and Ingemar Petersen (1973) suggested a consistent maturation of the nervous system in subjects without serious illness. Deviations from these norms due to learning disabilities, low socio-economic status, and/or illiteracy are detectable (Ahn et al. 1980; Harmony et al. 1990). In §32 of their target article, Elizaveta Solomonova and Sha Xin Wei consider theta as the fast desynchronized activity. However, this is in contradiction to the classical nomenclature of EEG rhythms, in which beta and gamma are traditionally the desynchronized rhythms (Niedermeyer & Lopes da Silva 2005).

« 4 » Innate EEG rhythms, their quantifiable activities and nervous system maturation mirrored in EEG, to mention only a few examples, could not be explained solely by an enactive approach since "individual sense-making and processes of production of meaning of the lived experience" (§5) could barely be said to be present in the neonate. In their abstract, Solomonova and Sha contend that "[t]his implies that dream experiences are neither passively lived nor functionally disconnected from dreamers' world and body." Clearly, in the above-mentioned cases, this cannot be sustained. While dreams and corresponding mental phenomena remain unknowable until verbal expression becomes possible, it can be asserted that some kind of organized internal neuronal stimulation is going on. The dependence of dreams on perception is also questioned in the case of neonates. Reports in the new neurophenomenology of dreaming would begin with verbal competence and perception, presupposing that a previously internal neuronal processing, at maturational and constrained intervals – such as critical periods – have reached a certain stage of development. Even if the enactive approach seems to accept a measure of innateism or pre-programmed development, a wider landscape will not weaken its position, but rather strengthen its neuroscientific side without diminishing its philosophical import. An innate structural apparatus is a necessity to begin with. To achieve "electric maturation," the brain needs environmental stimulation, nutritional input, and affective interaction and in this sense enaction would start in the uterus.

« 5 » The target article seems to suggest that neurophenomenology is a tentative discipline lacking a developmental framework. The need to integrate innate and developmental brain functioning has been outlined by Jean Piaget and should be crucial to the innate-maturational-environmental perspective of enaction and neurophenomenology. In the words of Solomonova and Sha:

> "When the brain activity is addressed and analyzed in context of the larger nervous system, including both autonomic and peripheral processes and afferent and efferent sensory systems, as well as direct contact with the world, *it can be seen not as a representation of an information-processing within the head*, but rather as a marker of dynamic processes involving the whole embodied subjectivity, embedded in the world, and affectively interacting with others." (§43; my emphasis)

« 6 » As I see it, some types of brain activity must be construed as an information-processing representation within the head. The above remarks of the target article are also correct. In this sense, the terms "embodiment" and "embrainment" are irrelevant, as neuroscience accounts for both even when the brain serves as the executioner of many psychological functions, and frontal development can explain a consecutive control of the body. Concerning "embrainment" and "embodiment," it should be underlined that "representation of an information-processing within the head" is not the only thing that neuroscientists have to demonstrate because the body, including the brain, can be shaped depending on the type of environment and its mutual interaction. A global multilevel understanding has characterized neuroscience for decades, as can be epitomized by Mark Rosenzweig's classic studies of enriched environments (Rosenzweig 1966).

« 7 » Solomonova and Sha's endorsement (§19) of the quantifiable methodology of Allan Hobson's group (§§17, 14) must be reconsidered. In these studies, "nightcaps" were used to obtain EEG, EMG and EOG signals at the homes of multiple subjects (Pace-Schott et al. 1994). Phenomenological questionnaires about quality of sleep and qualitative dream experiences such as bizarreness, flying, colored dreams, and other innumerable qualities were applied in healthy, deaf-mute, paraplegic, or schizophrenic subjects and in many other examples, always searching for further quantitative measurements (Scarone et al. 2008; Voss et al. 2011; for a review see Rosales-Lagarde et al. in press).

« 8 » The "depth" methodology may expand the "breadth" methodology (§3). Questions about how an experience happens are, as Solomonova and Sha point out, a form of metacognition that could be not be the dream itself, but rather an interpretation (see Díaz 2015). Nevertheless, exploring dream quality by means of interviews to search for temporality, perceptions, and emotions must be welcomed into dreaming research.

Alejandra Rosales-Lagarde has collaborated in projects about EEG and learning disabilities, and REM sleep deprivation and its effects on executive functions and emotional decision-making. She is also interested in the neuropsychology and psychophysiology of aging, the mind-body problem, and the methodological analysis of dreams.

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We Need to Go Deeper! Conceptual and Methodological Considerations on the Depth of Dream Experience

Jennifer M. Windt
Monash University, Australia
jennifer.windt/at/monash.edu

> Upshot • This commentary aims to sharpen the conceptual distinction between the breadth and the depth of dream experience. I discuss several possible readings and argue that the best one construes breadth and depth as distinct but complimentary research strategies distinguished not just by the kinds of evidence they rely on, but also by the degree to which different types of data are integrated and focused on the same experiential episode. I identify promising candidates for depth approaches and challenges for future research.

http://constructivist.info/11/2/407.solomonova

« 1 » In their target article, Elizaveta Solomonova and Sha Xin Wei take a bold and in many ways refreshing and thought-provoking perspective on scientific dream research. They defend a number of substantive claims about the prospects of explaining dreaming in an enactivist framework and raise methodological issues. The overarching theme is the concept of the depth of dream experience. To me, this was the most useful and original aspect of the article. So rather than focusing on potential points of disagreement, I will use this commentary to sharpen the distinction between the breadth and the depth of dream experience. I hope that in the end, it will become clear that this is more than an exercise in conceptual nit-picking. Ideally, we will end up with a more precise conceptual tool for categorizing existing dream studies and identifying promising strategies for future research.

Clarifying depth

The original distinction: Typical versus exceptional dreams or dreamers

« 2 » When the breadth/depth distinction was first introduced in relation to dream experience, it was described as a contrast between "what is 'typical' in dreams of a certain socio-cultural population (the 'breadth' of dreaming), [and] what is 'possible' in the dream state (the 'depth' of dreaming)" (Solomonova, Fox & Nielsen 2014: 1). The idea was that dream research can be split into (at least) two complimentary strands: laboratory studies involving timed awakenings immediately followed by dream reports are most useful to investigate breadth, and studies conducted with experts or specifically trained participants can help probe depth.

« 3 » A straightforward and initially appealing reading of the breadth/depth distinction is that it distinguishes between the typical features of a majority of dreams and specific types of dreams (such as lucid dreams) and/or rare dream experiences (such as pain; see Raymond et al. 2002). Within the *typical/possible*[1] (or perhaps more simply: *typical/exceptional* or even just unusual) distinction we can see, however, a number of further ones. The distinction between *typical versus exceptional kinds of dreams* is often, but not perfectly, aligned with that between *typical versus exceptional kinds of dreamers*. Investigating the exceptional dreams (confusingly sometimes called typical dream themes[2]) of the general population is a promising research topic in its own right, and lucid dream studies are sometimes used to investigate the typical aspects of dreaming in general (such as the neural correlates of sensorimotor dream imagery; Dresler et al. 2011) – though the generalizability of results from lucid to non-lucid dreams is controversial.

« 4 » Expertise, and more generally what defines groups of exceptional dreamers, also allows for different readings. One might investigate whether *expertise in a variety of waking activities* (such as gymnastics; see Sauvageau, Nielsen & Montplaisir 1998) is reflected in dream content. Or one might concentrate on long-term meditators, who have presumably acquired some kind of introspective expertise (Fox et al. 2012). *Expertise in observing experience* might, however, be different from *expertise in describing* those experiences retrospectively. Similarly, experts at inducing lucid dreams are not necessarily also expert dream reporters, and vice versa. One might even argue that the majority of laboratory dream studies already concentrate on expert participants of sorts: for purely practical reasons, dream studies tend to focus on participants with high dream recall – again raising questions about the generalizability of results (Domhoff 2013). Even without specific training in describing their dreams, *expertise in recalling dreams* might subtly bias research results. This is just to say that the initial breadth/depth distinction, construed as one between typical and exceptional dreams and/or dreamers, is rich and multifaceted.

Contextualizing depth: Depth, breadth, and existing approaches to dream reports

« 5 » Solomonova and Sha set out from this initial distinction, but expand it (§3), suggesting that where questions about breadth focus on the content of dreams (or what one was dreaming about), questions about depth focus on formal features (or how the dream elements appeared to the dreamer). In the *content/form* reading of the distinction, depth approaches focus on the experiential character of dreams. For instance, where a study investigating content categories might focus on dreams of family members versus unfamiliar characters, a formal approach would ask whether dream characters were identified through their behavior or visual appearance, or whether they were *just known* to be a particular person even though they did not resemble their real-life counterpart (Kahn et al. 2000). Importantly, dreams can be similar on the level of content, but different in their formal features.

« 6 » While the *content/form* distinction sits well with the broadly phenomenological perspective taken throughout the article, it is different from the breadth/depth distinction. The content/form distinction, as the authors note (§4), is already well-established in scientific dream research (Hobson 1988), and reintroducing it under a new label would not add to the discussion. It is also orthogonal to the typical/exceptional distinction: formal features can be typical or exceptional (for instance, visual imagery versus pain sensations), and the same applies to content categories. But perhaps most importantly, depth approaches go beyond the formal features of dreaming (§3). For example, investigating the memory sources of dreaming requires information on waking experiences and their temporal relation to dream content (§5).

« 7 » Before suggesting what I take to be the most constructive reading of the breadth/depth distinction, I wish to make a more general point. This is that breadth and depth are neither properties of dream experience nor of dream reports. Dream reports can have varying degrees of detail and specificity. For example, if I say that last night, I had a long and complex dream about George Clooney, my report would be highly specific, but not at all detailed. Still, for a study inves-

1| It is notoriously difficult to determine what is possible in dreams. In lucid dreams, attempts at reading, flipping on a light switch, seeing one's face in the mirror, etc. too easily end up as self-fulfilling prophecies, reflecting what the dreamer expected all along (Levitan & LaBerge 1993).

2| Examples are dreams of flying, floating, falling, being chased, taking an examination, etc. These dream themes are typical in that most people recall them on occasion; they are everyone's rare, but memorable dreams (Nielsen et al. 2003).

tigating, say, the occurrence of celebrities in dreams, this could be enough. Tweaking the optimal levels of detail and specificity in view of the respective research question is important, but tricky. Asking participants for free, detailed dream reports can, especially over longer periods of time, decrease motivation (Zadra & Robert 2012), while the use of specific questions (or affirmative probes; e.g., Merritt et al. 1994) enhances specificity, but may also introduce bias.

« 8 » Reports also vary in their expressive granularity. For instance, visual imagery can be described verbally, by producing a dream drawing, or by choosing among photographs with different degrees of color saturation and brightness (Rechtschaffen & Buchignani 1992). The resolution of verbal reports can also be enhanced by introducing specific experiential categories or even by developing such new conceptual tools together with participants (Lutz et al. 2002). Here, my point is only that the *detail-specificity-expressive granularity* distinction (Windt 2015a: ch. 3) does not align with the breadth/depth distinction. Determining the optimal levels of detail, specificity, and expressive granularity can benefit depth approaches – and may even play a role in training, by helping convey to participants what type of report is needed – but the same applies to breadth approaches.

« 9 » The breadth/depth distinction also does not describe different strategies for interpreting dream reports. Depth-analysis might, for instance, be thought to involve attempts to probe the hidden meaning of dream content or deeper levels of the unconscious mind, as in Freudian dream theory and popular culture.[3] The contrast would be to say that *a dream's meaning is transparent* to the dreamer: it lies on the surface and there is no need for further interpretation (Hobson 1988).[4] A related but slightly different sense is to say that *dream reports are transparent*: dream reports, at least when gathered under certain ideal conditions (including appropriately trained participants), are trustworthy sources of evidence about the occurrence and phenomenal character of dreams from the immediately preceding sleep stage (Windt 2013, 2015a). This last use is indeed crucial for both breadth and depth approaches – investigating dreams only makes sense if at least a subgroup of dream reports is regarded as trustworthy – but again this does not serve to distinguish between them.

Breadth, depth, and multi-level dream research: A constructive proposal

« 10 » The last and I think best way of constructing the breadth/depth distinction is to apply it to two types of research strategies. In this reading, speaking of the depth of dream experience is shorthand for a *multi-level, inclusive, and integrative research strategy*. Depth approaches aim to improve the conditions for gathering and reporting dreams (including training), but do not stop there; instead, they strive to relate first-person data from dream reports to various types of third-person data. Moreover, depth approaches are inclusive with respect to the types of data they take into account. While neurophenomenological paradigms, from which Solomonova and Sha take their lead, at least nominally focus on the relationship between first-person reports and neural activity, depth approaches cover other kinds of data as well. One example are studies on the dream-lag effect (Nielsen & Powell 1989; Blagrove et al. 2011), in which waking activity logs are used to identify the memory sources of dreams; another are studies investigating bodily experiences in dreams and their relation to muscle twitches, sleeping position, sleep behavior, or experimental stimulation during sleep (Windt 2015a: ch. 7 & 8). Finally, depth approaches are integrative in that they focus on different types of data in relation to the same dream – for instance by relating dream reports to polysomnographic measurements from the same sleep stage. This may sound trivial – but it is the point at which the contrast with breadth approaches becomes most evident.

« 11 » A large portion of scientific dream research, again for largely practical reasons, relies exclusively on dream reports. This single-level type of approach is, I think, a good example of what the authors mean by a breadth approach. In other cases, data drawn from different studies and different participant groups are used to inform a multilevel theory of dreaming. For example, theoretical work on the neural basis of dreaming often emphasizes that patterns of regional brain activation during REM sleep nicely match findings on the formal features of dreaming, such as the predominance of emotions and of visual and motor imagery (e.g., Desseilles et al. 2011). However, the neuroimaging studies that provide the input for these claims typically do not gather dream reports – or even ask participants whether they dreamt at all. These are best conceptualized as sleep-only studies; and while their fit with purely report-based studies of dreaming is compelling, the next step would be an integrative (or depth) approach, relating dream reports to neuroimaging data from the same sleep stage.

« 12 » In this reading of the breadth/depth distinction, the two approaches are complimentary. Breadth approaches focus on comparatively easy questions on which researchers can gather large amounts of data. In this way, they can help identify candidates for depth research, which aims at a more systematic and concentrated integration of first-person data with various types of third-person data from the same sleep stage or relevant to the same experiential episode. At least initially, because of its demanding nature, depth research is best conducted with small groups of trained participants. Where breadth approaches involve "expanding quantifiable categories of dream elements," depth approaches involve "zooming in on dream elements in order to explore their manner of appearance in temporal, spatial, and affective terms" (§3).[5] But ultimately, the aim should be to bring them into alignment, by deepening breadth and broadening depth.[6]

3| While this commentary's title is, of course, a play on *Inception*, this is a surface similarity only.

4| In the philosophical literature on dreaming, there is a similar debate on whether conceptual analysis can be used to uncover the hidden meaning or depth-grammar, for instance, of the concept of dreaming and its use in everyday language. See Malcolm (1962) for a famous example, and Putnam (1986) for a critique.

5| The breadth/depth distinction is also not, as Solomonova and Sha note (§3), reducible to the contrast between quantitative and qualitative studies: studying the quality of dream experience is itself a step towards expanding the quantifiable categories used for the investigation of dreaming.

6| The study of lucid dreaming is a success story in this respect (see §22). Based on the deac-

Future challenges

From expert participants to researcher-practitioners? Balancing expertise and bias

« 13 » Researchers may want to go even deeper, in several ways. There may be genuine added value in regarding specially trained participants as scientific collaborators, or, conversely, in researchers attempting to increase their own familiarity with the types of conscious states they are investigating (§§41f). Given the version of the breadth/depth distinction introduced here, however, it seems that there is no principled requirement for dream researchers themselves to be "practitioners of skillful dreaming" (§42f), for example, for lucid dream researchers to be lucid dreamers. Here, the challenge will be how to balance the potential benefits of expertise and firsthand familiarity with the risk of bias, and in some cases, bracketing one's own experience may be the most cautious approach. Progress on this issue could be made by carefully contrasting results not just from different types of expert participants and laypersons, but also from different researcher groups, including the new species of researcher-practitioners envisioned by Solomonova and Sha. For now, however, what exactly can be gained from dissolving the distinction between researchers and expert participants is an open question.

Expanding the breadth/depth distinction beyond dreams and sleep?

« 14 » Depth approaches might also be applied beyond dreams, including sleep onset and dreamless sleep. One example is Thompson's (2014, 2015a) proposal for investigating long-term meditators who report witnessing during deep, dreamless sleep. A next step would be to broaden the depth approach to further expert participant groups (Windt 2015c). Another example are serial awakening paradigms, which contrast dreaming and dreamless sleep within the same sleep stage (Noreika et al. 2009; Siclari et al. 2013). But it might also be useful to expand the breadth/depth distinction beyond sleep and dreaming altogether. Mind wandering and spontaneous thoughts in wakefulness, which appear to be closely related to dreaming (Fox et al. 2013; Windt 2015a), might be a good first candidate.

Probing the limits of depth?

« 15 » A key methodological challenge for depth approaches is to refine first-person reports and objective measurements, including sleep-stage scoring, in concert (Thompson 2014, 2015a; Windt 2015c). It is also possible, however, that the subtle aspects of sleep-related experience will ultimately remain elusive. Due to their retrospective nature, the expressive granularity of dream reports may lag behind that of waking reports. For instance, do dreams involve background bodily sensations such as awareness of posture, gravity, or proprioception (Nielsen 2011)? If the resolution of one type of data (and/or report) outruns that of another, there may be principled limits to increasing depth, even in expert participants. Exploring these limits would in itself be progress.

Jennifer M. Windt is a lecturer in philosophy at Monash University. From 2009–2015, she was an assistant lecturer and researcher in philosophy at Johannes Gutenberg University of Mainz and group manager of the MIND Group. Her research centers on philosophy of mind and philosophy of cognitive science, especially on the topics of dreaming, sleep, and self-consciousness.

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tivation of the prefrontal areas, especially the dorsolateral prefrontal cortex, in REM sleep and the comparative rarity of rational thought and self-reflection in non-lucid dreams, it has long been suspected that lucidity might be related to a selective reactivation of just those areas. This hypothesis is now supported by lucid dream studies that nicely fit the requirements of depth approaches (Voss & Hobson 2015 for review). The next step would be to broaden this approach to include instances of critical thought and self-reflection in non-lucid dreams, for instance by investigating the transition between non-lucid and lucid dreams in more detail (Voss et al. 2013; Windt 2015a).

Authors' Response

Towards a Neurophenomenology of Embodied, Skillful Dreaming

Elizaveta Solomonova & Sha Xin Wei

> Upshot • A successful program for an enactive view of dreaming would have to clarify phenomenal and neurophysiological similarities and differences between waking perception, imagination, and dreaming. An embodied and skillful view of the dream process would require careful investigation of somatic sources of dream content, including sensory incorporation, and global, indirect ways in which dream content reacts metaphorically to changes in bodily states. Neurophenomenology of dreams would benefit from developing dreaming-specific approaches to training researchers and participants in phenomenological methods.

« 1 » We would like to thank all the peer commentators for their insightful and constructive engagement with our target article. In our response, we will discuss the central themes that were addressed in the commentaries.

« 2 » Our target article focused on an idea that an enactive framework, paired with a practical neurophenomenological paradigm, is of particular benefit to dream research. We have proposed that dreaming, as a form of spontaneous imagination (Thompson 2014) during sleep, is an embodied process of sense-making. We contrast this position to the view, prevalent in cognitive science of sleep, that dreaming is an "embrained," passively lived hallucinatory or delusional experience (Rechtschaffen 1978; Hobson 2004; Gottesmann 2006).

« 3 » The target article encompassed two parts: an outline of a theoretical framework, and a set of practical strategies for research. We will follow the same structure in this response. Regarding an *enactive framework* for dream research, we will discuss:

- a central and, arguably, the most controversial, claim of our target article: that dreaming is a process of imagination,