Dreaming as a story-telling instinct

The Harvard community has made this article openly available. Please share how this access benefits you. Your story matters

<table>
<thead>
<tr>
<th>Citation</th>
<th>Pace-Schott, Edward F. 2013. Dreaming as a story-telling instinct. Frontiers in Psychology 4:159.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Published Version</td>
<td>doi:10.3389/fpsyg.2013.00159</td>
</tr>
<tr>
<td>Citable link</td>
<td><a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:11181194">http://nrs.harvard.edu/urn-3:HUL.InstRepos:11181194</a></td>
</tr>
<tr>
<td>Terms of Use</td>
<td>This article was downloaded from Harvard University’s DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA">http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA</a></td>
</tr>
</tbody>
</table>
Dreaming as a story-telling instinct

Edward F. Pace-Schott*

Department of Psychiatry, Harvard Medical School and Massachusetts General Hospital, Charlestown, MA, USA

*Correspondence: epace-schott@partners.org

Edited by:
Jennifer M. Windt, Johannes Gutenberg-University of Mainz, Germany

Reviewed by:
Jennifer M. Windt, Johannes Gutenberg-University of Mainz, Germany

Dreams create new stories out of nothing. Although dreams contain themes, concerns, dream figures, objects, etc. that correspond closely to waking life, these are only story elements. The story itself weaves these mnemonic items together in a manner far more novel than a simple assemblage or collage, producing an experience having a life-like timeframe and life-like (if often bizarre and impossible) causality (Pace-Schott, 2007; Hobson, 2009). It is as if one is immersed in another “reality” entirely of one’s own non-volitional, making (see Rechtschaffen, 1978). Given this phenomenology, it’s not difficult to see why some indigenous animist societies believe dreams represent a separate world parallel with waking life (Nielsen, 1991). But neuroscience offers some other explanations.

Recent speculations have focused on the brain’s “default network” as a possible neural substrate of dreaming (Pace-Schott, 2007, 2011a,b; Nir and Tononi, 2010; Wamsley and Stickgold, 2010; Domhoff, 2011). The default network consists of regions that, in the absence of exteroreceptive attention or narrowly focused mental effort, support self-directed concerns, immersion in one’s inner life (e.g., daydreaming) or imagining the inner life of others (Theory of Mind) (Buckner et al., 2008; Andrews-Hanna, 2012; Buckner, 2012). Most importantly for the current topic, the default network also simulates future scenarios and re-creates past ones drawing upon material in episodic, autobiographical, and semantic memory (Schacter et al., 2007; Schacter, 2012). Here I will suggest that such constructive activities of the brain represent a “hard-wired” tendency to represent reality in the form of narrative—a “story-telling” instinct or module.

The default network was originally identified using positron emission tomography (PET) as those regions showing task-induced deactivation (Gusnard et al., 2001; Raichle et al., 2001). Subsequently, it was discovered that temporal synchrony of low frequency (0.01–0.1 Hz) spontaneous fluctuations of the blood-oxygen dependent (BOLD) signal of fMRI identifies both anatomical and functional connectivity among regions of the default network (Fox and Raichle, 2007; Greicius et al., 2008). This network consists of (1) medial parietal areas: posterior cingulate (pCC) and retrosplenial (Rsp) cortices; (2) posterior-lateral areas: inferior parietal lobule (IPL), temporo-parietal junction (TPJ), lateral temporal cortex (LTC), temporal poles (TP); (3) medial temporal regions: hippocampal formation (HF), parahippocampal cortex (PHC); and (4) medial prefrontal areas: ventromedial (vmPFC) and dorsomedial (dmPFC) prefrontal cortices (Buckner et al., 2008; Spreng et al., 2009; Andrews-Hanna, 2012).

Resting state functional connectivity analyses of BOLD oscillations in waking have identified two default-network subsystems each of which fluctuates synchronously with central nodes in the pCC and anterior medial PFC (amPFC) but not with each other (Buckner et al., 2008; Andrews-Hanna et al., 2010; Andrews-Hanna, 2012). The dorsomedial prefrontal subsystem includes the dmPFC, LTC, TPJ, and TP whereas the medial temporal lobe subsystem includes the HF, PHC, Rsp, IPL, and vmPFC. The dorsomedial prefrontal subsystem selectively activates during experimental tasks involving reflection on one’s own mental state and that of others as well as other forms of social cognition (Andrews-Hanna et al., 2010; Mar, 2011; Andrews-Hanna, 2012). In contrast, the medial temporal lobe subsystem is selectively activated by retrieval of episodic and autobiographical memories as well as by imagination of future scenarios and concerns (Schacter et al., 2007; Andrews-Hanna et al., 2010; Andrews-Hanna, 2012; Schacter, 2012). The central nodes activate along with most tasks that recruit one or the other subsystem (Andrews-Hanna, 2012).

Synchrony of BOLD fluctuations among components of the default network persists into light (Drummond et al., 2005; Horovitz et al., 2008; Larson-Prior et al., 2009) and Stage 2 (Laufs et al., 2007) NREM sleep. However, in slow-wave sleep (SWS), frontal regions may uncouple from the rest of the default network (Horovitz et al., 2009; Samann et al., 2011, but see Koike et al., 2011). In one study examining REM, unlike both waking and NREM, there appeared a lack of connectivity between the dorsomedial prefrontal subsystem and the posterior central node of the default network in the pCC (Koike et al., 2011). Koike et al. speculate that this disconnection contributes to the illogic and bizarreness of dream cognition, as has also been suggested for loss of antero-posterior EEG synchrony in the fast, gamma (>30 Hz) frequencies during REM (Corsi-Cabrera et al., 2003, 2008).

Earlier PET and fMRI activation studies of sleep also showed distinctly different activity in medial limbic versus lateral association cortex during REM sleep. After sleep onset during NREM, widespread cortical and subcortical areas become less active (Braun et al., 1997; Maquet et al., 1997; Nozinger et al., 2002; Kaufmann et al., 2006). However, with the onset of REM sleep, midline limbic regions of the frontal cortex and subcortex reactive to levels equaling and sometimes exceeding those of waking, whereas lateral and posterior-medial cortical areas remain in a NREM-like deactivated state (Maquet et al., 1996, 2005; Braun et al., 1997, 2006; Wamsley and Stickgold, 2010; Domhoff, 2011; Andrews-Hanna, 2012).
However, story-like structure may also be experienced as organized, multimodal hallucinations (Hobson, 1999; Pace-Schott, 2007, 2011a). Of course, hallucinosis differentiates dreaming and confabulation as does the fact that vmPFC/pmOPFC damage leads to confabulation whereas its activation accompanies dreaming. Nonetheless, in both phenomena, involuntary generation of an organized, fictive narrative entirely lacking insight suggests that they may share neural mechanisms. Possibly, the loss of pre-frontally mediated reality monitoring, due either to pmOPFC damage in confabulation or lateral frontal inactivity during dreaming, may release narrative-production mechanisms from inhibitory restraint.

But what about normal narrative production? Braun et al. (2001) performed PET conjunction analysis to identify modality-independent regions activated by storytelling in both English and American Sign Language. Although activity was shared in widespread medial and lateral cortical areas, medial prefrontal activation could be most directly related to the generic production of narrative discourse apart from the imagery, lexical, and memory processes shared by the two modes of storytelling (Braun et al., 2001). Therefore, portions of this same network may be engaged in volitional storytelling (see Mar, 2004 for review).

However, this putative storytelling module expressed as dreaming or confabulation rarely yields levels of organization equal to volitional narrative. For example, discontinuities in dream plots are sufficiently common that judges are unable to distinguish artificial reports created by splicing together text from different dreamers’ reports from intact dreams (Stickgold et al., 1994). Nonetheless, the brain may attempt to impose wake-like temporal causality on any experience, real, or imagined. Dream hallucinosis itself may generate low-level narrative coherence by associative processes in which images evoke related images (see Rittenhouse et al., 1994) that are successively woven together by this putative tendency to organize experience as a story (Pace-Schott, 2005). In dreaming, diminished capacity for working memory, due to lateral prefrontal inactivity, may prevent reflection upon immediately past events leading to an unquestioned, forward progression of the plot as well as frequent narrative divergence. Interestingly, recent studies of lucid dreaming have shown both return of wake-like, gamma-frequency activity in
the lateral PFC (Voss et al., 2009) and re-
activation of portions of posterior default
network along with lateral parietal, pre-
frontal, and occipito-temporal regions
(Dresler et al., 2012).

So what might this storytelling mod-
ule operating during dreams suggest to
individuals wholly unfamiliar with neuro-
science and scientific psychology? A keen
interest in dreams among some hunter-
gatherer societies is exemplified by the
practice of dream sharing (Wax, 2004).
Dreams are sometimes recounted as ex-
periences from another, parallel existence.
For example, The Amazonian Ese Eja
believe that, during dreaming, their spirit
inhabits a parallel world populated by
other spirits, including those of animals
(Peluso, 2004). Similarly, the Amazonian
Mehinaku believe each individual con-
tains several types of souls distinct from
their waking selves, one of which, the
"eye soul," is active during the night expe-
rriencing dreams but sleeps during the
day (Gregor, 1981). Similarly, among the
Andamanese Ongee society, discussion of
sensory details from multiple individu-
als’ dreams is used to build consensus as
to the probable locations of seasonal
food sources (Pandya, 2004). Therefore,
recalled dreams provide a ready source of
story-like narrative that can acquire cul-
tural significance equal to or exceeding the
retelling of waking events.

Basic human storytelling tendencies are
widely postulated (e.g., Schechtman,
1996; Nigam, 2012; Stafford, 2012). By
providing a template into which any expe-
rience, real or imaginary, can be inserted,
story-telling may be one way the brain
evolved to efficiently represent and
record waking experience. Evolution may have subsequently exploited this capacity for
multiford purposes including future simula-
tion. Hobson’s (2009) protocon-
sciousness theory, describes how dreams
adaptively support waking consciousness.
Similarly, evolution may have exploited
dreamed scenarios to rehearse survival
strategies (Revonsuo, 2000). In indige-
nous societies, story-like structure may
have facilitated integration of dream phe-
nomena such as parasomnias (e.g., sleep
paralysis, see Cheyne, 2003), lucidity, par-
tial awakenings and dream bizarreness into
existing belief systems, or even to create
new beliefs and legends (see Nielsen, 1991).

ACKNOWLEDGMENTS
NIMH R21MH090357. Thanks to Deirdre
Barrett, Ph.D. for helpful suggestions.

REFERENCES
Andrews-Hanna, J. R. (2012). The brain’s default net-
work and its adaptive role in internal mentation.
Neuroscientist 18, 251–270.
Andrews-Hanna, J. R., Reider, J. S., Sepulcre, J.,
Poulin, R., and Buckner, R. L. (2010). Functional-
anatomical fractionation of the brain’s default net-
Braun, A. R., Balkin, T. I., Wesensten, N. J., Carson,
R. E., Varga, M., Baldwin, P., et al. (1997). Regional
cerebral blood flow throughout the sleep-
wake cycle. An H2O PET study. Brain 120(Pt 7),
1173–1197.
Braun, A. R., Balkin, T. I., Wesensten, N. J., Gwadry, F.,
pattern of activity in visual cortices and their pro-
tections during human rapid eye movement sleep.
Science 279, 91–95.
Braun, A. R., Guillemin, A., Hosey, L., and Varga,
M. (2001). The neural organization of discourse:
a H2O-15O-PET study of narrative production in
English and American sign language. Brain 124,
2028–2044.
Buckner, R. L. (2012). The serendipitous discovery
of the brain’s default network. Neuroimage 62,
1137–1145.
Buckner, R. L., Andrews-Hanna, J. R., and Schacter,
D. L. (2008). The brain’s default network: anatomy,
function, and relevance to disease. Annu. N.Y. Acad.
Sci. 1124, 1–38.
Cheyne, J. A. (2003). Sleep paralysis and the structure
of waking-nightmare hallucinations. Dreaming 13,
163–179.
verbal reports of mental sleep experience after
awakening in REM sleep. Sleep 15, 133–142.
like organization of dream experience in different
periods of REM sleep. J. Sleep Res. 7, 13–19.
Corsi-Cabrera, M., Guevara, M. A., and Del Rio-
coupling related to eye movements during REM
sleep: EEG and MEG results. Brain Res. 1235,
82–91.
Corsi-Cabrera, M., Miro, E., Del-Rio-Portilla, Y.,
Perez-Garcí, E., Villanueva, Y., and Guevara,
M. A. (2003). Rapid eye movement sleep dreaming is
characterized by uncoupled EEG activity between
frontal and perceptual cortical regions. Brain Cogn.
dreaming: is it a subsystem of the default network?
Dresler, M., Wehrle, R., Spoormaker, V. I., Koch, S. P.,
Holsober, F., Steiger, A., et al. (2012). Neural corre-
lates of dream lucidity obtained from contrasting
lucid versus non-lucid REM sleep: a combined
Drummond, S. P., Bischoff-Grethe, A., Dinges, D. F.,
The neural basis of the psychomotor vigilance task.
Sleep 28, 1059–1068.
fluctuations in brain activity observed with
functional magnetic resonance imaging. Nat. Rev.
Neurosci. 8, 700–711.
Gilboa, A., Alain, C., Stuss, D. T., Melo, B., Miller,
spontaneous confabulations: a strategic retrieval
Gregor, T. (1981). "Far, far away my shadow wandered . . .": the dream symbolism and dream
theories of the Mehinaku Indians of Brazil. Am. Ethnol.
8, 709–720.
Greicius, M. D., Supekar, K., Menon, V., and
covariability reflects structural connectivity in the
default mode network. Cereb. Cortex 19,
72–78.
Gusnard, D. A., Raichle, M. E., and Raichle, M.
Neurosci. 2, 685–694.
Hirstein, W. (2005). Brain Fiction, Self Deception and
the Riddle of Confabulation. Cambridge, MA: MIT
Press.
Hobson, J. A. (2009). REM sleep and dreaming:
Neurosci. 10, 803–813.
consciousness of sleep: neuronal systems,
3, 679–693.
Hobson, J. A., Pace-Schott, E. F., and Stickgold,
R. (2000). Dreaming and the brain: toward a
cognitive neuroscience of conscious states.
Behav. Brain Sci. 23, 793–842. discussion:
904–1121.
Horovitz, S. G., Braun, A. R., Carr, W. S., Picchioni,
Decoupling of the brain’s default mode network
106, 11376–11381.
Horovitz, S. G., Fukunaga, M., De Zwart, J. A., Van
Low frequency BOLD fluctuations during
resting wakefulness and light sleep: a simultane-
ous EEG/ fMRI study. Hum. Brain Mapp. 29,
671–682.
Kahn, D., Stickgold, R., Pace-Schott, E. F., and
Hobson, J. A. (2000). Dreaming and waking con-
sciousness: a character recognition study. J. Sleep
Res. 9, 317–325.
Kaufmann, C., Wehrle, R., Wetter, T. C., Holsober,
F., Auer, D. P., Polinacher, T., et al. (2006). Brain acti-
vation and hypnagogic functional connectivity
during human non-rapid eye movement sleep: an
Koike, T., Kan, S., Misaaki, M., and Miyatachi,
S. (2011). Connectivity pattern changes in default-
mode network with deep non-REM and REM
Larson-Prior, L. J., Zempen, J. M., Nolan, T. S., Prior,
Cortical network functional connectivity in the
106, 4489–4494.
‘Brain activation and hypnagogic functional
connectivity during human non-rapid eye move-
ment sleep: an EEG/ fMRI study’—its limitations

www.frontiersin.org
April 2013 | Volume 4 | Article 159 | 3
Human regional cerebral glucose metabolism during non-rapid eye movement sleep in relation to waking. Brain 125, 1105–1115.


