CREATIVITY AND CHAOS WHILE WAKING AND DREAMING

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INTRODUCTION

This paper looks at the dynamics of creative cognitive activity by examining waking and dream processes that are often thought of as pathological and counterproductive but may, in fact, be healthy and useful.

During waking states, there is evidence suggesting that there are healthy benefits for creativity, even in the context of bipolar spectrum mood disorders, as well as in daily life; yet creativity may be pathologized and misunderstood because of its assumed links with pathology or "abnormalities"—even when this creativity serves a healthy purpose. Furthermore, creativity is sometimes pathologized or stereotyped for people without a bipolar diagnosis—for example, the unkempt inventor, the absentminded professor, the antisocial artist—and these stereotypes may include young people whose nonconformity is not always understood or appreciated. Meanwhile, creative functioning may be very valuable indeed, and may be further understood using dynamic models of brain function including "edge of chaos" phenomena, certainly as a metaphorically and perhaps as a psychoneurological descriptor. In view of these data, society might value innovative "divergence" rather than assuming that deviations from what is "normal" are invariably "pathological." Indeed, creative personality traits may be useful predictors for the enhanced generation of divergent thought, perhaps because a greater proximity to the "edge of chaos" provides a useful fit with nonlinear dynamic models.

In dreaming, one may see certain of these phenomena in even bolder relief, where our sensory world and the usual rules of logic are suspended, yet valuable insights may emerge--including highly "divergent" processes that to be worked through in dreaming, at times, and sometimes upon waking where "convergent" processing can occur.

However, some writers see dreaming as no more than random patterns due to random brain activity, rather than an intentional process holding potential meaning. Meanwhile, although dreaming may have random elements, one can also discover patterns of content for which the meaning has potential social as well as individual significance. These patterns are not only suggestive of immediate value, but of potential value because they were adaptive during the course of evolution. It is likely that further clarification of nonlinear dynamical processes and the balance between divergent and convergent forces can further reveal the healthy potentials of our creative minds, during both waking and dreaming states.

Most Asian, African, Native American, and other indigenous traditions used creative imagination to enrich and enhance everyday life; original contributions were typically seen as gifts from deities or spirits who used humans as their "channels." These insights would often come in nighttime dreams or daytime visions and were thought to recreate divine truth. In some of these societies, individuals who produced something unprecedented (such as a mask or weapon) would be hailed as heroes, but in others they would be censured for breaking with tradition. Women's creativity was undervalued for centuries and they were given few educational opportunities or life circumstances on which creative productivity depends; this situation still characterizes many contemporary countries where innovations are suspect, especially if women are the innovators.[1]

The English word "creativity" is a social construct that has been linked with the concept of "origin" itself (from the Latin *creare*, to make, and the ecclesiastical Latin *creator* or Creator). Some researchers and theorists focus on creative *products*, requiring that they be of social value or have attained some other type of consensual validation if they are to be called "creative." Others emphasize the *process* by which the products (artwork, technology, concepts, etc.) come into being or the *milieu* in which they emerge. Others conceptualize creativity as reflecting the unique *achievement*, *ability*, and/or *attitude* of a person or a consortium. In each of these perspectives, there can be levels of accomplishment, utility, or originality, implying that some persons or groups can be more or less creative than others. The concept of *everyday creativity*[2] directs attention to creative outcomes in office management, child-rearing, home repairs, food preparation, or community service, as well as the "dark side of creativity" characterizing the all-too-frequent acts that are innovative but destructive. Thus, from a Western standpoint, "creativity" is a term that can be used to describe the process of bringing something new into being by becoming sensitive to gaps in human knowledge, identifying these deficiencies, searching for their solutions, making guesses as to a potential solution, testing one's hypotheses, and communicating the final results.

This paper will be written through a Western lens, keeping in mind that dream reports are honored and valued in several contemporary cultures that take different approaches to their cultivation and use (e.g., Korea, many Native American tribes, and various countries in the Middle East).

CREATIVITY FROM THE PERSPECTIVE OF CHAOS THEORY

The creative process is imperfectly understood. It may occur in a planned sequence or spontaneously, and/or may be intentional or largely unconscious. Herein we take several concepts from non-linear dynamics in an attempt to illuminate certain aspects of the understanding of the creative process, the creative person, the creative product, and the creative environment from the perspective of Western science.
(a) During waking states, there is evidence suggesting that there are healthy benefits for creativity even in the context of bipolar spectrum mood disorders as well as in daily life.

"Everyday creativity," the originality of everyday life, is defined using two criteria: originality and meaningfulness.[3] There needs to be novelty, and the outcome needs to be communicated to others. Such creativity has been adaptive in the course of human evolution.[1] The Lifetime Creativity Scales of Richards et al. [2]not only look at everyday creative *outcomes*, but consider originality in creative *process*, or in what way an activity is conducted, as part of the assessment. One can do many tasks in innovative versus conventional ways (e.g., teaching a class, repairing a car, fixing a meal, writing a report at the office).

LCS make norm-referenced assessments of how people manifest *everyday creativity*, or originality across a broad range of activities at work and leisure; the scales show high inter-rater reliability and multiple indications of construct validity.[3] LCS allow rough comparisons among people in unselected populations, such that one need not study creators who are only writers, or artists, or entrepreneurs. One can select individuals on other variables (such as psychopathology) and look at creativity as a broad-based, real-life outcome variable.

(b) Creativity may be pathologized and misunderstood because of its assumed links with pathology or "abnormalities"—even when this creativity serves a healthy purpose. Furthermore, creativity is sometimes pathologized or stereotyped for people without a bipolar diagnosis—for example, the unkempt inventor, the absentminded professor, the antisocial artist—and these stereotypes may include young people whose nonconformity is not always understood or appreciated.

The LCS-approach permitted a new look at the age-old question of whether *everyday creativity* is enhanced in those people with diagnosed bipolar spectrum mood disorders or associated conditions,[4] whereas much of the previous researches have too often focused only on celebrated people (e.g., Jamison, 1993). The answer was more positive than reported in previous studies. Richards and her associates used a model for *compensatory advantage*, as in sickle cell anemia, where the homozygous individual can be severely ill, yet the carrier may have a mild anemia at best. The *compensatory advantage* is found in such unexpected places as resistance to malaria.

Ruth Richards and her associates speculated that everyday creativity, in turn, might represent a compensatory advantage to people with familial risks for bipolar disorders. These familial risks may have a strong genetic component (although the genetic model would likely be more complex than that for sickle cell anemia). Despite great pain and human suffering, these mood disorders have remained stable in the population across time and geographic regions.[5]

Richards and her associates compared severe and moderate bipolar spectrum disorders (bipolar I and cyclothymia) among relatives and controls without the bipolar diagnosis.[6] In addition, they asked people diagnosed with bipolar spectrum disorders for their preferred mental states for creating. In fact, the data supported the hypothesized *compensatory advantage* related to bipolar family risk. The *advantage* for creativity appeared to peak during relatively better functioning conditions on the bipolar "spectrum" (e.g., cyclothymia, a trait variable), and especially during mild mood elevation (a state variable). Here is a potentially healthy outcome. So why might creativity in this context (or in general) sometimes be considered somewhat unhealthy and even harmful? Can dynamical systems thinking help here?

Krippner[7] has noted how the ontology of the mind exhibits bifurcations characteristic of nonlinear dynamical systems. Might moments of creative insight, the renowned "Aha" moment of creative process, even involve bifurcation and "edge of chaos" reconfigurations of mental possibilities?[8] Animal models (e.g., Skarda & Freeman, 1987) suggest, for example with novel odors and the olfactory bulb, that far-from-equilibrium mental systems may rapidly generate new attractors related to novel stimuli. An extension of this phenomenon would suggest the generation of new attractors during state and trait variables of people with diagnoses that categorize them as psychopathological. For these individuals, creative functioning may be very valuable indeed, and may be further understood using dynamic models of brain function including "edge of chaos" phenomena, certainly metaphorically (e.g., Moran, 2009) and perhaps even as a psychoneurological descriptor (e.g., Rossi, 2004).

(d) In view of these data, society would do better to value innovative "divergence" rather than assuming that deviations from what is "normal" are invariably "pathological."

Goertzel suggested that the psyche can manifest highly patterned strange attractors—we can think of these as dynamic branching figures in phase space—for associative memory, for example.[9] Included can be hierarchies of attractors—where clusters of ideas form further self-similar clusters. Hardy refers to these as networks of meaning.[10] Gruber and Davis also use a developmental approach involving

multicomponent systems comprising networks, both within the mind and among individuals.[11]

Abraham noted how the balance of forces of convergence and divergence within one's psyche may provide necessary conditions for creative cognitive chaos.[12] He suggested, for "creative cognition…that there is a range of optional dimensionality…in the mid-dimensional range. This process is autopoetic, (and) self-organizational".[13] In fact, a balance of *divergent* and *convergent production* abilities, as in the work of founding creativity researcher J.P. Guilford,[14] a well-known equation for creativity,[15] may be related to Ernst Kris's "regression in the service of the ego." One must generate novelty within the context of sufficient control and executive functioning, to hold thoughts and feelings together, creative work that needs to be adapted to real-world needs.[16] It might follow that, with too little or too much convergent processing, the balance might tip from adaptive creativity toward more pathological patterns of thought and behavior. Similarly, with too little or too much exploration of alternative solutions to problems, the balance may be upset between convergent and divergent thinking, and one moves outside the mid-dimensional chaos that is optimal for useful, healthy creativity.

To summarize, some aspects of systems theory that may give at least metaphoric clarity to understanding creativity: creative systems seem to require mid-dimensional chaotic complexity as a necessary (but perhaps not sufficient condition) for healthy creativity. Such conditions are achieved through a mixture of interactive forces, some toward an attractive surface (or hypersurface) or within it; some divergent, either away from an attractive surface, or within it. The convergent forces must win for an attractor to exist, but must have some balance to achieve mid-dimensional chaos. For bifurcations to occur, there needs to be movement away from stable attractors to the unstable conditions near and at the bifurcation point ("far from equilibrium"), and intentional systems achieve this through self-control (self-organization, *autopoesis)* as well as environmental conditions, what we have called "navigation in parameter space". Bifurcations from non-chaotic attractors to chaotic ones are sometimes called "on the edge of chaos," but bifurcations from one type of chaotic attractor to another may well be important for a bifurcation sequence to chaotic attractors playing home to healthy creative solutions.

In other words, the peaking of everyday creativity among so-called "better functioning" individuals with a bipolar diagnosis or during milder mood states (e.g.,, cyclothymia, above average mood elevation) could represent an optimal balance within risk for these disorders where certain advantages (e.g., rich associations, emotional resonance, and higher energy and motivation during mild mood elevation) can peak without loss of the adaptive function needed to utilize them. In Barron's terms, these creative products could be both original and meaningful.

This *compensatory advantage* needs further understanding, and may offer hope for people carrying risk in their families; for example, data from people with bipolar disorders on the Lifetime Creativity Scales.[17] It is possible that higher creativity potential helped those "better functioning" individuals cope resiliently, such that they were healthier than they might have been otherwise. It is interesting that mild mood elevation appears to carry benefits for creativity in the population at large.[18]

The pathologizing of creativity, whether "every day" or "exceptional" is a popular stereotype. The media is filled with images of creators as odd, absent minded folk who cannot help bumping into walls. In these stereotypes, the "mad scientist" is too busy, or too unconventional, even to comb his or her hair. The link of creativity to mental disorders may be a factor in stereotype production, combined with the misunderstanding that, if creativity is associated with mental health problems, it will therefore be a problem itself (rather than a healthy response).

In addition, there is a general social discomfort with "difference." Beyond that, some people who are uncomfortable with their own unconscious processes and bizarre thoughts –even those that might have creative potential—may prefer to attribute them to others.[19] Unfortunately, some teachers see creative youth as problematic, and more compliant youth as the creative ones. This unfortunate stereotype has damaged the self-concept of some vulnerable and talented young people in the schools.[20] Because a response is odd or "abnormal" however, does not mean it is inevitably harmful or "pathological." Rather, it may be "usefully exceptional."

These creative moments were uniquely characterized by Kristeva[21] as: "If the semiotic is pre-Oedipal, based on primary processes and is maternally oriented, by contrast the symbolic is an Oedipalized system, regulated by the secondary processes and the Law of the Father. The symbolic is the domain of positions and proposition. The symbolic is an order superimposed on the semiotic. The symbolic control of the various semiotic processes is, however, tenuous and libel to break down or lapse at certain historically, linguistically and psychically significant moments. It results in an upheaval in the norms of the smooth understandable text. The semiotic overflows its boundaries in those privileged 'moments' Kristeva specifies in her triad of subversive forces: madness, holiness and poetry."[22]

(e) Creative personality traits may be useful predictors for the enhanced generation of divergent thought, perhaps because a greater proximity to the "edge of chaos" provides a useful fit with nonlinear dynamic models.

Certain personality traits have been linked with high scores on measures of creativity (e.g., Barron 1969: Barron & Harrington, 1981), including openness to experience, tolerance of ambiguity, and preference for complexity. It has been suggested that certain traits, or cognitive styles, also might be part of the (evidently healthy) *compensatory advantage* for those at risk for bipolar disorders (e.g., Kinney & Richards, 2007).

A dynamical framework may help explain what mental events might transpire in, such traits as, for example, openness to experience, even if they might sometimes "go a little too far," thus fitting in with some of the previous biases and stereotypes. How then might cognitive style or stylistic features linked to personality, create conditions that enhance novelty? Abraham,[23] discussing Howard Gardner's[24] views of creativity, agrees that "certain personality characteristics are necessary"[25] for the bifurcation to more innovative modes. Might a stylistic bent such as openness to experience, for example, raise the odds for multiple bifurcations? That is to say, might this orientation open the gates to a stronger stream of ideas, ones which can be picked through later, so the creator can choose some for adaptive creative purposes?

One study[26] indicates that people with "faith in intuition" tend to have lower *latent inhibition*, that is, that they lower a gating mechanism that keeps out irrelevant (or seemingly irrelevant) stimuli. Low latent inhibition is related to types of schizophrenia but—with stronger executive functions, it is also related to creativity! Some of these new associations might be odder than others.[27] Yet, might a few unusual ideas, when the gates are lowered, lead someone to *pathologizing* a process that should lead to celebration? For example, a person diagnosed with a mild thought disorder might write something viewed as gibberish in a mental hospital; but the same creative product might be viewed as beautiful poetry in a different context.

Group brainstorming offers a useful example (e.g., Putman & Paulus, 2009). In our own inner, personal brainstorming (recall Goertzel's branching structures) perhaps some occasional bizarreness of ideation may emerge. One would welcome this in a group brainstorming session, following the rule that "anything goes," but it might be easy to dismiss in a personal reverie even though that "crazy idea" might be exactly what the experiment would find most useful. It makes sense to elicit a broad range of options, sort through them later, and find the one that has the greatest promise for utility. Again, it is important not to *pathologize* difference just because an idea is different—especially when it may be a sign that one is breaking free from the ordinary, and moving toward new possibilities. With the right balance of divergent and convergent processes, one may be on the route to higher creativity—a goal sought and valued by a great many people.

(e) In dreaming, one may see certain of these phenomena in even bolder relief, where our sensory world and the usual rules of logic are suspended.

The fractals found in Nature can be used as metaphors for the "branching" that characterizes the work of many creative people, even while they are asleep. Switching between attractors can be accomplished by (a) bifurcations, (b) resetting initial conditions, and by jumping boundaries of basins of attraction, this last being facilitated by fractal boundaries between basins (separatices).[28] Dreaming could involve all three. During dreaming, the neural networks that comprise the waking circuitry of the brain seem less constrained by daytime reality and are more open to novel connections.[29] Stanley Krippner and Allan Combs have noted that the formal analysis of activity patterns in complex neural networks, such as those found in the dreaming brain, can be carried out in terms of chaotic attractors.[30] They proposed that the dreaming brain (both in rapid eye movement or REM sleep and non-REM sleep) "relaxes" into natural patterns of self-organized activity that often reflect the residual moods, stresses, and concerns of waking life. During dreaming, the brain is immersed in something like a sensory isolation tank, cut off from the influences of external sensory input. In this situation, patterns of brain activity can slip into forms that are primarily dependent upon internal considerations.[31]

In J. Allan Hobson's (e.g., 2000) terms, during both waking and dreaming there is an *activation* of the brain, a source of *information* that is evoked during the waking or dreaming process, and a biochemical *modulation* that differs radically from wakefulness to sleep. Dream experiences are, in part, a product of self-organizing tendencies in the brain during which the randomly evoked informational data are creatively patterned into a narrative to which meaning can be attributed.[32]

(f) Valuable insights may emerge--including highly "divergent" processes that to be worked through in dreaming, at times, and sometimes upon waking where "convergent" processing can occur.

In the creative process, small changes in cognition or behavior can trigger an avalanche of new insights or novel creative products. Krippner and Combs have found this "butterfly effect" to characterize many dreams that lead to a creative solution to an ongoing problem.[33] The human brain with its many chaotic patterns of activity is subject to the butterfly effect and the introduction of "noise" into such a system can produce a response too small to be ordinarily noticed. However, the presence of this "noise" or "vibration" keeps the system in motion, following the signal, rather than allowing it to become stuck. Termed *stochastic resonance,* this seemingly paradoxical effect has been demonstrated in electronic signals as well as in nerve cells.[34] On the other hand, the dreaming trajectories may be more under autopoetic (divergent and convergent) control than in those systems attempting to follow a repetitive signal as in most stochastic

resonance. As in problem solving, they have a problem in mind, and use divergent trajectories and bifurcations to resolve it.

For instance, objects on a vibrating tabletop are sometimes seen to "walk" about, especially if the table is not level. In fact, they are following the line of least resistance down the slope of the surface, ordinarily not available to them because of friction with the top of the table. Here one might imagine that the neurochemical stimulation of the higher brain by the lower brain could cause activity there to "slide" in the direction of least resistance, resulting in dreaming. Hence, the dreaming brain, isolated from daytime sensory bombardment and detached by neuromodulatory amnesia from those experiences that immediately precede sleep, chaotic patterns such as the butterfly effect and stochastic resonance produce a brain state especially responsive to subtle influences such as faint residual memories of emotional residues.

Affect regulation is one of several adaptive functions of dreaming; unpleasant dreams are a way to process a discomforting emotional experience from waking life by placing it in novel settings, often with strangers playing a key role, especially during REM dreams.[35] This highly creative way of managing *affect load* seems to depend upon chaotic dynamics; when they are not functioning properly, this self-regulatory creativity has broken down and the result is a nightmare in which the discomforting experience, often traumatic in nature, is repeated over and over in the brain's unsuccessful attempt to restore its self-regulatory functions.

(g) Some writers see dreaming as no more than random patterns due to random brain activity, rather than an intentional process holding potential meaning.

One of William Shakespeare's characters, in *Romeo and Juliet*, derided dreams as "full of sound and fury, signifying nothing." In more recent times, Frances Crick and Graeme Mitchison proposed that dreaming performs a housecleaning function for the brain and that their content is "best off forgotten."[36] However, Crick and Mitchison described a neural network that underlies dreaming, one that other authors (e.g., Hartmann, 1999) have used to propose a more creative function of the dreaming process. Hobson (e.g., Hobson & McCarley, 1977; Hobson, Pace-Schott, & Stickgold, 2000) has taken the position that dream content results from random stimulation of cortically-stored memories, but that the dreaming brain "makes the best of a bad bargain," creatively weaving a narrative from the images. Krippner and Combs' model of dreaming as a chaotic, self-organized process attempted to span the chasm between the neurobiology of dreaming and the study of dream content,[37] a task also performed by G. William Domhoff.[38] However, Domhoff took the position that dreaming was an epiphenomenon of sleep while Krippner and Combs held that it was adaptive in nature, serving an important role in the evolution of higher vertebrates.[39]

For Hobson, dream content is so bizarre that dreaming could be described as a "model psychosis" and "delirium." Crick and Mitchison also wrote about the "bizarre intrusions" that characterize dreams.[40] Carol S. Uppercut took a more creative approach to bizarre elements in dreams, stating that "bizarreness is the means by which the dream represents objects, persons, or experiences that cannot…be isolated from the dreamer's history in time and space.[41] In the dream state we re-create the diachronic world from the standpoint of its synchronic coherence as established in a unique memory."[42]

Deirdre Barrett has described a "bizarre" dream reported by the Italian composer, Giuseppe Tartini in which he handed the devil a violin bow.[43] "The Devil played a haunting melody of unearthly beauty. The instant he awoke, Tartini grabbed his violin and tried to reproduce it. All he could remember was the distinctive double-stop trill. Around that marvelous sound, he composed a piece her called *The Devil's Trill Sonata*."[44] Thus, where one person sees delirium, another person may see creativity.
(h) Although dreaming may have random elements, one can also discover patterns of content for which the meaning has potential social as well as individual significance.

Dreams can generate multiple meaningful possibilities. During the process of dreaming, random activation within the cortex (primarily the visual-motor areas) can evoke images and memories that connect with an unsolved issue that can serve as a chaotic attractor. "Branching" can lead to alternative ways of resolving the issue; the resulting dream narrative might favor a particular solution or it might predispose the dreamer to solve the problem upon awakening. Again, Goertzel's' branching models help to explain this dream process, and if divergent and convergent processes are at work, it is likely that the more convergent occur later, upon waking, to fully understand an insight from dreaming.[45] Many models of the creative process include an "incubation" phase that is followed by "illumination"; Tartini's dream could serve as an example since he was hard pressed to produce a new composition and had a creative block for which his devilish dream provided a welcome breakthrough.

Hartmann encourages dreamers to seek a "central image" in their dream, one that contains vivid imagery and intense affect.[46] This image, he maintains, can serve as the key to unlock the latent meaning of the dream narrative. In Krippner and Combs' model, Hartmann's central image would be a chaotic attractor, and neural networking would draw associated memories and images toward it to yield a coherent story.

Janice Bayless has proposed that branching, or bifurcating, can happen more than once, producing a *cascade*.[47] These bifurcations and cascades are specialized types of

associative thinking, in which two associated images have a linking similarity. She used the well-known example of Elias Howe's invention of the lockstitch sewing machine to make her point. While awake, Howe had worked in vain to design a machine that would sew garments, but nothing would work. One night he dreamed that savages had captured him and prodded him with their spears. As they were about to execute him, he noticed that each spear had a hole in the pointed end. He woke up with a start, realizing that what his machine needed was a needle with a hole in the pointed end. The needle and the spears had a similarity of shape—long, narrow, ad pointed. Chaos theory adds an important dimension to the understanding of dreams; information is not simply accumulated, as Hobson maintained. It is also generated, creating connections that were not there before, and the Elias Howe dream is an example because he generated a working model for his sewing machine.[48] This dream had social significance since it initiated an industrial paradigm that required fewer workers. Because many of the skilled sewers were slaves, it could be said that Howe's dream was an initiator of the death knell to slavery in the United States.

Hence, nighttime dreaming serves as another example of "everyday creativity," as each dream is unique and novel. Because each brain constantly self-organizes data, whether it is awake or asleep, creativity can be seen as part of the human potential rather than a trait limited to an elite group of individuals. This phenomenon is of great social significance because it "democratizes" creativity, demonstrating that the term need not be limited to a few "creative geniuses."

(i) These patterns are not only suggestive of immediate value, but of potential value because they were adaptive during the course of evolution.

Social psychology rests, in part, on the understanding that evolutionary processes led to the selection of genetic patterns that facilitated social interactions.[49] The outcome of such patterns is seen not only in these social interactions per se, but also in the thoughts, feelings, and dreams of humans. Indeed, there is evidence that social interactions are more likely to be depicted in dream reports than in spontaneously evoked waking reports. Furthermore, aggressive social interactions are more characteristic of REM than either NREM or waking reports. Finally, dreamer-initiated friendliness is more characteristic of NREM than of REM reports. Therefore, processing of social interactions is often performed "off-line" during dreaming. This difference may be linked to the proposal that there is a reciprocal interaction of two neuronal groups, acetylcholine in REM, norepinephrine and serotonin in non-REM. These specializations suggest that dreams exert a regulatory impact on waking social interactions.[50]

(j) It is likely that further clarification of nonlinear dynamic processes and the balance between divergent and convergent forces can further reveal the healthy potentials of our creative minds, during both waking and dreaming states.

In the dream state, too, there may be misunderstanding and mislabeling of certain dream phenomena that are healthy and adaptive—in this case calling them bizarre and

delusional at best, and random and meaningless at worst. Yet dreams may represent another highly adaptive creative process that should not be overlooked.

Dreaming is a complex neurocognitive process with a neurochemistry, a neuroanatomy, and an electrophysiology as complex as waking processes.[51] The authors of this paper take the position that dreams are not, as some claim, an epiphenomenon; indeed, we suspect that dreaming played an important role in evolution of the nervous system. Dreams are not, as others claim, a spandrel, a decorative piece of architecture that serves no structural function; instead, they are central to the organization and architecture and development of the brain. Dreams are not, as still other insist, a nighttime discard that are best off forgotten; rather, they can lead to affect regulation, memory consolidation, and even creative problem solving. Gould and Lowentin have proposed an evolutionary significance for 'spandrels'.[52] It is likely that dream content is initiated by chance stimulation, primarily of the visual motor cortex. Once images and memories are evoked, neural networking occur, primary through emotional branching. We take the position that the neurocognitive architecture of the sleeping brain produces order out of chaos, often with a central image serving as a chaotic attractor.

Conclusion

If dreams are simply epiphenomenal images without causal, intentional, or semantic content, then one would not expect to find that dream states exhibit processing specializations. If dreams are nighttime discards, one would not expect the emphasis upon social interactions that has been reported in the literature. If dreams are spandrels that randomly reflect snippets of daytime experience, there would be no reason to expect high levels of aggression in either REM or NREM dreams.

Instead, the available evidence points to creativity as a hallmark of a healthy mind in dreaming as well as waking. The sometimes bizarre appearances of new ideas, or new dream material should be carefully observed and even honored. Here one finds patterns of information that appear meaningful, socially relevant, and of evolutionary importance. One should not assume that dream material is random and meaningless because its special rules aren't understood, and thereby miss patterns of meaning and creativity. Rather than pathological bizarreness (while awake) or meaningless random activity (while dreaming), our cognitive-affective productions may be showing their own logic, which can open us to deeper parts of the psyche with benefits we would otherwise lack. A study of waking and dreaming creativity from the perspective of chaos theory may help us understand the underlying mechanisms.[56] More broadly, it may even point the way to a synthesis of science and aesthetics.

Endnotes

[1] Richards, 2007.
[2] Richards, 2007.
[3] Frank Barron, 1969.
[4] Abraham, 2007.
[5] Richards, Kinney, Lunde, & Benet, 1988.
[6] Richards, Kinney, Benet, & Merzel, 1988.
[7] Richards, Kinney, Lunde, & Benet, 1988.
[8] Kinney & Richards, 2007; Richards, et al., 1988.
[9] Richards, Kinney et al., 1988; Richards & Kinney, 1990.
[11] Krippner, 1994.
[12] Abraham, 1996; Richards, 1996, 2000-2001; Schuldberg, 1999; Zausner, 1996.
[13] Goertzel, 1995a, b.
[14] Hardy, 1998.
[15] Gruber and Davis, 1988.
[16] Abraham, 1996.
[17] Ibid., p. 385.
[18] J.P. Guilford, 1968.
[19] Richards, 2000-2001.
[20] Richards, in press.
[21] Confer Goleman, 1988.
[22] Isen, Daubman, & Nowicki, 1987.
[23]Richards, 1996, in press.
[24] Cramond, 2005; Richards, in press.
[25] Kristeva 1972, 1977, 1980.
[26] Sarup, 1993, 124.
[27] Abraham, 1996.
[28] Howard Gardner, 1982.
[29] Abraham, 1996, 389.
[30] Kaufman, 2009
[31] Goertzel, 1995a, b.
[32] Abraham, 1995
[33] Hartmann, 1999.
[34] Stanley Krippner and Allan Combs, 2002.
[35] Ibid., p. 1454.
[36] Kahn & Hobson, 1993.
[37] Krippner and Combs, 2002.
[38] Moss & Wiesenfeld, 1995.
[39] McNamara, McLaren, Smith, Brown, & Stickgold, 2005.
[40] Frances Crick and Graeme Mitchison, 1986.
[41] Krippner and Combs, 2002.
[42] G. William Domhoff, 2003.
[43]also see McNamara, 2004.
[44]Crick and Mitchison, 1986, 231.
[45]Carol S. Uppercut, 1993.
[46] Ibid., 25.
[47] Deirdre Barrett, 2001.
[48] Ibid., 69.
[49] Goertzel's, 1995 a, b.
[50] Hartmann, 1999.
[51] Janice Bayless, 2009.
[52] Ibid., 19.
[53] McNamara, 2004.
[54] McNamara, McLaren, Smith, Brown, & Stickgold, 2005.
[55] Pagel, 2009.
[56]Gould and Lowentin, 1979.

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