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The immersive spatiotemporal hallucination model of dreaming

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Abstract The paper proposes a minimal definition of dreaming in terms of immersive spatiotemporal hallucination (ISTH) occurring in sleep or during sleep–wake transitions and under the assumption of reportability. I take these conditions to be both necessary and sufficient for dreaming to arise. While empirical research results may, in the future, allow for an extension of the concept of dreaming beyond sleep and possibly even independently of reportability, ISTH is part of any possible extension of this definition and thus is a constitutive condition of dreaming. I also argue that the proposed ISTH model of dreaming, in conjunction with considerations on the epistemic relationship between dreaming and dream reports, raises important questions about the extent to which dreams typically involve a detailed body representation—an assumption that plays an important role in philosophical work on dreaming. As a commonly accepted definition of dreaming is lacking in current dream research, the ISTH model, which integrates conceptual analysis and epistemological considerations with results from empirical research, is an important contribution to this field. By linking dreaming to felt presence, full-body illusions, and autoscopic phenomena such as out-of-body experiences in wakefulness and in the hypnagogic state, the ISTH model of dreaming also helps integrate dream research, both theoretically and experimentally, with the study of other altered states of consciousness involving hallucinations. It makes straightforward and investigable predictions by claiming that all of these experiences have amodal spatiotemporal hallucinations as their common denominator. Finally, it is theoretically relevant for the philosophical discussion on minimal phenomenal selfhood.

Keywords Dreaming · Hallucination · Self-consciousness · Bodily experience · Altered states of consciousness · Full-body illusions

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Introduction: Why a minimal definition of dreaming is needed

One of the central desiderata in the field of empirical dream research is a commonly accepted definition of dreaming. Existing definitions range from "any mental activity occurring in sleep" to more narrow definitions in terms of formed, multimodal hallucinations, strong emotions, and specific cognitive features (Hobson et al. 2000; Pagel et al. 2001). In the philosophical discussion, the question of how to conceptualize conscious experience in the dream state is similarly controversial. Whereas the philosophical discussion in the second half of the twentieth century focused on the question of whether dreams should be regarded as conscious experiences during sleep at all—or rather as false memories inserted at the moment of awakening (Malcolm 1956, 1959; Dennett 1976)—most contemporary philosophers accept that dreams are phenomenal states occurring in sleep, i.e., that it is *like* something to dream. At the same time, different possibilities of conceptualizing dreaming are currently being discussed, with recent publications focusing on the status of subjectivity in the dream state (Metzinger 2003, 2009; Windt and Metzinger 2007) and the question of whether dreams should be conceptualized as imaginative or hallucinatory experiences (Ichikawa 2009; Sosa 2007; McGinn 2004; O'Shaughnessy 2002).[1]

In this paper, I will address these conceptual issues by offering a minimal definition of dreaming in terms of immersive spatiotemporal hallucination (ISTH) occurring in sleep or during sleep–wake transitions and under the assumption of reportability. This is not to say that dreaming typically or characteristically takes such a minimal form—in fact, this would be quite false. Dreaming is a notoriously heterogeneous and variable phenomenon (Hunt 1989; Nielsen 2000a). It certainly can be characterized in terms of its stereotypical features (i.e., multimodal imagery, which is predominately visual, and frequently auditory and kinesthetic, strong emotions, cognitive deficiencies, and bizarreness; for details, see Hobson et al. 2000). Nonetheless, certain types of dreaming differ systematically from this description. For instance, lucid dreams lack the cognitive deficiencies that characterize much of nonlucid dreaming (Brooks and

[1] On the view espoused here, dreaming is distinguished from imagination by the sense of immersion in a hallucinatory space. This differs from the type of fictional immersion that dreams, according to the imagination model, share with daydreams or waking fantasies (McGinn 2004, 2005). Dreams also only rarely, with the exception of lucid control dreams, exhibit the type of agentive control required on the imagination model. Most attempts to conceptualize dreaming as imagination (rather than hallucination) rely on a sharp distinction between perception, hallucination, and imagination. However, empirical evidence better supports the view that perception, hallucination, and waking imagination are deeply similar, both phenomenologically and in terms of the underlying neurocognitive mechanisms. Visual imagery, in particular, behaves like visual perception in terms of the time required to perform similarity judgments or mental rotation tasks, the overflow of the visual field, etc. (for an overview and further references, see Kosslyn 1994; Kind 2006; Grush 2004; Currie and Ravenscroft 2002:71ff). Perky (1910) showed that healthy subjects are prone to confuse perception and mental imagery under certain conditions. This may be especially pronounced in certain patient groups (Currie and Ravenscroft 2002:72ff). There is also compelling evidence both from neuroimaging and lesion studies for an overlap in the neural substrates involved in visual imagery and visual perception (Grush 2004: 387). With the sharp distinction between imagery and perception eroded, the argument for distinguishing dreaming from hallucination loses much of its force. The ISTH model can allow for a gradual distinction between imagination and hallucination, for instance regarding the intensity and color saturation of visual dream imagery, while maintaining only that a particular type of immersive spatiotemporal hallucination is constitutive of dreaming.

Vogelsong 1999). False awakenings, or realistic dreams of waking up, often lack the bizarre features that abound in other dreams (Green and McCreery 1994). This suggests that many of these stereotypical features of dreaming fall short of being necessary for dreaming to occur.

Rather than attempting to capture the characteristic phenomenological and cognitive profile of dreaming, the goal of this paper is to identify its phenomenological core. The idea is that the target phenomenon ought to be, first, something that is invariant and stable across different types of dreaming. Such a minimal definition of dreaming should state the necessary and sufficient conditions for dreaming to arise, i.e., these conditions would be constitutive of dreaming in the metaphysical sense. An alternative discovery could be that there is no such phenomenologically invariant core, i.e., no distinct and well-defined set of necessary and sufficient conditions on the phenomenal level of description across all dreams. It is also possible that there are several distinct or partly overlapping sets of jointly sufficient conditions, none of which is strictly necessary for dreaming to arise, i.e., a "family resemblance." In this case, none of these conditions would be constitutive of dreaming. The possibility of identifying a single phenomenological core, however, is clearly preferable, because it would allow for a unitary understanding of dreaming. Second, a minimal definition should help distinguish dreaming from types of conscious experiences during sleep or sleep–wake transitions that are typically considered as non-dreaming. Residual perceptions and sleep thinking, which are often thought to occur during NREM sleep, are an example of the former (see Hobson et al. 2000), hypnagogic or hypnopompic imagery occurring at sleep onset or upon awakening, from now on referred to as "hypnagogia," is an example of the latter (Mavromatis 1987). Third, there should be a circumscribed phenomenological description of the target phenomenon allowing for an easy identification in dream reports.

Aside from providing conceptual clarity and being relevant to the theoretical discussion on dreaming, the proposed definition would be an important contribution to the search for the neural correlates of dreaming independently of sleep stages.[2] It links dreaming to felt presence (FP) and full-body illusions (FBIs) such as out-of-body experiences (OBEs) in wakefulness and in the hypnagogic state by proposing that they all have amodal spatiotemporal hallucinations as their common denominator. This way, it helps integrate dream research, both theoretically and experimentally, with the study of other altered states of consciousness involving hallucinations. Finally, by shedding light on the relationship between immersion, phenomenal selfhood, and bodily experience in the dream state, it is also relevant to the philosophical discussion on self-consciousness and minimal phenomenal selfhood.

[2] Early dream researchers tended, overly optimistically, to equate dreaming with REM sleep and viewed non-rapid eye movement (NREM) sleep as a state of unconsciousness, giving rise, at best, to thought-like mental activity. Today, most researchers accept that there is a double dissociation between dreaming and REM sleep: REM sleep can occur without dreaming, and, more importantly, even vivid dreams can occur during NREM sleep and sleep onset. For a review, see Nielsen (2000a, b). As Noreika et al. (2009) recently pointed out, these findings highlight the need for a correlate of dreaming independently of sleep stages. However, as long as it is unclear which type of experience—or more accurately, which type of retrospective experience report—should be classified as dreaming, the attempt to investigate its neural correlates is futile.

The standard view: dreaming as a replication of waking experience

A central assumption in the philosophical discussion is that dreams potentially replicate waking experience both of the self and of the world. This plays an important role for Descartes' discussion (1911/1642) of the epistemological problem of dream skepticism in the *Meditations*, i.e., the question of how we can ever be sure that we are not dreaming, at any given moment. As he can find no certain marks to distinguish dreaming and wakefulness, Descartes not only doubts his sensory knowledge of the external world but also his existence as an embodied agent.

The view that dreams potentially or even typically replicate waking experience also plays an important role for philosophy of mind. Because dreaming is an example of conscious experience arising largely independently of sensory input and motor output,[3] Antti Revonsuo (1995, 2006) thinks that the phenomenological profile of consciousness in the dream state reveals the structure of consciousness itself. Despite the drastically different functional profiles of dreaming and waking consciousness, "there is nothing in the experience itself, in the actual qualitative character of the experience, that necessarily distinguishes the dream experience from a corresponding perceptual experience in the waking state" (Revonsuo 2006: 82). This can also be sharpened into a statement on phenomenal selfhood in the dream state:

> The self in the dream is the character who represents the dreamer. This character, the dreams self, usually possesses a *body image* much like the one experienced during wakefulness. The dream self is positioned in the center of the dream world. The dream setting and events are seen and experienced from his or her point of view. The dreamer feels as if he or she were *embodied* inside our bodies during wakefulness. Thus, the dream self has a bodily existence and location in the dream world. In this respect the dream self is not all that different from the waking self. (Revonsuo 2005: 207)

Even if one grants that this characterization fits a majority of dreams and that conclusions about the bodily dream self can be derived from dream reports, it is not helpful for a minimal definition of dreaming. At best, it is a description of what dreams are typically like, not a definition in terms of stating necessary and sufficient conditions. Standard dreaming has to be distinguished from types of dreaming that lack these stereotypical features. To arrive at a minimal definition dreaming, the atypical examples are actually more informative because they show which aspects of dreaming that are typically mentioned in dream reports should not be considered as defining features of dreaming.

More importantly, the view that dreaming replicates waking conscious experience suggests that dreaming is a global hallucinatory state: on the phenomenal level,

[3] At least REM dreams arise in a state of near-complete functional disembodiment: the transmission of external stimuli from the primary sensory neurons is actively inhibited, preventing peripheral information from gaining access to the central nervous system. At the same time, the postsynaptic inhibition of the motor neurons in the brain stem and spinal cord prevents the external enactment of internally experienced dream behavior. See Hobson et al. 2000 for details. Of course, there are exceptions: loud stimuli, such as the sound of an alarm clock, can awaken the subject or become integrated in the dream. Also, patients with REM sleep behavior disorder (RBD), in whom the inhibition of motor neurons fails, enact their dreams. For details, see Mahowald and Schenck 1999; Schenck and Mahowald 1996; Schenck 2005. Sleep behavior during NREM sleep, such as sleepwalking, may also be associated with dreaming; see Revonsuo 2006.

dreams consist of the experience of a self in a world but lack the close type of external stimulus correlation characteristic of waking perception. They fit the philosophical concept of hallucination, which is defined as "an experience which seems exactly like a perception of a real, mind-independent object, but where there is no mind-independent object of the relevant kind being perceived" (Crane 2005). Their subjective indistinguishability from genuine perception not only gives rise to the epistemological problem of dream skepticism but also challenges naïve realistic accounts of perception as putting us in direct contact with the objects of perception (see Crane 2005; Windt 2010).

For dreams, however, this standard definition has to be qualified in several respects. At least occasionally, dreams can involve the experience of objects that are actually present in the sleeping subject's environment. The best examples are false awakenings (see Green and McCreery 1994). Still, they can be considered as hallucinatory because they do not result from external stimuli but rather from spontaneous internal brain activation. If I dream I have woken up in my bedroom, visual imagery does not arise because I am actually *seeing* my bedroom. It may be caused by the activation of memory sources about my current sleeping environment, but it is not caused by the object—my bedroom—actually being present. In a sense, the actual presence of the object is contingent, because it does not constrain dream imagery in the same way as it does waking perception: I could have the same dream of my bedroom while sleeping in a hotel room. This shows that dream hallucinations are defined by the degree of stimulus correlation rather than the absence of the hallucinated objects. For auditory imagery, which occasionally becomes integrated into dreams, the distinction between hallucination and illusory perception is less clear. The sensory-input blockade during REM sleep is strong, but not complete, and dream hallucinations do not require a complete absence but merely a weak degree of external stimulus correlation. If the sound of my alarm clock is integrated into a dream in a slightly distorted manner, this is an illusion or a misperception of the properties of a mind-independent object that is actually present and causally related to my experience. If it gives rise to my hearing, in the dream, the sirens of a police car and seeing it driving by, this is an example of an external stimulus giving rise to hallucinatory dream imagery. This view is also supported by the psychological literature (Aleman and Larøi 2008) and suggests that the distinction between hallucinations and illusions is gradual rather than absolute. Finally, note that the philosophical concept of hallucination does not require that the subject be deluded about the nature of her experience. For instance, in lucid dreams, the dreamer realizes that she is dreaming rather than awake. In sum, the question is, first, whether a phenomenological core of dreaming can be identified that fits not just a majority but all types of dreaming and, second, whether this feature or set of features still fits the concept of hallucination.

Evidence from empirical dream research

Imagery in the different sensory modalities is a good place to start, because many empirical researchers consider the presence of multimodal hallucinations to be one of the central differences between dreaming and non-dreaming (Hobson et al. 2000;

Solms 2000). Historical and contemporary studies investigating the frequency of dream imagery in the different sensory modalities have yielded a surprisingly consistent picture (Schwartz 2000): visual imagery is the most frequent type of imagery and characterizes a majority of dreams. Auditory imagery and movement sensations are also relatively frequent, but imagery in the other modalities is rarely mentioned in dream reports (Hobson 1988). While dreams often integrate multimodal imagery, this suggests that multimodality is not strictly necessary for dreaming. The same is true for specific types of imagery, including visual imagery. For instance, blind subjects report vivid but nonvisual dreams (Kerr 1993),[4] and the loss of visual dreaming, typically following lesions in the occipital–temporal area, was first described by Charcot in 1883 (for discussion and further case studies, see Solms 1997, 2000). Consequently, even visual imagery, though characteristic of a majority of dreams, is not necessary for dreaming.

The same is true for the characteristic cognitive and mnemonic deficiencies, bizarreness, and the emotional quality of dreaming. Many dreams are in fact characterized by cognitive and metacognitive deficiencies: for instance, reasoning tends to take on an ad hoc and confabulatory quality in the dream state, and dreamers typically lack insight into the fact that they are dreaming (Kahn 2007). But lucid dreaming is an important counterexample. Lucid dreamers realize that they are currently dreaming, and this metacognitive insight or "state clarity" is often accompanied by wake-like reasoning abilities (Tholey and Utrecht 2000 [1995]). False awakenings can be deeply disturbing precisely because of their mundane, undreamlike nature, showing that dreams are not by definition bizarre (Green and McCreery 1994). Finally, some describe dreaming as hyperemotional, claiming that dream emotion may be a driving force of dream plot construction (Merritt et al. 1994; Hobson et al. 2000). Merritt et al. (1994) found that the frequency of reported dream emotions was increased 10-fold by asking subjects to give dream reports indicating the occurrence of emotions on a line-by-line basis. Nonetheless, they also found that approximately 5% of dream reports contained no mention of emotion whatsoever.

If none of the modality-specific types of imagery, cognitive/mnemonic deficiencies, or emotional tone are necessary for dreaming, then what about more general representational contents, such as the world and the self? Phenomenal selfhood is a particularly good candidate because many studies have shown that the vast majority of dream reports describe the presence of a dream self (Strauch and Meier 1996; Occhionero et al. 2005). Typically, the dream self actively participates in rather than passively observes dream events, and only rarely are dreams described as selfless. Due to the widespread cognitive and mnemonic deficiencies, many important aspects of phenomenal selfhood, which are related to cognitive and volitional agency, are lacking in a majority of nonlucid dreams. Integration with autobiographical memory, both within the dream state and

[4] A study reported by Bertolo et al. 2003 suggested (contrary to common belief) that congenitally blind subjects experience visual dreams. While this is highly controversial (see Kerr and Domhoff 2004; Lopes da Silva 2003), adventitiously blind subjects, who sometimes continue to experience visual dreams for years after losing their eyesight, also occasionally report nonvisual dreams.

following awakening, also tends to be weak. This means that the dream self not only differs from the waking self in terms of dream content but also that the experience of selfhood itself is impoverished in many dreams. Because the relationship between cognition and phenomenal selfhood in dreams has been discussed in detail elsewhere (Windt and Metzinger 2007), I will now turn to bodily experiences in the dream state. This is particularly interesting because, as discussed above, the idea that dreams replicate waking self-experience in terms of phenomenal embodiment plays a role in philosophy of mind as well as for the epistemological problem of dream skepticism.

Though mentioned in a majority of dream reports, the presence even of an actively participating dream self does not necessarily indicate that this was also a phenomenally embodied dream self in the sense of giving rise to a detailed and integrated experience of the whole body including body parts. First, self-representation varies considerably in dreams, ranging from the absence of a self, to passive observation, to active participation, and to a double representation of the self. Interestingly, the variation is even greater in NREM than in REM sleep dreams (Occhionero et al. 2005). Second, a brief look at more specifically bodily experiences shows that many types of bodily experience are systematically underrepresented in dream reports. Movement, typically involving the dream self, is present in 75% of dream reports, but vestibular sensations are mentioned in only 8% of dream reports (Hobson 1988) and are often associated with intense forms of dreaming (nightmares, lucid dreams, typical dreams of flying, falling or being chased, etc.; see Schönhammer 2005). Other bodily sensations are only rarely mentioned in dream reports, i.e., thermal (4%) and touch (1%) sensations, pain sensations as well as physical pleasure, visceral sensations, nausea, ticklish sensations, and proprioception (Hobson 1988). Another interesting finding is that dream plots are rarely self-centered, and explicit references to the self only comprise 3% of content categories in dream reports (Revonsuo and Salmivalli 1995).

Though frequent, even kinesthetic imagery is not always associated with the dream self. Noreika et al. 2009 found that subjects awakened from NREM sleep reported static dreams that not only lacked narrative progression but also movement sensations. The reports often described the experience of being present in a static scene, for instance quietly sitting on a bench, with nothing else happening. Yet, there was still a sense of duration and temporal, though not narrative, progression (Noreika; personal communication). An even more reduced form of the dream self are those cases in which dreamers report having been present as a disembodied entity or even "selfless" dreams, in which they experienced themselves as a disembodied point or freely moving center of awareness (Occhionero et al. 2005; LaBerge and DeGracia 2000).[5]

[5] Of course, reports from such a selfless state would involve a performative contradiction; see Metzinger 2003: 539. In lucid dreams in which the dreamer realizes that she is dreaming but experiences herself as disembodied or absent, there is still a cognitive self. In a very rudimentary sense that has to do with self-location, there is even still a bodily self. At least, these rudimentary forms of (bodily) self-experience are sufficient to give rise to retrospective reports of having been present, albeit in a disembodied manner. Descriptions of selfless and disembodied dreams may simply be different ways of retrospectively describing the same type of dream.

The interpretation of empirical research results: why we should trust dream reports

As so often, alternative interpretations of these results are available. The problem is that any statement about the phenomenology of dreaming involves implicit assumptions about the epistemic relationship between dreaming and dream reports. Given the fleeting nature of dream recall and the retrospective quality of dream reports, the problem may seem even more pronounced for dreaming than is the case for first-person reports of waking experience.

First, one can assume that dream reports are epistemically transparent with respect to dreams. Because dream recall in the laboratory is much more frequent and thus presumably a better indicator of dreaming than spontaneous dream recall,[6] one should qualify this by saying that dream reports are epistemically transparent when gathered under ideal reporting conditions. There are many methodological issues involved here that I cannot discuss in detail (see Kramer 2007 for an introduction). The appropriate wording of questions is crucial and depending on the thematic focus of the study, free dream reports may be supplemented by instructions, appropriate questioning, or interview techniques in order to minimize individual differences in reporting style. Further considerations may include the method of awakening, the gender of the interviewer etc. Given such conditions, dream reports are considered to transparently reflect the frequency of certain types of experiences in dreams. On this view, occasional reports, say, of detailed bodily experiences are just as much to be trusted as reports of being present as a disembodied subject.

Assuming epistemic transparency, the results summarized above suggest that a majority of dreams only give rise to phenomenal embodiment in a weak sense associated with movement and to a lesser extent with vestibular sensations but that dreams only rarely involve an integrated, anatomically detailed full-body representation. The experience of being present in the dream is associated with a phenomenally underdetermined core body experienced as an extended and often moving entity that forms the locus of the self.[7] Even in disembodied or selfless dreams, such a core body is present, but the lack of an anatomically detailed body representation is also available to attention and cognition. The ability to attend to or even think about this lack of a body representation, in turn, enables the dreamer to experience herself as disembodied and give a corresponding report.[8] Passive observer dreams, in which the dream self observes the unfolding dream events without actively engaging in the dream, and even active participation dreams may be similar in terms of lacking a detailed body representation without, however, giving rise to the experience of being disembodied. If no bodily representations of the relevant kinds are present, but this fact is neither cognitively nor attentionally available, the dreamer will neither have the explicit experience of having nor of

[6] Laboratory research has shown that average subjects can report many more dreams following experimental awakenings than they can recall spontaneously, suggesting that most dreams are forgotten (Hobson et al. 2000; Noreika et al. 2009).

[7] Similarly, Schwitzgebel 2002b has suggested that we may dream neither in color nor in black and white, but that dreams may be indeterminate with respect to color.

[8] According to Metzinger 2003: 117 ff, phenomenal experience is characterized by global availability to attention, cognition and behavior.

lacking a body, and the bodily dream self will be phenomenally underdetermined with respect to bodily experiences. Consequently, dream reports will refer to the presence of a dream self but will lack explicit references to bodily experiences.

The opposite interpretation denies that any reliable information about dreams can be extracted from dream reports. On this view, dream reports are epistemically opaque because they do not support any conjectures about dreaming. This would be the case, for instance, if reports of bodily experiences were systematically confabulated and filled in or forgotten and underreported after awakening.

The third and most pertinent position is that reports of bodily experiences are epistemically underdetermined[9] with respect to dream experiences: based on the available information, it is impossible to decide how such reports relate to the phenomenal character of the experience they are taken to refer to. If a subject reports a dream in which she had exactly the same type of body she has during wakefulness, it is unclear whether she knew this in virtue of detailed bodily experience, a visual representation of her body (for instance a reflection in a mirror), hearsay from other dream characters, or whether she "just knew." Retrospective confabulation is a further possibility.

Of the three possibilities, the assumptions of epistemic opacity and epistemic underdetermination are showstoppers. Unless one makes some positive assumptions about the epistemic relationship between dreaming and dream reports, nothing further can be said about dreaming. Without such positive assumptions, one would effectively deny the reliability of first-person reports, and though the epistemic reliability of dream reports is dubious, it is clear that relying on dream reports in fact plays a central role in empirical dream research. So, for pragmatic reasons, I will assume that dream reports elicited under ideal reporting conditions should preliminarily be considered as epistemically transparent with respect to the immediately preceding dream.[10] Though they should be treated with caution, we can allow certain limited inferences from dream reports. Call this the pragmatic approach to dream reports.[11] Of course, given an account of ideal reporting conditions, this approach could also be extended to other reports of internal experiences, including waking imagery (see, for instance, Schwitzgebel 2002a), and the problem of the reliability of first-person reports applies to consciousness research in general.

[9] Strictly speaking, epistemic underdetermination is a property of theories, not reports. The same is true for epistemic transparency and opacity. Thus, dream reports are epistemically underdetermined (transparent or opaque) given certain background assumptions about how they relate to the phenomenal character of the experience they are taken to refer to. They can also be regarded as a form of folk-psychological theory about what was experienced during sleep. Importantly, epistemic transparency, opacity and underdetermination differ not so much as to whether such an experience occurred, but as to whether dream reports justify such assumptions.

[10] This assumption underlies most empirical and theoretical work on dreaming. However, this point is rarely made explicit.

[11] There might be ways to decide the question. One could easily imagine, though less easily conduct, an extensive study involving scores of dreamers spending several nights in a scanner and reporting their dreams several times a night. By comparing references to bodily and movement sensations in their dream reports to images of regional activation patterns in the areas that correlate with these types of experiences during wakefulness, one might then decide the question. Due to the practical difficulties and the high cost of such studies, however, it would be hard to accumulate a sufficiently large database. Also, even persuasive results would still leave room for skepticism.

According to the pragmatic approach, we ought to note that a majority of dream reports lack descriptions of such bodily experiences as are related to a detailed and integrated representation of the full body including body parts. If one grants that dream reports have a limited epistemic transparency with respect to dreams, the most parsimonious interpretation is that the bodily self is phenomenally underdetermined in a majority of dreams: though involving self-experience, important types of bodily experiences, related to an anatomically detailed body representation, are lacking in the majority of dreams and their absence typically goes unnoticed. Under ideal reporting conditions, bodily experiences are neither forgotten nor confabulated but correctly reported. Moreover, the underrepresentation of certain types of bodily experiences in dream reports reflects their underrepresentation in the dream state.

On this view, one can still allow for a wide range of variability—for instance, even rare dream reports of detailed bodily experiences can be considered as epistemically transparent, and thus as indicating the occurrence of such detailed bodily experiences during sleep. Nonetheless, the idea is that those rare reports that quite explicitly describe the absence of a (bodily) self are distinguished from typical dreaming less by the absence of an anatomically detailed full-body representation than by the attentional and cognitive availability of this fact. These dream reports just might shed light on the type of experience that is absent in a majority of dreams—though its absence tends to go unnoticed. More importantly, they point to the sufficient conditions for dreaming to arise.

The immersive spatiotemporal hallucination model of dreaming

Based on the analysis of the empirical data so far, as well as on theoretical considerations on the epistemic status of dream reports, I suggest that the crucial factor that distinguishes dreaming from non-dreaming sleep experiences is precisely the sense of spatial and temporal presence in the dream. In a very basic sense, there is a hallucinatory scene that is organized around an internal, spatiotemporal first-person perspective (1PP)[12] as well as a sense of spatiotemporal self-location, i.e., the sense of occupying a space (even a point will be extended in a minimal sense), plus an experienced "now" and the experience of duration. While Blanke and Metzinger (2008) use the term weak 1PP to refer to a visuospatial or auditory 1PP, I use it here in the more reduced sense of a purely spatiotemproal 1PP. On this level, I think the distinction between a spatiotemporal 1PP and a sense of spatiotemporal self-location disappears: both refer to the phenomenological property of being located at (and relative to) a certain point in space at a certain point in time. From now on, I will use spatiotemporal 1PP to refer to self-location as well.

Importantly, even in the examples of static or "selfless" dreams discussed above, the phenomenology is that of being *in* the dream, rather than of looking *at* a visual pattern, as is often described to be the case in hypnagogic hallucinations experienced at sleep onset (see Nielsen 1992; Germain and Nielsen 2001; Mavromatis 1987). In more complex and longer dreams, this sense of self-location will not be stable but

[12] In the terminology introduced by Blanke and Metzinger's 2008:7, this weak 1PP is a purely geometrical feature of an egocentric model of reality.

rather will jump from one location in dream space to another. In terms of temporal location, dreams are similarly unstable and discontinuous, as evidenced by unconnected cuts in the dream narrative (Revonsuo and Salmivalli 1995). Another difference between dreams and hypnagogia is that the former are often described as involving a sense of duration and temporal progression (including static NREM dreams, which are nonetheless experienced as temporally extended; see Noreika et al. 2009), whereas hypnagogia often has an instantaneous, snapshot-like quality.

While vision and movement sensations are often associated with dreaming (giving rise to a visual in addition to a spatiotemporal 1PP), neither of these are necessary for dreaming. In contrast, ISTH is sufficient for bringing about a sense of self-location within a spatiotemporal frame of reference, a potential behavioral space. The example of hypnagogia also shows why visual or auditory imagery alone are not sufficient for dreaming: both types of imagery are only sufficient for dreaming if they have an immersive, "surround" quality, and at this stage, they will necessarily involve ISTH. The same is true for isolated movement sensations occurring relative to a hallucinatory environment (rather than a veridical perception[13] of one's actual environment, as is often the case in hypnagogia, where hallucinatory imagery can merge with veridical perception).[14] At the same time, ISTH can also occur without such movement sensations. In contrast, while experiencing a visual hallucination that does not have this surround quality, for instance during the hypnagogic state, there is also a sense of being located relative to, but not *in* the hallucinatory space[15]—and for this reason, this type of hallucination would not yet qualify as an ISTH.

Note that dreams—or at least reported dreams—only rarely take the form of pure ISTH. Moreover, the bare feeling of spatiotemporal presence, independently of visual, auditory, or movement sensations, might well be forgotten. After all, even the static dreams reported in the Noreika et al. 2009 and the "selfless" dreams reported by Occhionero et al. 2005 (which are more complex than pure ISTH due to the involvement, for instance, of visual imagery) were elicited following awakenings in the laboratory, and such dreams are rarely reported spontaneously. Finally, cognitive activity and/or emotion may of course accompany ISTH—but on their own, without having an immersive hallucinatory quality, they are better described as non-dreaming sleep mentation.

[13] Though problematic, I use the term veridical perception as a contrast to hallucinatory or illusory cases, i.e. for those cases of perceptual experience in which a mind-independent object is actually present, its properties are not misperceived and there is a close degree of stimulus correlation. In doing so, I do not, however, commit to a version of direct or naïve realism about perception.

[14] Note that while ISTH is distinguished from the feeling of self-location in *perceptual* space (in terms of a veridical perception of one's actual environment), it may not always be possible to make the distinction. I.e., if you have a particularly realistic dream of waking up in your bedroom and then going back to sleep, you may never be sure, even retrospectively, whether you dreamt the episode or really woke up. So while ISTH is not the same as spatial location in perceptual space (precisely because it has a hallucinatory quality), the two can be epistemically indistinguishable not just while they are occurring, but even retrospectively.

[15] Much as one is located relative to a movie screen without having the sensation of being localized or present in the scene one is observing. Another way of saying this is that you are located, both in a spatial and a temporal sense, relative to the screen without being localized relative to the objects, persons and events depicted in the movie, and the same description may apply to certain non-immersive visual hallucinations.

While ISTH may combine with multimodal (i.e., visual and auditory) hallucinations in the dream state, certain bodily experiences may better be regarded as illusory rather than hallucinatory. During the dream state, the physical body is not only trivially present but also modulates bodily experiences. Considering the gradual distinction between illusion and hallucination introduced above, bodily experiences in the dream state should be considered as illusory at least in those cases where such a close correlation with real-body inputs is plausible. The idea that dreams arise from bodily sensations was discussed extensively in late 19th and early 20th psychology (i.e., Wundt 1999 [1897]). More recently, Schönhammer (2005) suggested that many typical dream themes such as dreams of falling, flying, being unable to move, or being pursued can be understood in terms of a distorted perception of the largely paralyzed and deafferented sleeping body. The incorporation of pain in the dreams of hospitalized burn victims and through experimental induction, i.e., by inflating a blood-pressure cuff on the leg, which causes a mild pain sensation in wakefulness (Nielsen et al. 1993; Raymond et al. 2002), also supports this view. Finally, a cluster of experiences arising during the hypnagogic state is particularly interesting in this respect: the so-called old hag or incubus attacks. Here, subjects feel that they are being assaulted by a malevolent agent, typically sitting on their chest and chocking them, which is often associated with feelings of pressure or even pain as well as difficulties breathing (Cheyne et al. 1999; Cheyne 2003, 2005). All of which seems to result from a distorted or illusory perception of the shallow and rapid breathing pattern characteristic of REM sleep. This shows how closely bodily experience, both in full-fledged dreams and during sleep–wake transitions, is grounded in and modulated by inputs from the physical body rather than being completely cut-off from such inputs. Put differently, the degree to which REM sleep dreams are functionally disembodied in virtue of the sensory input and motor output blockade may be weaker and more variable than often assumed. Even if bodily experiences in dreams are illusory, however, the sense of being localized in a spatiotemporal space should be considered as hallucinatory: this immersive space is not brought about by a distorted perception of the sleeping subject's actual environment. To the extent that it is modulated by inputs from the sleeping body, the degree of stimulus correlation relative to this space (though possibly not to additional bodily experiences in the dream) is so weak that it merits the use of the term hallucination.

Finally, if this analysis of dreams as ISTH is correct, it shows that a minimal form of self-experience or minimal phenomenal selfhood (MPS) does not require what Blanke and Metzinger (2008: 12) call "a passive, multisensory and globalized experience of 'owning' a body." They suggest that this sense of "'global ownership'—functionally defined as availability of an integrated, transparent, and global representation of the spatiotemporally situated body—is the simplest form of self-consciousness." While I agree with their conclusion that MPS "is constituted by something 'less' than agency" (Blanke and Metzinger 2008: 12), I would submit that the subjective sense of presence—or at least the retrospective description of an experience as having involved the presence of a self—involves something even less: the sense of immersion or of (unstable) location in a spatiotemporal frame of

reference.[16] Neither global ownership nor a visual 1PP, however, are necessary for MPS. For this reason, the ISTH model of dreaming is also directly relevant for the philosophical understanding of self-consciousness.

In sum, I propose that dreaming is minimally defined by:

1. Immersive spatiotemporal hallucination

   On the phenomenal level of description, this denotes the experience of presence. First, this refers to the sense of being localized in and relative to a spatial environment. Second, presence can also be understood in the temporal sense, i.e., the experience of being present at a particular moment and relative to an extended time span. There is a sense of duration, with respect to which one has a particular temporal location: "now." ISTH is immersive in the double sense of being spatially and temporally located in and relative to a spatiotemporal reference frame.

   Due to the weak degree of stimulus correlation, the experience is hallucinatory, though this fact need not be cognitively available to the experiential subject. It is amodal because it can arise independently of and is prior to modality-specific types of hallucinatory content such as visual, auditory, kinesthetic, or even proprioceptive imagery. Also, dreamers tend to be disoriented as to the actual timing of their dream (Hobson et al. 2000), suggesting that not only the spatial but also the temporal reference frame is replaced in the dream state.

   Hallucinations have often been defined in terms of their sensory character—for instance, de Boismont (1860, xii) wrote that "Sensible objects are the exclusive materials of hallucinations." But the assumption of amodal hallucination depends not so much on whether or not a plausible account of amodal perception can be defended but rather on whether a plausible account of an amodal spatiotemporal hallucination can be defended. Consider the example of a congenitally blind person's dream (see Kerr 1993). In her dream, she enters a room and is aware of its rectangular shape as well as of the location of certain objects. Yet, the experience does not have a visual quality (assuming, as most do, that congenitally blind subjects do not have visual dreams). This sense of the spatial layout of the room would be both hallucinatory and potentially independent of any modality-specific information. Of course, it could additionally involve modality-specific (i.e., auditory, tactile, or kinesthetic) information, but this would not be necessary. Without entering into the discussion on amodal perception here (see Nanay 2009), it is at least plausible to assume that an object can be hallucinated in a purely spatiotemporal, nonsensory manner.[17]

   According to the emulation theory proposed by Grush (2004: 394), amodal spatial imagery is one of the central forms of imagery and indeed may be "a core form of neurocognitive representation." His theory posits an amodal environment emulator that operates with purely spatial imagery. Importantly, the resulting

[16] The argument of Kiverstein (2009) that minimal selfhood is a consequence of the temporal structure of consciousness also supports of this view.

[17] One could argue that spatial imagery is in fact a type of modal imagery corresponding to some sort of "spatial sense", much as is the case for proprioception. Whether the corresponding type of imagery is considered as modal or amodal, however, is a separate question that is beyond the scope of this paper. The important point for the ISTH model of dreaming is that immersive, purely spatiotemporal hallucinatory imagery rather than, for instance, visual or auditory imagery is both necessary and sufficient for dreaming.

forward models can be run online to provide expectation of sensory feedback during perception, as well as offline, for instance during mental imagery or even dreaming. While amodal spatial imagery will often be accompanied by modality-specific imagery, Grush takes the amodal spatial emulator to be dissociable from the modality-specific emulators. The dissociation between spatial and visual representational systems for imagery was already shown by Farah et al. (1988). Based on the case study of a patient who was severely impaired in visual imagery tasks while performing normally on spatial imagery tasks, they suggested that these are in fact two functionally independent and neurologically dissociable subsystems of imagistic representation. According to the ISTH model, minimal dreaming is just such an example of amodal, purely spatiotemporal imagery occurring independently of modality-specific imagery.

2. Occurring in sleep or during sleep–wake transitions

   Almost all definitions of dreaming specify their occurrence in sleep, and many allow that vivid dreams can also occur during sleep onset or upon awakening. The association between dreaming and sleep, however, may be more conventional than conceptual. If ISTH turns out to occur during other conditions as well—for instance during coma, epileptic seizures, certain OBEs or metachoric hallucinations involving a substitution of the entire visual field (see Green and McCreery 1994)—one may want to extend the concept of dreaming beyond the borders of sleep to cover these types of experiences as well. For instance, an OBE involving not only a hallucinatory self but also a hallucinatory environment qualifies as ISTH.

   If there are robust and systematic phenomenological differences between ISTH occurring in sleep and those occurring in other conditions, it may be better to reserve the term dreaming for sleep dreams and to distinguish these from ISTH occurring independently of sleep. If not, one could extend the term dreaming to cover ISTH occurring independently of sleep as well. This is both a conceptual decision and an empirical question.

3. Under the assumption of reportability

   A third factor included in many definitions of dreaming is the relationship between dreaming and dream reports. This concerns not only their epistemic relationship but also the question of whether dreams can occur independently of recall altogether. This is not the trivial problem of what to say about dreams that were in fact forgotten, for instance because the subject did not pay attention to a vaguely recalled dream upon awakening. The deeper problem is whether to say that dreaming occurs even if subjects are not able to report any dreams under ideal reporting conditions and following repeated laboratory awakenings—for instance, from the stages of deep sleep or following a sudden loss of dreaming, as is often the case following lesions.[18] If this question is answered affirmatively (Cigogna et al. 2000; Esposito et al. 2004), it means that the dreams occurring in certain sleep stages and/or certain subjects are unreportable in principle and

[18] In his extensive review of the neurological literature on losses of dreaming, Solms 1997 presents compelling evidence that a partial or complete loss of dreaming cannot be reduced to memory deficits. A rare study of so-called nondreamers, who never recalled dreaming spontaneously and were unable to report dreams following repeated REM sleep awakenings, also suggested that the inability to report dreams is independent of mnemonic deficiencies. See Pagel 2003.

would not, in fact, be reported under ideal reporting conditions. This assumption, however, is deeply problematic. As Dennett (1976: 167) observed in relation to dreaming, the concept of experience without recollection would be hopelessly impoverished. John Locke (1997 [1689] II.I) also argued that the assumption that we dream throughout sleep or indeed have any conscious experiences that we are unable to recall is purposeless and urged in vain.

According to the pragmatic approach to dream reports, dream reports are not only epistemically transparent but dreams are also precisely those experiences that could in principle and under ideal reporting conditions be remembered and recalled upon awakening—whether or not they are in fact reported is a separate question. Understood in this sense, and in view of the central methodological importance of dream reports for empirical dream research, reportability is part of a minimal definition of dreaming.

Of these three conditions, (1) is the most important. If one wanted to extend the concept of dreaming beyond sleep, i.e., if the family resemblance between sleep dreams and ISTH occurring in other conditions is sufficiently strong, sleep would no longer be part of a minimal definition of dreaming. Likewise, if a reliable correlate of dreaming could be identified or if new research results made it plausible to assume that a failure to report dreams could be explained in terms of mnemonic deficits after all, reportability might be dropped from the definition. Though the latter point is improbable based on pragmatic considerations and existing research results, it is at least possible. In other words, only ISTH is part of any possible extension of a minimal definition of dreaming. Thus, ISTH is constitutive of dreaming.

Importantly, this minimal definition of dreaming can accommodate what is often called the multiplicity (Hunt 1989) of dreaming. Though a statistical description of dreaming in terms of its characteristic phenomenal, cognitive, and mnemonic features can be applied to a majority of dreams, dreaming is an inherently variable phenomenon, and according to the ISTH model of dreaming, these variations can be understood as occurring around a common phenomenological core. Importantly, ISTH defines dreaming independently of the characteristic features associated with REM sleep dreams and can also accommodate dreams occurring during sleep–wake transitions, i.e., at sleep onset or upon awakening. Though more closely associated with hypnagogia, sleep onset can also give rise to full-fledged and complex dreams, and hypnagogia can gradually shade into dreaming. While the precise moment of transition from hypnagogia to dreaming may be hard to pinpoint in some cases, this nonetheless provides a conceptual distinction and empirically testable hypotheses.

Linking dreaming to felt presence and full-body illusions in wakefulness and in the hypnagogic state

The concept of ISTH is closely related to the idea of nonsensory, spatial hallucinations discussed by William James in the *Varieties of Religious Experience*:

It often happens that a hallucination is imperfectly developed: the person affected will feel a "presence" in the room, definitely localized, facing in one particular way, real in the most emphatic sense of the word, [...] and yet neither

seen, heard, touched, nor cognized in any of the usual "sensible" ways (James 2003[1902]: 51).

The phenomenon of FP, which Nielsen (2007) considers as hallucinatory content of a purely spatial nature (but see Cheyne and Girard 2007), often occurs during sleep–wake transitions and sleep paralysis (SP; the experience of waking up and being unable to move, which is commonly explained by the persistence of REM-sleep-related muscular atonia after awakening; see Hishikawa and Shimizu 1995). FP has also been associated with a number of conditions independently of sleep, including epileptic seizures and lesions, especially in the temporoparietal areas; it can be induced experimentally through electrical stimulation and occurs spontaneously in periods of heightened stress and emotional arousal (see Nielsen 2007).

Whereas FP integrates a circumscribed spatial hallucination, typically of an intentional being, with an otherwise veridical perception of the environment, dreaming is characterized by the complete substitution of the spatiotemporal frame of reference, i.e. the appearance of an immersive hallucinatory behavioral space organized around an internal, purely spatiotemporal 1PP. This shows that dreams place the Jamesian idea of amodal spatial hallucinations on a more global level.

To the extent that dreams involve bodily experiences, dreams are similar to FBIs such as OBEs, which combine illusory self-location, as well as, potentially, the illusory experience of a double body with a more-or-less veridical perception of the environment (Blanke and Arzy 2005; Blanke and Mohr 2005), as well as illusions of mislocalization and misidentification with a virtual body in virtual reality setups (Lenggenhager 2009; Lenggenhager et al. 2007). Once more, sleep onset provides an interesting link because it also often gives rise to vestibular-motor experiences, ranging from feelings of floating or falling to full-blown OBEs. While OBEs have been associated with dreaming in general and lucid dreaming in particular (Irwin 1988; Blackmore 1988), autoscopic phenomena (or the experience of seeing oneself from the outside) seem to be relatively rare in the dream state; vestibular-motor sensations, in contrast, are abundant in dreams. The sense of hallucinatory (though unstable) self-location is also a hallmark of FBIs in wakefulness and dreams. This suggests a common model for OBEs, sleep onset experiences, as well as sleep dreams (Cheyne 2003, 2005).

Cheyne and Girard (2009) have argued that anomalous vestibular-motor experiences giving rise to out-of-body feelings may be precursors to a particular form of autoscopic experience associated with out-of-body autoscopy or the experience of seeing oneself from the outside as in the classical OBE. The prediction of the ISTH model, however, is that vestibular-motor experiences are not necessary to FP and FBIs but that there exist purely spatiotemporal variants involving neither vestibular-motor experiences nor visual hallucinations nor any other modality-specific hallucinations. As is the case for dreams, vestibular-motor experiences are closely related to out-of-body feelings but not strictly necessary. Though lacking the immersive quality of dreaming, spatiotemporal hallucination (STH) is the core of FP and FBIs during wakefulness and the hypnagogic state. This means that the common denominator these experiences share with dreaming is STH, which can additionally, as in dreams and certain OBEs, take an immersive form. It

also provides a conceptual framework that grounds the family resemblance between all of these states.

Based on the evidence so far, this story is plausible: as many as one third of SP experiences in the study conducted by Cheyne and Girard (2009) did not involve vestibular-motor experiences. FP, either during the hypnagogic state or following electrical stimulation (Arzy et al. 2006), also does not always involve vestibular-motor experiences, suggesting that there is indeed a purely spatiotemporal variant (as in the example described by James) that is neither vestibulomotor nor visual. Though the terms autoscopy and heautoscopy—seeing a double of oneself and seeing a double plus unstable self-location, respectively—suggest the involvement of a visual component, there are also purely spatiotemporal variants of FP in which the subject experiences a doppelganger or a double of herself rather than a non-self agent (Brugger 2006). So while these spatiotemporal variants can occur without visual imagery, the visual variant will also involve a sense of the doppelganger being located in space relative to the self, i.e., will have a spatial component as well. OBEs and FBIs[19] also do not always involve vestibular-motor experiences nor do they need to be visual (Cheyne and Girard 2009). Again, it is the alteration of the spatiotemporal 1PP that is crucial to the experience.

This is not to say that these experiences arise independently of bodily inputs. As is the case for dreaming, a plausible hypothesis for FP, for instance, is that it results from postural and kinesthetic own-body representations falsely localized in extrapersonal space (Brugger 2006). Though causally grounded in bodily inputs, the resulting experience may nonetheless have an amodal, purely spatiotemporal phenomenal character. For those cases of FP involving the presence of a non-self agent, this is particularly clear: the experience only involves spatial location of a non-self agent relative to the self. There is also other evidence that modality-specific inputs can trigger an illusory or hallucinatory experience in a different modality as well as spatial imagery. In the rubber-hand illusion (Botvinick and Cohen 1998) and FBIs in virtual reality setups (Lenggenhager et al. 2007; Ehrsson 2007), conflicting visual and tactile stimulation triggers illusory ownership for the rubber hand or virtual body and spatial mislocalization.

Thus, ISTH predicts that it will be this spatiotemporal component, understood in the sense of amodal, purely spatiotemporal hallucination that unites dreaming, FP, and FBIs. Whether or not to consider these instances of spatiotemporal hallucinations as immersive, as is the case for dreaming, depends on the degree of stimulus correlation with the actual environment: FP, for instance, will often be better conceived of as a non-immersive spatial hallucination relative to an otherwise veridical perception of the self and the environment.[20] If the subjective sense of location in an environment is not or only weakly constrained by real-body inputs and inputs from the actual environment, as may be the case in certain OBEs during wakefulness as well as sleep dreams, these experiences are better described as ISTH.

[19] In experimentally induced FBIs in virtual reality setups, for instance, subjects stand still throughout the illusion. See Lenggenhager 2009.

[20] This is not to say that these cases lack an immersive quality altogether: of course, there is a sense of immersion in the perceptual environment. What they lack is the experience of immersion relative to a hallucinatory environment.

It is also clear that all of these experiences involve an experienced *now* and often a sense of duration. While their classification as hallucinatory (rather than illusory) and more specifically immersive hallucinatory experiences will vary, the family resemblance of these different phenomena resides in their spatiotemporal quality.

Finally, the search for a common denominator linking dreams with FP and FBIs is also plausible with respect to their respective neural correlates. Specifically, both FP and OBEs have been linked to lesions in the temporo-parietal junction (TPJ) and have been experimentally induced through electrical stimulation of the TPJ (Arzy et al. 2006; Blanke and Arzy 2005; Blanke and Mohr 2005; Blanke et al. 2005). Based on an extensive review of the literature on the cessation of dreaming following brain lesions, Mark Solms (1997, 2000) has argued that the occipito-temporal-parietal junction is essential for dreaming; moreover, changes in regional activation patterns in this region in dreaming as compared to wakefulness, as evidenced by neuroimaging studies (Dang-Vu et al. 2007), have been linked to frequent shifts between the first- and third-person perspective.

Conclusions

With the ISTH model of dreaming, I offer a minimal definition of dreaming in terms of (1) ISTH, (2) occurring in sleep or during sleep–wake transitions, (3) under the assumption of reportability. This definition distinguishes dreaming from types of non-dreaming sleep experience such as sleep thinking, residual perception or hypnagogia while remaining open to a wide degree of variation in dreaming itself. ISTH also takes seriously first person reports of being *in* a dream vs. looking *at* hypnagogic imagery, and thus is easily identifiable in dream reports. At the same time, this is not a definition in terms of folk psychology, but a theoretically and empirically informed one. Finally, because ISTH is part of any possible extension of this definition, it is constitutive of dreaming. Thus, it may be possible to extend the concept of dreaming beyond sleep and independently of reportability, for instance to cover certain types of OBEs.

This minimal definition of dreaming is closely related to existing philosophical work, according to which dreaming like waking consciousness is characterized by the appearance of a world (Metzinger 2003; Windt and Metzinger 2007) and which emphasizes the fundamental importance of spatiality and of egocentric reference frames for conscious experience (Revonsuo 2006: 165ff and Metzinger 2003: 107ff and 299ff). On the ISTH account, the appearance of a world, as is true for the experience of a self, should be understood in a very minimal rather than literal sense, involving the activation of an immersive spatiotemporal reference frame that is partially phenomenally transparent and thus not experienced as a model but simply as real (for the concept of phenomenal transparency, see Metzinger 2003: 163ff). Dreams can involve the multimodal experience of a world in the literal sense as well, but the precondition for this—and if ISTH is correct, this may be a condition for conscious experience as such—is the activation of an immersive and partially transparent spatiotemporal reference frame. The hallucinatory (rather than perceptual) nature of this spatiotemporal reference frame is what turns the experience into a dream.

The difference between the ISTH model of dreaming and existing definitions, both in philosophy and empirical research, is that it locates dreaming at a more basic level. Furthermore, in conjunction with the concepts of phenomenal underdetermination and epistemic transparency, it questions the assumption that dreams typically involve full-fledged bodily self-experience. In contrast, a purely spatiotemporal 1PP or sense of self-location is sufficient to explain the prominent role of the dream self in a majority of dream reports. Moreover, it may be possible to understand those cases in which (detailed) bodily experiences arise in dreams as illusory perceptions of the physical body. In view of the well-documented modulating role of the sleeping body in hypnagogia and full-fledged dreaming, as well as the finding that intense dreams such as nightmares are often accompanied by body movements (Germain and Nielsen 2003), the assumption that bodily experiences in the dream state are not completely decoupled from bodily inputs but are still constrained and modulated by the physical body is also empirically plausible. In such dreams, in which functional disembodiment is less than complete, it may still be true that the physical body shapes the mind—and the phenomenally experienced body, as one might add (Gallagher 2005).

By linking dreams with FP and FBIs and identifying spatiotemporal hallucination as their common denominator, the ISTH model of dreaming suggests the need for an integrated research program on dreams and altered states of waking consciousness (Windt and Noreika 2010) and highlights the potential contribution of dream research to consciousness research (Noreika et al. 2010). It also emphasizes the need for a more careful analysis both of dream content, especially in terms of the variations of bodily self-experience in dreams, and its neurophysiological substrates. It generates testable hypotheses on the neural correlates of dreaming, by emphasizing the role of specific cortical regions, i.e., the occipital-parietal-temporal area, in bringing about dreams independently of sleep stages. It also suggests that amodal ISTH, even more so than motor and visual imagery, is constitutive of dreaming and a driving factor underlying dream formation. Likewise, non-immersive STH is proposed as the basis of FP and FBIs during wakefulness or sleep onset. For dream research, but also for empirical research and philosophical work on altered states and (bodily) self-consciousness in general, this is an important contribution.

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