness, and different formats (imagistic versus thought-like) can occur both in combination and on their own in both states. Imagistic spontaneous experiences can be non-immersive or immersive, and again there is evidence that both types can occur in sleep. The occurrence of immersive, imagistic spontaneous experiences in waking remains an open question, and these experiences might or might not turn out to be dependent on behavioural states. Either way, in answering this question, we will plausibly move towards a more nuanced view and possibly even be able to reinstate limited forms of state-dependence in which particular types of imagery or dimensions of immersion are more or less strongly bound to (sub-)stages of waking, sleep or sleep onset.

Other open questions concern the frequency and precise conditions under which different subtypes of spontaneous thought and experience occur in sleep and waking as well as whether fine-grained distinctions in phenomenology and/or content exist between sleeping and waking after all. The proposed framework can certainly be enriched by further dimensions. And if these further dimensions were paralleled by a more fine-grained distinction of (sub-)stages of sleep and wake, this might bring us closer to a new and more robust understanding of state-dependence. Such a development would be consistent with my claim that our current and coarse-grained understanding of sleep and wakefulness does not necessarily track relevant differences in conscious

states and specifically in the broad categories of spontaneous thoughts and experiences discussed here. To pinpoint the relevant neural markers of conscious states as well as their phenomenological characteristics, it seems we will need to refine our understanding of sleep and wakefulness themselves. Specifically, we may need to realign how we think about and define behavioural states with the occurrence and fluctuation of spontaneous thoughts and experience, as well as their subtypes.

In sum, the joint discussion of dreaming and mind wandering has already narrowed the alleged rift between sleep and wakefulness to a distinction to be drawn neither between conscious and non-conscious states nor between spontaneous and non-spontaneous states, but within spontaneous thoughts and experiences. If the proposal I have presented here is on the right track, that alleged rift can be further narrowed to a distinction within subtypes of spontaneous experiences occurring in sleep: immersive and imagistic spontaneous experiences, or dreams, might well turn out to be dependent on sleep. At the same time, a variety of non-immersive spontaneous experiences appear to occur equally in sleep and waking. Moreover, if a subset of waking mind wandering, which I call daydreams, turns out to be immersive in a similar way to dreams, the alleged rift between sleeping and waking might virtually disappear.

Data accessibility. This article has no additional data.

Competing interests. I declare I have no competing interests.

Funding. This research was funded by the Australian Government through the Australian Research Council Discovery Early Career Researcher Award.

Acknowledgements. I am grateful to two anonymous reviewers for their thoughtful and constructive comments; this paper has been greatly improved thanks to them.

Endnotes

¹For a discussion of how sleep-related experiences might be aligned with refined sleep-stage scoring, see [18,20].

²I offer a more extended discussion of definitions of mind wandering than of dreaming because dream research seems to be closer to consensus (for further discussion and references, see [22–24]), whereas in mind-wandering research, conceptual debates are ongoing ([25,26]). Also, while I focus on the dynamic approach of spontaneous thought [27], content-based approaches still dominate large parts of the field [28].

³In wakefulness, the closest is the contrast between active and quiet (or resting) wakefulness. This distinction is not, however, formally defined through polysomnographic measures, but is typically drawn behaviourally. For example, quiet wakefulness may be operationalized as the state occurring during a so-called resting task, where participants fixate their eyes on a cross on a screen, or where they rest with closed eyes. The distinction between active and quiet wakefulness (or the resting state), while coarse-grained compared with conventional sleep stages, tends to be drawn in the context of sleep and dream research [36] and research on the default mode network and/or mind wandering [37–39].

It has also been suggested that EEG microstates lasting no more than a split second may be associated with shifts in conscious thought [40]. However, these do not complement conventional sleep staging, but can be distinguished across wakefulness and sleep. This could be a promising avenue for future research, but it would require setting the coarse-grained distinction between sleep and wakefulness to the side. Given the short duration of these microstates, it would also require a more nuanced phenomenological framework. Whether this could be reconciled with the dynamic framework, which operates at a larger timeframe (see footnote 9) is a separate question.

Finally, in relation to fine-grained wake-stages and mind wandering, one can also ask whether the occurrence of spontaneous thoughts and experiences in waking follows a similar cyclical pattern

as is the case for sleep. Some evidence suggests that in waking, fluctuations in thought generation and cognitive control, which may underlie mind wandering, may indeed follow a 4–6 h cycle [41]. There is also evidence that periods of REMs occur not just in sleep, but also in waking [42]. Further investigating such fluctuations across waking and sleep in relation to spontaneous thought and experience presents fascinating avenues for future research and might even give rise to a new conscious state architecture occurring across the sleep–wake cycle.

⁴Notably, the *Oxford handbook of spontaneous thought* [45] deliberately takes an inclusive perspective spanning wakefulness and sleep.

⁵An important objection to my assessment of the state-dependence question is that by focusing on spontaneous states, I am neglecting the most obvious way in which conscious states are dependent on behavioural states: if we look to non-spontaneous states, including focused attention, perception and bodily action, these seem to occur almost exclusively in waking. A plausible adjustment to the state-dependence thesis would therefore be that conscious states are dependent on wakefulness insofar as they are strongly constrained, e.g. by external stimuli, deliberate control, and/or involve prolonged physical action and especially interaction with other people and objects. I think this is an entirely plausible adjustment, and I thank an anonymous reviewer for raising this point. The resulting claim is that both state-dependence and state-independence have to be qualified: whereas certain types of states—call them non-spontaneous states—almost exclusively occur in waking, others, namely spontaneous states, occur equally in sleep and in waking.

This qualified version of state-dependence of non-spontaneous states still leaves room for asking whether, at least in principle, perception, bodily action, focused attention, metacognitive insight and deliberate control as the putative hallmarks of non-spontaneous states can occur in sleep. There is reason to think we can have perceptual or illusory experiences in sleep and dreams, particularly involving own-body perception [64]; outward behaviour, ranging from small muscle twitches to complex overt behaviours, might be associated with experienced dream actions [64,65]; and lucid dreams show that metacognitive insight and control are compatible with dreaming [51,53,66]. So while it is certainly possible to point to statistical differences between sleep and waking, drawing a sharp line in terms of what is possible in either state seems implausible and likely requires a nuanced account. Ultimately, it might make more sense to speak of spontaneous versus non-spontaneous aspects of experience rather than of spontaneous versus non-spontaneous states *per se*. Here, I leave these issues to the side and focus on spontaneous states, which I take to raise a more obvious problem for state dependence and thus a more suitable starting point for reassessing the relation between conscious and behavioural states more generally.

⁶Similar views have been proposed by Irving [71] and Sripada [78]. Here, I focus on the dynamic framework as introduced by Christoff and colleagues [6,21] because it explicitly aims to integrate dreaming.

⁷Generally, it seems possible that the diversity of mind wandering definitions is paralleled by diversity in the target phenomenon, and different definitions track different kinds of thought [79,80]. This would mean there are distinct and partially overlapping kinds of mind wandering, in which case a family resemblance view might be more appropriate than a single overarching definition [10]. While a single, unified definition is preferable [9], my proposal is consistent with that possibility.

⁸This is not to be confused with the imagery debate [83], which centred on the format of mental representations, with one side arguing that all thoughts are stored in a propositional format while the other side argued that some thoughts are stored in a depictive, quasi-pictorial format.

⁹How exactly to describe the quasi-sensory side of imagery and imagination raises important questions. Arguably, imagining an apple is neither like seeing an apple nor like seeing a picture of an apple, but requires its own phenomenological description [85]. I

leave these issues to the side here. My main point is that, regardless of how we resolve this descriptive issue, sensory imagination feels, in some sense, different from propositional imagination.

¹⁰It has also been proposed that imaginative mental agency is involved in focused daydreaming but not in mind wandering [87].

¹¹A related question can be raised in relation to attempts to define mind wandering as disunified thought [87,102]. Without a clear cut-off line or defined scale of observation, any sequence of thought will appear disunified from some perspective. Even if we have a period of sustained focus and unified content, zooming out to bring a longer succession of thoughts into view will inevitably lead to the appearance of disunity [103]. Hence, from some perspective, every train of thoughts appears as mind wandering. In a sense, I am asking the opposite question here: namely, what is the minimal cut-off line for determining whether a period of focus was interrupted by or switched to mind wandering? Because the dynamic framework focuses not on individual thoughts but on a succession of thoughts, it seems likely that a momentary snapshot would be insufficient to capture the movement of thought that is essential to mind wandering. At the same time, empirical evidence about the ideal probe frequency of mind wandering being at around 60 s suggests that even short periods of task focus can lead to mind wandering and that periods of mind wandering that are presumably even shorter than 60 s can be reported.

¹²The same is true for sleep-related experiences: most people rarely remember their dreams and can report at most one dream per night when sleeping at home, but awakenings in the sleep laboratory often lead to reports, even when they are conducted at short time intervals (every 15–30 min) and from all stages of sleep (e.g. [32]).

¹³A comprehensive proposal for how to distinguish different dimensions of dreams and identify their neural correlates is made by Nemeth & Fazekas [31]. The framework they propose integrates aspects of content, quality and form. It is broader than the framework I propose here by integrating content as a separate dimension; the dimensions of quality and form are also defined slightly differently. While Nemeth & Fazekas's main focus is casting doubt on the REM–NREM dichotomy, they also propose the application of their framework to mind wandering. And as I do here, they reject a global characterization of dreaming in favour of a more nuanced, multidimensional view. Despite some differences in terminology and scope, overall their proposal and mine complement each other.

¹⁴By contrast, a number of early modern authors regarded dreams as characteristic of our spontaneous, restless minds and very naturally discussed these in a way that integrated waking and sleep [110].

¹⁵For example, it is conceivable that reports of floating in the void, as are sometimes reported by lucid dreamers [19,101], would be classified as white dream reports; such experiences would count as minimally immersive and hence as dreamful. They would also include at least amodal spatial imagery. It seems equally conceivable that some white dream reports refer to experiences that lack this *here-and-now* quality.

¹⁶In this context, consider a recent proposal according to which the sense in which we feel present in dreams, or immersive presence, may just be part of the profile of presence in standard perceptual wake states. Barkasi [129] recently argued that presence in waking involves both immersion and the feeling of availability for action, where only the former but not the latter is present in dreams. Similarly, the profile of presence in daydreams might also only be partly fulfilled as compared with waking perception, and immersive presence in daydreams may or may not be analogous to immersive presence in dreams.

¹⁷This is in keeping with the distinction between field and observer perspectives in the literature on memory and imagination and does not, as pointed out earlier, align with the active participant–passive observer distinction commonly applied in dream research, which appears to track the level of agency rather than perspectival organization [132]. As Rosen & Sutton [132] point out, consistently applying the same terminology to research on dreams and waking imagery, but also autoscopic phenomena such as out-of-body-experiences [133] would be significant progress.

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