The Journal of Mind and Behavior
Spring and Summer 1986, Volume 7, Numbers 2 and 3
Pages 429 [299]–448 [318]
ISSN 0271–0137
ISBN 0–930195–02–7

Dreaming and the Dream: Social and Personal Perspectives

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Social (public) and personal (private) perspectives on the study of dreams and dreaming are contrasted. Dreaming is an intensely private and personal experience about public matters. Scientific descriptions of dream phenomena are publicly shared descriptions, and thus it is not possible to observe in a controlled manner the strictly private experience which is the essence of the dream. Housekeeping theories of dreaming, which posit that we dream so that unwanted material can be eliminated from the accumulating record of experience, founder because they rest upon a concept of undesirability that resists definition in terms of anatomical and physiological realities. Alternatively, the concept of undesirability may be founded on the categories of essentially private experience, categories which are inaccessible to public inspection. A vigilance theory of dreaming is described, a theory founded on familiar observable structures and processes in the nervous system. This vigilance theory is seen to be consistent both with present knowledge about the anatomy and physiology of the nervous system and with the widespread perception that dreaming occurs in order that the dreamer may be alerted to sources of tension and conflict in his/her relationships with others.

One important aspect of the phenomenon of dreaming is the contrast between the significance of the dream to the dreamer and the significance of the dream for the social context in which the dream occurs. Certain physiological signs accompany the dream state, and these signs are available for experimental observation; apparent regularities in dream imagery and life circumstances are subject to statistical estimation. But there are important aspects of the dream experience that are available only to the dreamer. We begin by offering an account of this intensely private aspect of dreaming. We suggest that it is reasonable to make such accounts available for discussion, although neither direct measurement nor statistical estimation can determine their validity. It is for the individual and for the individual alone to deter-

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mine whether or not his/her dreams are significant, and what constitutes that significance. It is important at least to articulate this account since it may affect other aspects of the study of dreams in ways that can reinforce a proposed theory, or cast serious doubt on tentative explanations of the phenomenon of dreams.

The Dream: Private and Public Aspects

We propose that the dream selects imagery out of the experience of novelties in the dreamer's immediate life experience and associates these images with topics from the dreamer's sometimes remote past. The intensity of the affect induced by this association draws the dreamer's attention to possible sources of conflict and tension—the origins of alienation, of fear, of a lack of a sense of self-worth, and the inability to deal with ongoing and problematic life situations[1]. In short, these feelings direct the dreamer's attention to the root causes of human suffering as these causes are manifest in the dreamer's own life. But the signals the dream presents to the dreamer are signals about social tensions and conflicts, about failures to establish and maintain stable and fruitful relationships with others. The dream is an intensely personal and private experience, but its message concerns, in essential ways, the dreamer's public life, the life that is found in interactions with others. This contrast between the dream as a private and individual experience about public and social issues provides two different perspectives on dream work. These refer both to the work that the individual does in order to understand the dream, and to the work that society, represented by helpers or a helper, does to assist the dreamer. This includes the work that is done to formulate a rational and scientific account of the phenomena that surround the dreaming experience.

An important aspect of this contrast is found in the process whereby the dreamer reaches an appreciation of a particular dream. This is the experience in waking consciousness of grasping the meanings of the symbols that appear in the manifest dream content and of the emotional impact created by the relationships expressed therein. Of particular importance is the highly original perspective which the dream casts on these relationships. Anyone who has profited from dream work will be familiar with this steadily unfolding oneiric "Aha!" experience. This flash of insight is of course a private experience, directly available only to the individual. But there is convincing evidence that the attainment of this insight is facilitated by a context that is both public and social. If the dream experience is a private articulation of a social issue, the substantive content of the dream is discovered through a social transfor-

[1]Not all dreams have this negative connotation. What is experienced as novel, i.e., heretofore unknown, may be the emergence of positive resources. Most remembered dreams, however, do expose areas of vulnerability.

mation, a process in which others have an essential function. In fact, it seems that this insight into the significance of the dream generally eludes the dreamer in the absence of a suitable facilitating social setting. It is the dreamer's task, and the dreamer's only, to read the metaphorical image that embeds the dream's message. To do that requires that the dream be socialized, i.e., that its content be shared and explored with others. It is only natural that if the dream speaks to social issues, to relationships with others, the discovery of the particulars requires the presence of others in a supportive context in order to unfold.

Of equal importance, this contrast is manifest in the variety of ways in which one attempts to discover the significance of the dream. On the one hand, there is the idea that an informed and experienced therapist is needed to lead the dreamer to this understanding. In such a situation, carried to an extreme, publicly and professionally established principles may exert a determining influence over a proposed interpretation of the dream. The dreamer may find himself/herself encouraged to move closer to discover this authorized interpretation, a discovery that earns the dreamer the security attendant on authoritatively confirmed doctrinal compliance. In this situation, whether it involves an individual therapist or a group, there is the risk of the dreamer saying, "Yes, I see," whether or not there is an accompanying "Aha!" experience. When that happens, the public, authoritative ingredient is dominant. The public sector pronounces, "See the dream as I [we] do," and the dreamer complies.

On the other hand, the private and profoundly personal perspective may be given primacy. In an experiential dream group setting, for example (Ullman and Zimmerman, 1979), the dreamer can discover the significance of the dream without appeal to institutional, social or authoritarian norms. The members of an experiential dream group are in general dreamers themselves, without professional clinical training, and without commitment to any particular theory about dreams. In such a group setting, the dreamer relates the surface or manifest content of the dream, leaving aside all interpretation. The other members of the group then assume the dream to be their own experience, and offer commentary from that perspective. No attempt is made to "understand" what the dream might have meant to the dreamer who offered the dream. Group members exercise their skill in responding to the dream as though it were their own. In many cases that exercise of skill by itself seems sufficient to stimulate the dreamer's insight into the dream, its origins in the dreamer's immediate and more distant past experience, and the particular aspects of the dreamer's life situation that the dream may be addressing. The therapist, or the group, offers the dreamer a social milieu in which there is no ground for apprehension or anxiety, one in which the dreamer's security is protected, one that is relatively free of interpersonal conflict. The dreamer's

life situation is marked by social relationships in conflict. The dreaming experience points to these conflicts in highly representational images. If and when the dreamer comes to appreciate the reality and nature of these conflicts, he/she begins to glimpse the possibility of a life without them, a life free of the apprehension or insecurity connected with them. A supportive setting for discovering the dream's significance in this case provides the dreamer with a scaled-down life situation that is like the one he/she will find when the conflicts expressed in the dream are resolved.

The contrast between personal and social points of view is thus found in the attitude displayed in the social setting in which the dreamer pursues the significance of the dream. These attitudes may be focused outward toward conformance with theoretically shaped interpretations, or inward toward a more spontaneous and individual understanding. In the latter case, clearly the preferred one, there are no scientific theories to be understood, tested for, confirmed or invoked in any way. Since fundamental aspects of the dream experience resist scientific inspection, at least for the present, the suitability of this framework of ideas for characterizing and appreciating dreams must be judged first by dreamers themselves.

The tension between the self and society, as that tension is depicted in the dream, is manifested further in the use the dreamer makes of the dream's message, once that message has been discovered. Consider the following dream fragment:

> I am to be an acolyte at Easter Mass. I arrive at the sacristy and discover that I am late and that the service is already in progress. I look around for my cassock and surplice but cannot find them, and am unable to join in the service. While searching for my vestments I find the cupboards to be filled with multiple brand new copies of phonograph records. I plan to come back dressed in a business suit, with a briefcase, and steal one of each of these stacks of records.

The dreamer is a college professor who saw himself as avoiding commencements and convocations as assiduously as he avoids other social situations. He said that he occasionally "dresses up" in business clothes to foster the illusion, before his colleagues, that he is some kind of man of affairs, perhaps too busy for socializing. Instead, he frequently substitutes technologically elaborated forms of amusement, often involving music and phonograph records, for public interaction.

If the dreamer develops this understanding of the dream, we may ask how he can make use of the dream to free himself from the tensions arising from his anti-social orientation. It is clear that we are rarely in a position to rearrange reality to suit our prevailing attitudes and habits. Perhaps it is the dreamer's own personal, private, individual orientation that has to be modulated in order to remove or at least weaken the sources of tension and

conflict. The inner-directed nature of this focus assumes some importance when we consider scientific attempts to characterize the dreaming experience. Science is an essentially public affair with its emphasis on observables, quantitative measurement and prediction. These very considerations command science to ignore the essentially private and personal aspects of the dreaming experience.

For example, when we investigate the occurrence of culture-specific imagery in certain kinds of dreams we begin by assuming a great deal about that culture—its language, its institutions, its myths, its religions, its technological artifacts, judgments about right and wrong, about happy and unhappy, and so on. Against this rich body of assumptions we articulate a discriminating hypothesis, collect data in a controlled way, and extract a statistical inference.

On the other hand, if we wish to investigate those aspects of dreaming that are essentially biological, perhaps specific to the human species, perhaps universal across the species, the requirements for "scientific" observation may be of a different character. We may not trust our ability to exclude arbitrary cultural factors at subtle levels. Instrumentally mediated quantitative measurement is the tool of choice for such a situation. When we use the word "science" we mean to invoke that very stringent requirement that such instrumentally mediated quantitative measurement provides the final judgment for the rightness of a theory. We have, by this means, some assurance that the experimenter's feelings, judgments and dispositions will not intrude on the results obtained. Theories about dreaming touch in a very profound way the life of the individual, and dreams themselves are, by the testimony of large numbers of people, a major factor in the emotional lives of dreamers. It is to protect the right of the individual, to have available a wide range of treatments of dreaming, that we insist on the most stringent standard we can find for experimental confirmation of dream theories.

There is no science in an experimental dream group. Such a group deals with those aspects of dreaming that are not amenable to scientific observation. That is why we offer a discussion of the contrast between personal and public perspectives on dreaming. For us, "science" implies the direct quantitative measurement that may be used to confirm or disconfirm an explicitly defined theoretical construct. The rest belongs to the dreamer as an individual. In short, efforts to theorize about dreams in ways that do not submit to the most stringent of objective scientific standards threaten the integrity of the individual and encourage a certain intolerance for those who are unwilling to accept a purely materialistic or behavioral description of the human personality.

Although other members of the dream group belong to the "public sector" and cannot share in the dreamer's direct experience, they rely on good faith, spontaneity of the creative imagination, and trust in the basic biological pro-

cesses which we are assuming make up the organism's equipment for dealing with dreams. The scientist cannot acknowledge these factors, because he/she can neither observe nor explain this kind of interaction. There are thus two qualitatively distinct aspects of the public perspective on dreaming, as indeed our discussion explains.

Recent Theories: Neurophysiological and Computer Analogs

If our understanding of the nature of the dreaming experience is clarified by an appreciation for the contrast between personal and social perspectives, this contrast figures even more prominently in theories about dreaming, about the structure, the substance, and the function of dreaming. An exclusive orientation toward the public perspective as realized in a scientific approach erodes the healing potential of the dreaming experience, excluding as it necessarily must, the inherently private aspect of that experience. Similarly, if we ignore the public aspects of dreaming we risk losing touch with the substance of the experience, the basic commentary on the nature of our relationships with others. If we ignore the scientific study of dreams we may overlook the fact that dreaming is a biologically rooted activity. It is important to assume an experimental, scientific posture in thinking about dreaming precisely because that posture requires us to confront the boundary between what science can and what it cannot do in its study of the mind. It would seem that we are encouraged to take the middle way, in which the integrity of the individual is given primary focus, supported by a theoretical framework that is as experimentally impeccable as it is tolerant and compassionate. Such a stance provides the greatest possible opportunity for the dreamer to profit from his/her experience, while it encourages science to construct the most comprehensive and factual description of the dreaming process that objective observation can offer.

There are a number of recent proposals to the effect that dreaming is principally concerned with a kind of housekeeping function—in one instance (Crick and Mitchison, 1983, see also this volume) the removal of "undesirable modes of interaction in networks of cells in the cerebral cortex" (p. 111). In another (Evans, 1983), the sleeping brain is said to go "off line" and uses dreaming time to review, revise and update programs, or discard outmoded programs. At the root of these housekeeping theories there is the idea that for the individual the remembering of certain experiences is "undesirable," in the sense that these expreiences have no value to the individual. (For the moment we set aside the possibility that the word "programs" is seriously misused in this and other contexts.) Crick and Mitchison (1983), for example, claim that during sleep, "the more or less random stimulation of the forebrain by the brain stem . . .

will tend to excite inappropriate modes of brain activity" (p. 112). These inappropriate modes of behavior are described as "unwanted" or "parasitic" modes of behavior, which arise [in the cortex] as it is disturbed either by the growth of the brain or by the modifications produced by experience" (p. 111). From a rigorously scientific point of view, of course, the assumption that the stimulation of the cortex by the brain stem during dreaming sleep is "random" is gratuitous. In fact, given the universality and predictability of the phenomenon of dreaming, one would expect that an objective scientific consideration of the observable facts would lead us to postulate that something quite the opposite of randomness underlies this stimulation. If we call into question this assumption of randomness, then such words as "unwanted," "inappropriate," "parasitic" and so on, are seen to be based on theoretical speculation associated with the assumption of randomness. If housekeeping theories rested only on this completely unjustified assumption, they would have to be rejected. Fortunately, however, they rest on other assumptions that are equally difficult to justify.

Housekeeping theories in general depend in a fundamental and essential way on the concept that underlies the words "inappropriate," "parasitic," "outmoded," and so on. In a scientific context we are thus justified in asking for an explicit and precise specification of this concept of undesirability. But we have to ask for more. We must ask not only for an objective criterion according to which we can decide, in specific cases, whether a particular mode of neural activity is or is not undesirable, but also for a process which applies that criterion to suitable objects, on suitable occasions, with suitable and predictable results. Given the present state of our knowledge about the relation between neural activity and the categories of ordinary human experience, this criterion may not refer to the abstract or conceptual ingredients of thinking. We do not yet understand the connection between neural activity and thought. Moreover, if there were a housekeeping function of the kind proposed in these theories, it would have to be able to apply its criterion of undesirability at any level of particularity and to any degree of detail that might be required. Suppose that the raw materials of experience are individual sensations orginating in the periphery. Suppose that instances of these sensations are organized into classes of sensations concomitant with the aggregation of nerve fibers as anatomically recognizable bundles. These fiber bundles permit an abstracting of sensations into categories or classes where a sensation belongs to a certain class if its nerve fiber belongs to a corresponding fiber bundle. It is believed that as neural signals move away from the periphery toward higher processing centers, neural events are organized into increasingly more abstract categories. It is an important, serious and open empirical question whether or not there are categories of neural events that cannot be explicitly and exactly determined with reference to initial sensory events

or categories derived from them. For example, we may assume that ordinary perceptions are derived from sensory events, but this derivation must necessarily proceed by successive stages of classification of the signalling events occuring in specific neural fibers. These classifications into categories eventually become increasingly more abstract if we are to arrive at categories suitable for representing ordinary experience. At present it is very difficult to conceive of an undesirability criterion that is well-defined in terms of the structure of increasingly more complex neural events whose relation to direct experience is increasing in abstractness as well. Assemblies of neurons, with delicately configured dispositions to respond, seem more attuned to make arbitrarily fine distinctions than to gloss over them. Progress along the phylogenetic scale of complexity, in fact, is progress in developing the skill to make increasingly refined distinctions.

The abstract categories that may be unsuitable for use in formulating a criterion of undesirability are those that are specified with reference to the categories of conscious experience but are not (yet) relatable to direct sensory events or classes of such events. These abstract categories may determine important aspects of the organization of an organism's perception of its immediate experience, and its organization of that experience into an accessible historical record. Even an organism's immediate behavior requires these categories.

Modes of neural activity are currently distinguished on the basis of anatomical structure and physiological process. Neurons have a well-defined structure in terms of axonal and dendritic elaborations. The cell membrane and the axon hillock have regular and identifiable structure. Synapses develop in specific neighborhoods on cell bodies, apparently according to a fairly exact plan. The distribution of electrochemical potential in a normal functioning brain occurs according to precise physical principles. The events at the synaptic cleft have predictable effects given a pattern of sub-threshold electrical activity in the region of that excitation[2]. These are the facts, whether we refer to the forebrain, the brain stem, the reticular activating system or to any other subsystem of neurons. (We do not suggest that the integration of these physiological factors is fully understood, or less, that we can correlate these events with abstract mental categories. But at a clearly defined level of organization, these are the observable realities in neural tissue.) Given that there are at least ten billion neurons in the human central nervous system (a very conservative estimate) and as many as ten thousand synaptic end bulbs associated with a single neuron, the number of stable interconnections is simply beyond comprehension. Yet this colossal number is the starting point from which we would begin to calculate the number of possible distinct modes

[2]The basic concepts cited here are described in Katz (1966), or in Shepherd (1974).

of neural activity. It is in this domain that we will have to be able to apply a criterion for undesirability. And that criterion will have to be framed solely with reference to the anatomical and physiological facts about the nervous system, if that criterion is to be acceptable as a foundation for reasoning based on controlled experimental observation.

The Computer as a Model of Brain and/or Mind

It may be appropriate here to correct some serious misunderstandings about the nature of computation, misunderstandings that pervade any suggestion that there is a computer executing programs in the brain, or that in any precise sense neural processes may be properly understood as executing or refining "programs" or judging the "suitability" of particular programs. The perspective in these observations is that of the experimental scientist who is concerned with the question whether or not a given mechanism is a computer, and not with the culturally determined tasks that we might assign to the computers we have ourselves designed and constructed.

A computing machine deals exclusively with symbolic structures that are in principle devoid of interpretation. We may use a computer for payroll processing, to balance chemical formulas, to calculate a solution to a differential equation, to "translate" from German to English, to compile FORTRAN programs into machine language programs, and so on. In each of these and many other cases it is the same computer, the same memory, the same instruction set that is used. We can, with equal facility in each of these cases, understand or interpret the computer's structures with complete freedom. The first conclusion we draw from these observations is that since the same computing facilities are used for all these different structure manipulations, a necessary element is the notion of a symbolic structure that is meaningless except as a complex manipulatable symbol. Second, we notice that some agency external to the computer has prepared the various programs from a vantage point informed by purposes and strategies that are not derivable from the fundamental concepts of computation. And finally, we appreciate that the computer can be programmed to execute any of a literally infinite variety of kinds of programs.

It is important in this connection to appreciate that a "program" is an exact specification of a sequence of events, a sequence that will manipulate a complex arrangement of symbolic structures. If the goal of the program has significance in any terms other than as an exercise in symbol manipulation, that signficance is not discoverable by inspecting the program. Professional programming at the present time consists less in producing "working" programs and more in establishing by precise definition and correct reasoning that a program in fact achieves a certain goal, and achieves it in a certain way. There

is in fact no way to produce "useful" programs except by this kind of "correctness" reasoning. Without it a program is a meaningless succession of instructions void of interest on any other grounds. It should be clear that it is for this reason that the structures and algorithms found in the field we call "artificial intelligence" are not relevant to the present considerations. That field begins with the assumption that there is a computing agent involved, while we are calling that very assumption into question.

The basic structures manipulatable by a computer must be discrete, stable and addressable. A bistable device must be, whenever the computer inspects it, in exactly one of its two possible conditions. Once put into one of its conditions it must remain in that condition until reset under program control. And a program must be able to access a specified symbol in a systematic way by means of an explicitly given address. (The so-called "content addressable" memories elaborate in a singular way on this requirement, but do not dispose of it. Something must still be accessible by address.)

In operation, a computing machine must be fully automatic. It may be programmed to accept data from a terminal at frequent points in its computation, but in general the machine must be able to run, if commanded, without external intervention of any kind. This fully automatic process is currently implemented, without exception, in every general purpose computer, by a "fetch/execute" cycle which is built into the basic logic of the computer. It controls the selection and execution of machine instructions one after the other according to the scheme specified in the (externally prepared) program. Simply put, without its fetch/execute cycle, the computer is a dead duck!

The art and craft of programming consist simply in choosing an interpretation according to which the structures and regularities that are intuitively meaningful to us are formally encoded into the configurations of bistable devices which the computer manipulates. Then, informed by our intuitive understanding of the processes we wish to simulate, we prepare a program so that its manipulations of the computer's bistable devices mimic, simulate, and calculate corresponding effects on the meaningful structures we want to compute with[3].

In the absence of a meaningful interpretation, the computer is seen as engaged in an elaborate, sometimes subtle exercise. But it is one which by its very nature has no significance except as an intriguing combinatorial puzzle. For this reason alone all housekeeping theories about dreaming founder decisively. If, for example, as Evans (1983) describes it, a computer system surveys its programs, updating, refining, and disposing, it does so with

[3]Turing (1937) first attempted to define precisely a general purpose computing device apart from what it is used for. The topic of program correctness pervades the literature in computer science. Dijkstra (1976) is a suitable starting point.

reference to externally imposed criteria introduced by the programmer when he/she wrote the program to carry out the housekeeping operation. There are no intrinsic housekeeping functions in a general purpose digital computer. The housekeeping functions that do occur, for example, include those that copy infrequently accessed files to an "off-line" mass storage device, but even this needs to be deliberately invoked, once or twice a week, by an operator. Programs that update other programs, refine them, or keep them contemporary in the light of recent computational transactions, are non-existent. In fact, a graduate student who prepared such a refining program in terms of non-trivial principles would qualify for what we facetiously call an "instant Ph.D." When such programs are developed, if ever, it will be because we, the sentient, conscious, intelligent agents have discovered how to represent the features relevant to the refining criteria in terms of bistable devices and pure symbol manipulation.

We note that these remarks help us to appreciate more of Crick and Mitchison's proposal. If the meaningful categories of everyday life are associated with neural structures and processes by a systematic interpretation, then the development of a criterion for "unwanted" modes of neural activity may refer only to the anatomy and physiology of the neural structures and processes. The alternative is to admit, on a rather large scale, an extra-physical agency in the management of events in the central nervous system. On the other hand, if these meaningful categories of everyday life are explicitly realized in neural tissue, then we await the details with considerable interest. In the meantime, it is important to criticize any theory of dreams that rests on a fundamental notion, for example, that of "unwanted" or "unsuitable," for which we have no definition and no measurable characteristics.

When we turn attention to the nervous system the computer analogy breaks down completely. There is no experimentally observable evidence of any kind to suggest that there are computations taking place in the brain. Reverberating circuits achieve a kind of discrete but transient stability, but certainly not of the kind required to achieve long term memory. We know of no systematic addressing scheme whereby the nervous system can depend on the fact that what was set to a specified condition at an earlier time will remain in that condition, indefinitely, until accessed again. And most important, there is no known neural structure that can be recognized as playing precisely the role of the fetch/execute cycle, operating the driver of a general purpose (interpretation free) computing agent.

We consider briefly one neural system that has been identified with sufficient precision to consider it a candidate for a computing device of some kind. The swimming movement of the leech and the neural events that generate it have been studied with exquisite care and patience over a number of decades. It has been shown (Stent, Kristan, Friesen, Ort, Poon, and Calabrese,

1978) that a recognizable neural network, in fact, accounts for the periodic pattern of muscle contractions giving the body of the leech a sinusoidal shape that ripples through the body as a function of time, the time scale being determined by the associated neural events. The identified neural network, when inspected in isolation from its motor effects, looks very much like a finite-state computing device. But there are two important observations that must be made. In the first place, while the periodic pattern of threshold activation is itself a discrete, digital event, that event drives a process whose very nature is graded, smooth and continuous—the antithesis of the discrete and the digital. This discrete neural event participates in generating a non-digital event outside itself. Nothing intrinsic to the net can be used to identify it as expressing a time-varying sinusoidal signal which manages muscle contractions in such a way that a small marine animal propels itself through the water by assuming the form of a sine wave. In the second place, the system is in no sense a general purpose computing device. Very simply, there is no program. There is no set of instructions awaiting inspection by a universal program interpreter. The mechanism that generates the sine wave is not usable to achieve any other effect (although its parts may be so involved). We know exactly what will happen when this system is activated. Thus, we cannot refer to facts of this kind to justify the claim that there is a general purpose computing agent of any type in neural systems. That it is a discrete event generator bears little or no relation to the idea of a general purpose computing agent.

While it is possible that memory traces are laid down by some process acting at the synaptic cleft, we are hardly justified in labelling such traces as computer memory. When Crick and Mitchison (1983) characterize information storage as being distributed, robust and superimposed, ". . . not assigned specific locations for each item, as in a digital computer" (p. 111); they correctly discourage any computer analogies that are not experimentally confirmable at the present time. One very important analogy brought out by Crick and Mitchison is between the uninterpreted symbolic structures processed by the computer and the equally uninterpreted anatomical structures and physiological processes found in nervous tissue. Their criterion that memory is distributed, robust and superimposed still requires the explication of an access strategy along with its physical implementation. However memory is laid down in neural structures (or wherever it is laid down), interesting questions ask how access to distinct individual elements is distinguished, how that access is achieved in organic tissue, and exactly what constitutes the event of recall. We are so far away from an account of these and the other factors mentioned, that all analogies between brain and computer should be held in abeyance.

Any serious attempt to develop computational analogies for neural activity will of course consider a wide range of issues that are receiving intensive study

within the field of computer science. Studies in concurrent processing, for example, are concerned with the situation in which a number of distinct computations, constituting an integrated system, interact with each other in ways that must preserve the integrity of each distinct process. No process should prematurely terminate another, and no pair of processes should engage each other in such a way that neither can participate effectively in the activity of the integrated system. Surely this system of ideas is of importance to the study of complex neural processes.

A second, related notion is that of a "distributed" computer, a system of processors operating in parallel, but with no distinguished process exercising authority over the whole system. A basic question is to determine, for a given algorithm A, whether or not one can find a set of algorithms whose effects when executed, can be used to synthesize (perhaps dynamically) the computational effect of executing A, but with the restriction that none of the algorithms participating in the synthesis expresses all essential aspects of the algorithm A.

Cutting across these and related issues, however, there remains the contrast between special purpose devices, those which are designed and constructed for exactly one purpose, and general purpose devices, those which can in principle generate any well-defined computation (any finitely expressible transaction in symbol manipulation). It is a matter of empirical judgment whether or not one assumes the human central nervous system to be a special purpose or general purpose instrument. Beyond that very basic question, it is a matter of observation whether or not there are special purpose sub-systems (and there surely are), whether the whole system or important parts of it may be expressed in anatomy and physiology as distributed systems, and exactly how concurrency is achieved in neural structures so that the integrity of participating processes is preserved. We wish to point out that a precise characterization of the way in which contemporary computer systems are specified may provide a rigorous framework of ideas for describing possible modes of neural activity, a framework within which interesting and important questions of fact can be asked, and then perhaps answered, by reliable experimental procedure.

It is a most striking characteristic about dreaming that what is publicly observable about dreaming is entirely distinct from the dreamer's direct personal experience. Rapid eye movement, changes in "brain waves," modulations in breathing and heart rate, are all publicly observable and seem to be associated specifically with the dreaming state[4]. The substance of the dream however, its manifest content and the affect associated with that content, are beyond

[4]Wolman (1979) offers a collection of papers that introduce topics covering a variety of aspects of dream phenomena.

detection with reference to those physiological perturbations in the sleeping state. We cannot know of the dream's substance and feeling until the dreamer awakens and tells us. Conversely, the dreamer is entirely unaware, while dreaming, of the accompanying variations in physiological state. Any scientifically appropriate framework for thinking about dreams is complicated by this reappearance of the contrast between the perspective of the individual and that of society and its institutions.

Dreaming and Vigilance

Dreams are structured, however idiosyncratic that structure may appear to the waking state, and it is reasonable to seek a precise account of the class of structures that one can find in dreams. Dreams also have substance—meaning and affect, and it is equally reasonable to seek an objective account of this substance. Finally, given the universality of the experience, we inevitably feel that dreaming is a purposeful activity. From a careful consideration of the structure, the substance and the function of dreaming, we may hope to come to a clearer understanding of the phenomenon and of what we may expect from a scientific description of dreaming. In the broader perspective, we may be better informed about the nature of the human personality. We will not be surprised to find that the contrast between the concerns of the individual and those of the social contexts informs our intuitive understanding of all three aspects of the study of dreaming, its structure, its substance, and its function. We will review the vigilance theory proposed by Ullman (1958, 1961, 1973) and others (Snyder, 1966; Tolaas, 1978) in order to see how a carefully formulated theory fares from these three perspectives.

There is no doubt that every organism with a nervous system has within that system a subsystem concerned essentially with a vigilance function. Every such organism in the waking state maintains a state of vigilance that is at least tacit and is sometimes subject to voluntary orientation. It is clear that this vigilance mechanism enjoys a certain primacy. No matter where attention is focused, that attention is always interruptable by an excitation from the periphery that is either sufficiently novel or sufficiently intense. The value of this capacity to the organism is too obvious to require comment, and its genesis in phylogeny is equally clear. It is, in fact, difficult to conceive of a capacity with more direct and unambiguous bearing on survival.

Fortunately, we have some understanding of the neural substrate that implements this vigilance capacity. It is known and experimentally verified that the agency for alerting the organism to the presence of novel or intense stimuli arriving at the periphery is to be found in interactions between the cortex and the great afferent systems mediated by the reticular activating system (RAS). It appears that the RAS monitors sense input, refers it to the cortex,

receives signals back from the cortex and, if appropriate criteria are met, interrupts other neural activity. Thus, the RAS receives information from the periphery and the cortex and distributes information back to the cortex. One of its essential functions is to alert the organism to the occurrence of novel or intense stimuli.

An important virtue of the vigilance theory of dreaming is that it refers, at a fundamental level, to this already existing universal vigilance capacity. No new neural systems are required. Awake, we are more apt to respond to novel rather than to familiar stimuli to which we have become habituated. Analogously, dreaming consciousness is oriented to what the dreamer experiences as novel in the form of a residual tension that has yet to be resolved. It is a defining characteristic of the sleeping state that the central processing of afferent impulses is inhibited during sleep[5]. The RAS then receives only minimal data from the periphery during sleep, but communication between the cortex and the RAS continues. The particular hypothesis of the vigilance theory of dreaming is that the processes involved in inspecting incoming data continue unabated during the sleeping state, except that the material inspected now originates not from the periphery but from cortical activity itself. Going further, the theory proposes that this inspection, like that occurring in the waking state, refers essentially to the organism's historical record in order to arrive at judgments about novelty[6]. In the absence of peripheral excitation, considerations of intensity are likely to be referred to affective components which are as much a part of the historical record as is what we call the "cognitive" component. One can recall the feeling of fear as well as the fact of its occurrence in a particular situation. The vigilance theory postulates that when the strengths of the novelty and intensity measures associated with these signals impinging on the RAS exceed certain thresholds, the RAS alerts the organism and awakening may occur. The organism's waking consciousness is then presented, at least for a short time, with a certain residue of the dreaming experience, a residue which we have come to call "the dream." On the other hand, if novelty and intensity, however measured, are below threshold, the organism remains temporarily in a somewhat unstable dream state, and then may return to a non-dreaming phase of sleep.

We can now draw attention to a particular aspect of the vigilance capacity whether that capacity is exploited in the waking or the dreaming state. The value and efficiency of a vigilance capacity, relying on a historical record of the organism's experience, will be affected in fundamental ways by the com-

[5]There are situations where a selective channel to the outside is kept open, e.g., the sleeping mother hearing the faint cry of her infant.

[6]See Bremer (1954) for a treatment of the evidence bearing on the vigilance theory.

pleteness, precision and accuracy of that historical record. It would seem then that seeking to identify certain aspects of experience as "undesirable" or "parasitic" would seriously risk degrading the performance of the vigilance mechanism. Given the universality of this mechanism and the fundamental biological advantage it can confer on the organism, the survival of the organism is likely to be best served by a retention of a record of experience that is as complete, as precise, and as accurate as possible. But even more is required. If the vigilance mechanism is to perform adequately, the historical record must be categorized, classified, organized in a suitable way. Given the biological facts, it is much more congenial to hypothesize that the brain, during sleep, is concerned with this organizing function rather than with a disposal process whose arbitrary criteria we cannot at present specify in objective scientific terms. The detection of novelty or intensity of associated affect would arise very naturally in the course of this organizing activity.

We are now in a position to review our understanding of the dreaming process, with attention to the related structures, the substance or content of dreams, and the function of dreaming. We consider the perspective of the individual and the social perspective, and within the social perspective we distinguish the social context that is relevant to particular dreams for the individual and the broader social context provided by the impulse to construct scientific accounts of dreaming. The reader will appreciate that something of what we say is applicable to the "brain-mind problem" more generally, with modifications needed to incorporate the role of afferent impulses.

The dreaming state is a well-defined state of consciousness from a physiological point of view. The presence of rapid eye movement is experimentally and reliably associated with that state as are changes in the EEG record and in the cardiovascular and pulmonary systems. These phenomena are observable, however, only by an external agency. They seem to be common to all dreaming experiences and it does not appear to be feasible, in general, to differentiate dream content with reference to them—at present they are irrelevant to the study of dream particulars, the images found in the dream, the visual metaphors that constitute the expression of these images, and the emotional associations that may attend these metaphors. They characterize the physiological state in which dreaming occurs, and at least for the present, not much more. The individual knows nothing of them in his/her awareness, either while dreaming or later when awake. The college professor who dreams of his avoidance of social interactions does not recall the rapid eye movements that accompanied his dreaming state. Neither have these observables any bearing on the particular social context that might have given rise to the dream. The social context varies from day to day, from one situation to another, and between dreamers.

The observables are as common and as predictable as we could want.

The substance of the dream, on the other hand, has a wealth of psychic structure. It has emotions which determine its feeling tone. It has what we may call a "cognitive" structure, a literal representation usually approximated by a linguistic rendering by the dreamer in the waking state. And it has the structure that allows the vigilance mechanism to associate it with elements from the organism's history in a highly selective and detailed way. All these structures and the processes which manipulate them (for whatever reason) constitute a specific biological capacity, one which is universal across the human species and possibly across all organisms with nervous systems, associated as it is under our hypothesis with the vigilance capacity. It is interesting to speculate that these formal structures and their attendant processes may be described in terms of a "generative" system, an explicit finite set of exact rules operating on finitely representable, explicitly defined structures, in much the same way that a generative transformational grammer proposes to describe our capacity to associate (verbal) sounds with meanings, and our capacity to produce, on demand, arbitrary utterances that are well-formed according to the grammar.

We feel that at the present time there is no feasible way to offer an explicit account of the substance, or content of dreaming. In this connection it is important to appreciate that what we call "the dream" is an artifactual, largely linguistic expression of a transient, unstable, and perhaps emotionally charged experience that occurred prior to the verbal expression, and in a state of consciousness quite distinct from the waking state. The images, relationships and events that the dreamer perceives are often quite meaningful to him/her, perhaps less so to others. Ceremonial functions, phonograph records and a failure to participate socially were of significance to the college professor, but were less important to the people around him. Many of us deal with the ceremonial aspect of social existence; we sometimes experience difficulties in submitting to social relationships; and we sometimes substitute stylized entertainment for personal interactions with others, whether that entertainment is found in the theatre, television, sports, bars or the public park. It is surely quite particular that these issues find expression in terms of Easter Mass, a briefcase, and phonograph records inappropriately concealed in closets in a church.

If the scientist cannot observe these details with his/her instruments, the dreamer can share them with others. Those aspects of the dreaming experience that are not publicly observable are precisely those that are of potential significance to the dreamer and to his/her social context. Nowhere do we find more sharply defined the contrast between the concerns of the individual and those of the scientist. The dream's content is entirely beyond the scientist's reach, and it is the only aspect of the dreaming experience that falls

within the dreamer's perception. It is clearly altogether inappropriate to suggest that on that basis dream content is of no significance. If the dreamer finds substantial value in the dream content, then from the individual's perspective there *is* significance, and the absence of a publicly observable manifestation of this content is irrelevant. If we live in a global community that values conformity and submissiveness and assigns the individual an importance that is secondary to that of its institutions, we will be prone to denigrate those experiences that are entirely private and personal. The primacy of the individual is not derived from the rational scientific formulations. It is a given. If the individual cannot survive with his/her behavioral, intellectual and affective skills intact, then the survival of the species is at risk. Under the vigilance hypothesis, dreaming is a universal biological capacity of enormous significance and survival value both to the individual and to the species. If there are aspects of the dreaming experience that are obvious to the individual but inaccessible to the scientist, then the appropriate scientific stance is to maintain a discreet silence on those aspects.

We note as well that the content of the dream may be of significance to the social context in which the dreaming experience occurs and to the context in which the dreamer reports it. Anyone who has had the experience of uncovering in a supportive social milieu (Ullman and Zimmerman, 1979) metaphorical references contained in the manifest content of the dream, knows that this process of uncovering and the feel of the metaphorical connections can be of substantial value to others as well. It shows others how the dreamer's relationships are impaired. It shows them in what is for them objective and emotionally neutral terms how relationships in general may founder. It respects them for their capacity to listen and to respond. For the individual dreamer it restores some of the dignity that is lost in a technologically oriented society dominated by the institutions that administer that technology. Driving here and there in our cars, we avoid immediate contact with others. Speaking on the telephone, we avoid direct contact with the other individual. Watching television (listening to the phonograph), we avoid public entertainment in the company of others. But in working out our dreams in a social context we are scaling all these barriers. We are expressing and dealing with our connectedness (or lack of it) with others in a tolerant and compassionate social setting that is a model of what is absolutely essential if the species is to survive.

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