

EDITORIAL ARTICLES

Rethinking the Fundamental Processes of Dream and Sleep Mentation Production: Defining New Questions, that Avoid the Distraction of REM versus NREM Comparisons

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The Aserinsky & Kleitman (1) discovery of the strong, but not perfect, association between sleep state and dreaming initiated a half century of unparalleled productivity in dream research. But that productivity has not yielded the advance in the understanding of dreaming that we had hoped for 50 years ago. I would like to take this opportunity to comment on this effort and to make some recommendations for future research on dreaming.

Our conception of dreaming, both across the centuries and within contemporary times, been almost totally dependent on advances in neighboring fields of science. Back in early Athens when Greece medicine was dominated by dream interpreters who translated the messages from the spirit world, it was the persuasion of Aristotle and his colleagues to find explanations in nature that led Hippocrates to hypothesize that dreams might identify the latent symptoms of physical illness. Now 2,500 years later, with a technology that Hippocrates would have died for, Schredl et al. had provided strong evidence for this idea. The burst of activity in the last half century may be credited to advances in the measurement of brain activity and, most recently, in the field of cognitive neuroscience.

But the strength of cognitive neuroscience depends on methods that associate brief intervals (< 5 sec) of brain activity with the

presentation of external stimuli. Although dream "incorporation" studies share some of the advantages of these waking procedures, no experiments of this type have been carried out in recent years. Nevertheless, it is generally assumed that the content of the dream is largely independent of external stimuli so that the inability to employ this powerful experimental tool to study dreaming has not been not deeply regretted.

Moreover, the association between the sleep stage REM, and dreaming was, and is, so strong that most investigators assumed that with improved accuracy in the measures of the neurophysiological processes, a perfect association between dreaming and neural processes would eventually be found. The implicit assumption here was that if such an association were found, it would somehow explain the process of dreaming itself! It is instructive to note that even today we know relatively little about how the mind-brain creates sequences of imagery, thought and affect in the waking state so that models of waking mentation offer us only speculative working hypotheses about how dreaming is carried out. But at the peak of the search for the cognitive-neural dream association - 1970-1980, we knew even less. The hope that discovering a neural-cognitive link that was unique to dreaming was therefore pretty much a matter of blind faith.

This search became confounded as the attempt to identify the neurophysiological correlates of dreaming was translated into the attempt to identify the cognitive correlates of REM versus NREM sleep. Mentation reported from REM sleep is discretely and strongly more dreamlike than that from NREM sleep (2). That

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does not mean, as some assume, that dreaming is the exclusive property of REM sleep. Antrobus, Kondo, Reinsel, & Fein (3) showed that the leading edge of the diurnal wake-sleep cycle, in subjects whose sleep onset and REM-NREM mentation report times were delayed by 3 hours, accounted for a magnitude of dreamlike imagery that was 1/3 that of the REM-NREM effect. This finding supports the position that dreaming is not exclusively linked to the REM-NREM dimension. Nevertheless, as we learn more about the neurophysiological characteristics of these two states we are make better models about how they produce the differences in dreaming that they do. But there are two serious negative consequences of this effort.

The first is that when the research focus is narrowed to cognitive characteristics that distinguish sleep states, some of the more important questions about dream formation may be neglected. The questions that sparked our initial curiosity about how dreams are created, tend to be forgotten. Other questions that should be raised simply aren't. For example, studies of the cognitive correlates of sleep stage focus primarily on the modality of the reported imagery - visual, or auditory, and bizarreness - the probability of the relations between two or more image features. Important as these studies are for the understanding of the dreamlike characteristics of sleep states, they may inadvertently distract us from asking and testing more fundamental questions about the nature and function of dreaming.

Working within the theoretical framework of psychoanalysis, Solms (4) has once again emphasized the motivational character of dreaming. Aside from the work of Ellman (5) and his students who worked on animal models of REM sleep and drives, and Cartwright and her colleagues (see this issue), this fundamental characteristic of dreaming has not been well-studied. Furthermore, an explicit model of how drive, motives, or personal concerns act to produce the dream has never been described.

Consider for a moment the assumptions upon which dream interpretation is based. The interpreter starts with a reported sequence of dream events, and attempts to infer back to the motivations that were the assumed cause of the dream images. The interpreter implicitly assumes that the inferred motive was the cause, the initiator, for the production of the imagery sequence. In the waking state, on the other hand, our motivational states may determine

our verbal images - "thoughts" - and our motor actions, but not our visual images - our "percepts"- which are controlled largely by input from the retina - input that is absent in sleep. If they don't control visual percepts in waking, it's less than plausible that they do so in sleep.

In my 1991 Psychological Review paper (6), I showed how a computational model of a brain attractor processes could quite easily generate imagery in the absence of any input from an external source, or input from another brain region; its "image" could also be constrained by activity in neighboring brain regions. This neural network, computational model also allows for interactions between visual image production and motivation and goal structures that are not possible within the traditional motive-to-image model. For example, the raw visual-spatial features of an image may be generated in the parietal cortex and passed forward to the temporal and frontal regions where they are "recognized" - though not named, and to the limbic system where their significance as a threat or personal significance is determined, and back to the motor cortex where the decision to run, fight or just watch is executed. In this dream sequence, the dreamer's interpretation of the image and the response to it may provide evidence about the motivational characteristics of the dreamer, but the properties of the visual image may be independent of those motives. In other examples, the dreamer may dream a response to the visual image, and later be unable to "find" the image. This implies that the visual image has a origin of its own. It may not be modified by the motivational characteristics that determine the dreamer's reaction to the initial image.

But the collaboration between image, motive and action may vary within a dream depending on the magnitude of disconnection versus interaction among different brain regions. If interaction is high, motive and motor action in the dream may collaborate to jointly modify the visual features of a visual image. If not, the model in the previous paragraph may hold.

In waking perception-response sequences, regions of activation change rapidly across different brain regions as successive steps in a novel sequence are executed. One might assume that a similar relationship holds in dreaming sleep. But in sleep, our best measures of brain activation are static activation maps based on averages across sustained time intervals within a dream interval, and across

many dreamers. It is perhaps the static character of these maps that writers who have speculated about the relation of the functional architecture of the brain during sleep have neglected to take account of the sequential character of mind-brain processes. In conclusion, this nature of this sequence has strong implications for any theory of dreaming, and we know almost nothing about it!

Space does not permit me to describe other issues that I think are basic to our understanding of dream process. But I think this one issue alone illustrates my argument that our extended efforts to describe the cognitive characteristics that differentiate REM from NREM sleep have distracted us from defining the more fundamental questions about how dreaming and other classes of sleep mentation are produced, and from then attempting to experimentally answer these questions.

One of the consequences of using sleep mentation reports to test ever more complex questions, is that increasingly larger data sets are required. The greater statistical power of larger data sets is demonstrated by the Natale et al. paper in this issue, which uses 645 dream reports obtained from the Bologna University Department of Psychology, and the Hartmann, et al. study which used 1401 reports from the authors' lab.

The biggest problem for every dream researcher is the high cost of collecting data.

For this reason, the sample size for most dream studies is close to about 20 subjects for a total of, say, 80 reports. Because reports from the same subject are not independent, the degrees of freedom in these studies is a function of the number of subjects, of course, not the number of reports. And if some subjects produce different proportions of dreams in different conditions, differences among subjects and conditions are confounded.

One partial solution to the cost issue is to establish an international sleep mentation data base that is available to all investigators. Such a plan is being developed for brain imaging data which is very costly to collect. Why not do the same for dreaming? Reports could be classified by sleeper, sleep stages, time of night and other experimental variables, as well as a host of subject characteristics such as gender, age, psychological test variables, and life stressors such as those reported by Schredl et al., Hartmann et al., and Cartwright et al. in this issue. They could be translated into several languages. I suggest that such a Dream Report Library be administered by a group of young investigators from labs that have already acquired large data sets. I would be happy to contribute data from at least 100 subjects, and to compile a list of volunteers to administer the project. If that includes you, e-mail me at <john@psyche.socsci.cuny.cuny.edu>. And thank you.

REFERENCES

1. Aserinsky E, Kleitman N. Regularly occurring periods of ocular motility occurring during sleep. *Science* 1953;118:273-274.
2. Antrobus JS. REM and NREM sleep reports: comparison of word frequencies by cognitive classes. *Psychophysiology* 1983;20:562-568.
3. Antrobus J, Kondo T, Reinsel R, Fein G. Summation of REM and Diurnal Cortical Activation. *Consciousness and Cognition* 1995;4:275-99.
4. Solms M. Dreaming and REM sleep are controlled by different mechanisms. *Behavioral and Brain sciences* 2000;23(6):XXXX-XXXX.
5. Ellman SJ, Weinstein LN. REM sleep and dream formation: A theoretical integration. In: Ellman S, Antrobus JS, eds. *The mind in sleep*. (2nd edition). N. Y.: Wiley Interscience, 1991;466-488.
6. Antrobus J. Dreaming: Cognitive processes during cortical activation and high afferent thresholds. *Psychological Review* 1991;98:96-121.