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Announcement
11th Annual APSS Meeting
June 10-15, 1997,
San Francisco Hilton Hotel and Towers
333 O'Farrell St, San Francisco, CA

Article
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On The Nature and Functions of Dreaming

News and Comment
2nd Congress of the Asian Sleep Research Society
August 24-29, 1997, Jerusalem, Israel

European Sleep Research Society Meeting
September 9-12, 1998, Madrid, Spain

SRS Bulletin is on the Web
http://bisleep.medsch.ucla.edu/srs/publications.htm
• There was a 35% increase in abstract submissions over last year.

• Postgraduate courses will be held June 10-11

• Scientific program: June 12-15.

• Speaker at opening ceremonies: Claude Lenfant, M.D., Director of Heart, Lung, and Blood Institute of NIH.

• Keynote address on circadian rhythms and sleep, Charles Czeisler, Ph.D., M.D.

Symposia topics:

Sleep Heart Health Study, chaired by James Kiley, Ph.D. of the National Center for Sleep Disorders Research, NIH
Chronic Use of Hypnotics, Thomas Roth, Ph.D
Sleep and Neurobehavioral Functioning in School Children, Avi Sadeh, D.Sc.
Circadian Desynchronization—Theoretical and Practical Implications, Peretz Lavie, Ph.D.
Brain Topography of Sleep, Alexander Borsely, M.D.
Dorsal Raphe Neurons: Why Do These REM-off Neurons Turn Off?, Robert McCarley, M.D.
Gene Knockout Studies in Sleep Research, Priyattam Shiromani, Ph.D.
Sleep disordered Breathing and Cardiovascular Disease, John Floras, M.D
Neurophysiological and Pharmacological Aspects of Sleep Modulation by GABAA Receptors, Marike Lancel, M.D.
On The Nature and Functions of Dreaming

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I will outline here my current thinking on the nature and functions of dreaming based on several pieces of new research, clinical work with dreams, and a developing view of the network characteristics of the mind.

I will make some relatively broad statements in outline form followed by an attempt to back up the statements with available research; when such research is lacking I will discuss the point using inferences from research in related areas.

The mind is a net. The cerebral cortex — which, with some input from underlying areas constitutes the substance of our minds — functions as a complex net

This is of course a model and cannot be proven by data. There is always a danger of picturing the mind according to our latest technological fashions; nonetheless since we think in terms of visual models I believe we definitely require some image of the mind on which to hang our thoughts and at this point I believe the best model involves a net or network of nets. Such network models have proliferated lately—sometimes optimistically called "neural nets" in hope that they would correspond with the actual structure of the cortex and more conservatively called "connectionist nets" described by computer models assuming a large number of simple "on/off" units with variable connections between them. Although these are tremendously over-simplified nets even a connectionist net of this kind containing only a few tens or hundreds of units have shown success in modeling certain human
learning tasks — for instance the learning of regular and irregular verbs (1) or performance on the Stroop Color Naming Test (2).

I have previously postulated "connecting" and "reconnecting" as basic aspects of dreaming (3, 4, 5), without specifying any particular connection mechanism. It appears that the connections occurring in dreams can fruitfully be examined in such a neural net or connectionist net model.

**Dreaming makes connections more broadly than waking in the nets of the mind**

In this sort of net, all that can happen, during waking, dreaming, or non-dreaming sleep, is the lighting up of certain patterns and the strengthening or weakening of the weights on certain connections; we make connections all the time. I suggest that there is an important difference: dreaming connects more broadly and more widely than does waking; in this sense dreaming can be considered "hyperconnective". Figure 1 illustrates part of what I have in mind. This is a highly simplified rendering in two dimensions of a few aspects of the net: using a "spread of excitation" model. I suggest that in waking there is a tendency for linear development of specific imagery usually guided by a specific task or goal. For instance, in thinking of a house, my waking mind seldom pictures a generic house; rather it is looking for a particular house to answer a specific question: "Where did I live in 1980?" An entire pattern lights up representing not just house but very quickly a specific house in my memory, and in fact, the specific house in which I lived in 1980. The excitation follows a set pattern; it remains in a "groove", with relatively little "spread". **SEE FIGURE 1**

In dreaming, I suggest the progression is less specific and less focused. The pattern representing house may be lit up, but then rather than only moving to a specific house, the excitation process also spreads "laterally" to patterns representing other houses and other similar structures -- hotels, institutions, etc. Waking -- and for now I am speaking of focused waking thought, the sort of waking thought that is furthest from dreaming -- tends to stay in a sort of "groove" or "rut" whereas dreaming thought tends to wander and combine. The setting for a dream can often be a generic house or a combination of several houses. In looking over 100 of my recent dreams in which I had very carefully noted details of the setting, I found that the most common settings (60%) involved a kind of generic house (or room or outdoor area); a house that was somewhat like my house, yet different, a room that was partly a lobby and partly a lecture hall, etc. Freud's best known dream likewise starts with a generic setting: "A great hall...". These common "generic" settings would be scored as either "unfamiliar" or "questionable" settings in Hall and Van de Castle's standard content analysis (6); their norms in students are 57% (male) and 53% (female) for the sum of these two categories. Inge Strauch has recently found in a group of 11-13-year-olds that the setting for their home dreams as well as lab dreams (REM dreams) were most often unfamiliar or generic whereas their fantasies usually took place in familiar settings (unpublished).

This broader and less focused character of dreaming is consistent with some well-known facts on the biology of the forebrain in REM sleep, the state during which most though not all dreaming occurs. I suggested as early as 1973 based on pharmacological studies that dreaming represents the functioning of the cortex without the influence of norepinephrine (3). This has been confirmed and extended: REM sleep appears to be characterized not only by the virtual cessation of norepinephrine release at the cortex but by similarly reduced serotonin and increased acetylcholine (7, 8). The neuromodulatory action of norepinephrine at the cortex can be summarized as "increasing signal-to-noise ratio" and "inhibitory sharpening" (9, 10, 11). The lack of such sharpening can easily be related to the view of dreaming pictured in Figure 1.

I view our hypothetical net as having some more tightly woven or over-learned portions and other looser portions. The more tightly woven portions refer to well-learned rapid-processing
feed-forward activities which lead relatively directly from input to output. The less tightly woven looser regions are those further removed from these postulated pathways. In Figure 2, I outline, again very roughly, a model of the brain seen as a growing complexity of interconnections (interneurons) superimposed on the simplest "reflex arc" connection between sensory input and motor output. In this simplified picture I place "feed-forward" mental activities such as calculating (for instance plotting trajectories in hunting prey or in catching a baseball) as still relatively close to the "center". All our verbal and mathematical abilities, which activate many different parts of the cortex according to recent imaging studies, are nonetheless placed relatively "centrally" in this diagram. The "outer reaches" consist of the memory nets more readily accessed in reverie, daydreaming, and dreaming. This is a land populated by moving pictures and by metaphor (by the potential for producing pictures and metaphor - - see below) with relatively little direct connection to sensory input or motor output. In this sort of picture, focused waking is more a hunt and dreaming is more an exploration. SEE FIGURE 2

One postulate derived from this view is that certain activities of focused waking — rapid processing, feed-forward activities, etc. should be relatively neglected by dreams. This has led to a study of reading, writing, and arithmetic (the "Three R's") in dreams.

We do not dream of the three R's

In a preliminary study two scorers simply examined 129 dreams from two other studies of 68 home dreams and 61 laboratory dreams. The two blind scorers agreed perfectly that in these dreams there were zero instances of writing, zero instances of reading, and one instance of arithmetic described in the dreams (12).

In a broader survey study a questionnaire was sent to 400 good dream recallers (a mean of 6.8 dreams recalled per month) asking about any dreams involving the Three R's (12). In the first part of the questionnaire respondents were simply asked how often they had dreamt about reading, writing, typing, and calculating on a scale going from "never" to "very frequently". Respondents were also asked how much time they spent in these activities during waking. The results were quite consistent for the four questions; in each case about 90% responded that they dreamt "never" or "almost never" about the activity in question, although these subjects reported spending a mean of six hours per day on these tasks during waking.

Respondents were then asked about the relative prominence of six activities — walking, writing, talking with friends, reading, sexual activity, typing — in their waking lives and in dreaming. The results were very clear-cut (see Table 1). Reading, writing, and typing were much less prominent than the three other activities (p < .0001). The activities "writing", "reading", and "typing" did not differ significantly from each other; nor did the three "other" activities differ from each other, though they were chosen to cover a wide range of "Non-three R" activities. All these results demonstrate that we dream very little of the Three R's.

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tr>
<td>Relative prominence of six activities in</td>
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<tr>
<td>waking and dreaming (X ± S.D) in 240 respondents:</td>
</tr>
<tr>
<td>WALKING*</td>
</tr>
<tr>
<td>2.9 ± 1.1</td>
</tr>
<tr>
<td>WRITING**</td>
</tr>
<tr>
<td>1.4 ± 0.8</td>
</tr>
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Each variable marked ** differed significantly from each variable marked * by pairwise t-tests (p < .0001). There were no significant differences between variables within the two groupings (* and **). There was no correlation between sex or age and any of these six variables.

The broader connections in dreaming are not made randomly — the process is guided by emotion

I have outlined above some ways in which dreaming appears to make connections more broadly than waking, producing "generic" rather
than "specific" imagery — in a more "peripheral" portion of the nets (further from rapid input-to-output processing such as the 3 R's). But is this making of connections a random process? I think not. In terms of a net such as I have discussed above, there is a constant flow of excitation and shift of weights. One can see this as an equilibration, a smoothing out of peaks and valleys.

In an auto-associative net this can be described mathematically as a settling into a pattern of reduced "computational energy" or increased "harmony" (13). We can visualize this roughly as a windswept sea which when the wind dies down tends to settle towards a relatively smooth surface. This settling occurs especially when there is less new input and when the net functions less in a feed-forward and more in an auto-associative mode — thus in dreaming. The process can be seen as "driven" by regions of "storm" and high waves — regions of the net with increased "charge" — or computational energy. But these waves and wind are not random or meaningless. I suggest that in everyday human terms they are the emotions and emotional concerns of the dreamer. The data I have collected (below) suggests that emotion — the dominant emotion of the dreamer — is the force which drives or guides the connecting process and determines which of the countless possible connections are actualized at a particular time and thus which images appear in the dream. Dreams "contextualize" the dominant emotion.

 Dreams after trauma as the trauma resolves: dreams contextualize emotion

I have collected series of dreams from over thirty adults and adolescents who have experienced a severe trauma (14). We are beginning to analyze these in a quantifiable fashion (see below) but one qualitative finding leaps out immediately which I call the tidal wave phenomenon.

People who have experienced any kind of trauma — an attack, a rape, escape from a fire — in the weeks after the trauma usually dream to some extent of the actual event, but they also dream of being overwhelmed by a tidal wave or of being caught in the path of an onrushing train or being caught by a gang of thugs. What is happening here? Clearly in these very common dreams the person is dreaming not about his/her sensory experiences but about his/her emotional state. The dream seems to be picturing or finding a context for the emotional state; the dream "contextualizes emotion". For instance in the period immediately after trauma, we have many examples such as the following which seem to contextualize fear or terror:

A huge tidal wave is coming at me.

A house is burning and no one can get out.

A gang of evil men, Nazis maybe, are chasing me. I can't get away.

There are also dreams contextualizing helplessness and vulnerability:

I dreamt about children, dolls -- dolls and babies all drowning.

He skinned me and threw me in a heap with my sisters; I could feel the pain; I could feel everything.

There was a small hurt animal lying in the road.

For some, guilt is especially prominent and in fact in the longitudinal series, after dreams that appear to picture fear and terror, there are dreams dealing with guilt, especially survivor guilt:

A shell heads for us (just the way it really did) and blows up, but I can't tell whether it's me or my buddy Jack who is blown up.

I let my children play by themselves and they get run over by a car.

I leave my children in a house somewhere and then I can't find them.
In cases where a recent loss — a death of someone close — has occurred, dreams seem to contextualize grief:

A mountain has split. A large round hill or mountain has split in two pieces, and there are arrangements I have to make to take care of it.

A huge tree has fallen down.

I'm in this huge barren empty space. There are ashes strewn all about.

The above of course have been picked out as examples, simply "illustrating" rather than demonstrating.

To begin to quantify this difficult area we have recently developed a scoring system for contextualizing images and have reported some early results (15). For instance in one group of 135 dreams consisting of 68 dreams following trauma and 67 dreams without trauma, in the case of dreams with trauma there were 46 in which two (or in some cases three) scorers agreed perfectly. Of these dreams 39 were scored yes (there is a contextualizing image) and seven were scored no. In the 50 dreams without known trauma where there was perfect agreement 25 were scored yes and 25 were scored no ($X^2 = 13.0; p < .001)$. The images after trauma were also scored higher on intensity of the image (2.2 versus 1.8 on a scale of 1 - 3). In the most "severe" case where eight dreams were collected in the weeks immediately after a rape, raters agreed perfectly on scoring eight out of eight dreams. Seven of the eight were scored yes (definitely having a contextualized image) and the mean intensity was rated as 2.50. In another sample 42 dreams as well as 33 daydreams of students with no known trauma were scored on a blind basis by two raters. The dreams were scored as containing a contextualizing image in 57% of cases, whereas daydreams had such an image in only 21% ($p < .002$). Thus we are beginning to feel confidence that these contextualizing images can be scored.

Over a period of weeks or months as the trauma gradually resolves, the dreams often follow a discernable pattern. First the trauma is replayed vividly and dramatically but not necessarily in precisely the way it occurred: there is often at least one major change in the dream, something that did not actually occur. Very rapidly the dreams begin to combine and connect this traumatic material with other material that appears emotionally similar or related. Often, as we have seen above, a person who has been through one kind of trauma dreams of all kinds of other traumas that may be related to this same feeling of helplessness, terror or guilt. In some cases this connecting involves reactivating previous trauma and other emotionally important personal themes evoked by the trauma ("rekindling"). If the dreamer is a "survivor" while others have been killed or injured, the theme of survivor guilt almost always emerges. The themes of the dreams and nightmares are often "Was it him or was it me?" and/or "How come I survived and he/she didn't?" (For instance: "... a shell blows up but I can't tell whether it's me or my buddy who is blown up"; "I get burned in the fire and my brother's safe."). If someone was injured there is often a theme of guilt in the sense of "did I have something to do with bringing this on, was I responsible for it?" (This can occur even if there is absolutely no realistic evidence that this was the case). The process of connecting the trauma with other emotionally related material from the dreamer's life (and imagination, reading, daydreaming) gradually expands and takes in more and more other material; the trauma itself plays a smaller and smaller role and the dreams return to their pre-trauma state.

The process seems to consist of cross-connecting or interweaving -- making connections with whatever related material is available in memory and imagination, guided by the dominant emotions of the dreamer, which gradually become less intense and change their character as the trauma is resolved or integrated. Although at the level of the neural net we are still talking of smoothing out peaks or waves or spreading excitation from over-excited zones, the process follows definite non-random paths which we can
understand in terms of the dreamer's emotions and past experiences.

There is often a typical progression of emotional concerns. First, as noted, the dreams deal with absolute terror and fear; then sometimes vulnerability and helplessness; then, quite often, the dreams deal with guilt, especially survivor guilt. Later still the dreamer deals with grief and loss and attempts to come to terms with a new reality, etc. These are now individual concerns of the dreamer and of course become more complex; I can no longer give "typical" examples of the imagery used.

Post-trauma dreams are a paradigm — the same process occurs, though it is harder to discern, in all dreaming

I believe that dreams after trauma, as the trauma resolves (above), may be a paradigm and an excellent place to start since we know precisely what emotion must be on the dreamer's mind. This is usually less clear in other situations.

I suggest that the same making of connections in pictures and contextualization of emotional concern can be found in other situations — probably in all dreams. If one examines dreams in "stressful situations" in studies such as the classic ones by Breger et. al. (16) one finds many very similar contextualizing images. The progression seems to be similar to that after trauma though without the initial step dealing directly with the trauma.

A huge body of literature on dreams in psychotherapy can be explored in the same way though of course we must be wary about the selection process: hardly anyone in therapy (or out of therapy) provides a complete record of his or her dreams. I have been able to obtain some relatively complete series — for instance the dreams of a woman who has recently been overcome by guilt about not being a good enough mother for her children, reviving a longstanding childhood guilt of never being able to do anything well enough to satisfy her demanding parents. I have a record of 35 dreams told to me by this woman and almost all of them are of the same kind:

My children are lost in a storm; I can't find them. I leave my son alone and a big cat is clawing him, killing him. I'm at a hotel by the seashore. My two children are off in separate rooms and the tide is coming up fast. I wake up panicked that they'll drown.

In this very common kind of situation dreams appear to be neither crazy nor random. They are picturing (contextualizing) a very clear emotional concern.

Similarly, patients beginning long-term psychotherapy or psychoanalysis have an obvious concern: "what am I getting into?" or "what is going to happen to me?". I am aware of three different cases in which very similar dreams were reported more or less as follows:

"I am walking along a mountain path with steep drop-offs on each side. It is a bit dangerous. There is a large, shadowy figure accompanying me -- I am not quite sure whether this figure is good or evil."

Dreams of pregnant women provide another situation in which there is a series of fairly predictable emotional concerns which can be traced. Any number of dreams early in pregnancy deal with body distortions, etc., clearly picturing "what is happening to my body or will I still be attractive?" Dreams later in pregnancy deal with small animals or other objects getting larger and sometimes looking weird and deformed, obviously dealing with the concern of "what is this baby going to be like". Finally towards the end of the pregnancies there are dreams dealing with "will I be able to be a mother" and "will I be able to take care of him or her" (17, 18).

I am suggesting that though my recent data come mainly from dreams after trauma as the trauma resolves, this contextualizing of emotion may be a more general aspect of the nature of dreams. Dreams contextualize the emotional
concerns of the dreamer. However I suggest that when one simply looks at a few dreams collected from a few college students, the dreams may seem confused and almost random since we know little about the true emotional concerns of the dreamer (even if we ask for a list) and furthermore the concerns at any time may be multiple and not very strong.

The form of dreams is metaphor. Dreams can be thought of as explanatory metaphor.

So far, I have suggested that dreams make connections more widely, more broadly, than waking and that the connections are guided by emotion and emotional concerns. Dreams contextualize emotion. But what form do these connections or contextualizations take? Obviously they do not, or very rarely, take the form of verbal narratives or mathematical formulas. Though we are often forced to work with verbal dream reports, we need to keep in mind that these are only attempts to render the dream experience in a preservable and reproducible form. What is experienced generally is images and usually — in sighted persons — visual/spatial images in motion. The dream-world looks very much like the waking world. The visual/spatial form of dreams is a fascinating problem in its own right; for instance, David Foulkes and his associates have studied in detail how the visual/spatial imagery of dreaming develops gradually in children at about the same time such imagery develops in waking life (19).

I do not consider it surprising that dreaming takes the form of moving visual/spatial imagery because basically that is all there is. The nets in our minds are made of units and connection weights, which we cannot directly see or experience, but which represent the ability to construct, or approximately reconstruct, a visual/spatial "reality". This view derives from the basic parameters of distributed processing: memory is not facsimile but reconstitution. It is also consistent with work from a totally different direction: Antonio Damasio (20), based on his clinical neurological work with brain-damaged patients speaks of knowledge as embodied in "dispositional representations". "What 'dispositional representations' hold in their commune of synapses is not a picture per se, but a means to reconstitute a picture." Dreams provide contextualizations in pictures. Another way of putting this is to say that dreams deal in metaphor. This may seem far-fetched if one thinks — as many of us were taught — that metaphor is a specific "trope" used as a rhetorical device. However, metaphor is ubiquitous. The work of Lakoff, Johnson, and others (21, 22) has recently demonstrated the ubiquity of metaphor in our thoughts as well as our language. We can hardly speak of important topics such as life or relationships without using metaphor such as a "I am stuck", "our goals are in sight", "we are spinning our wheels", "it should be smooth sailing from here on", "I have to bail out of this relationship", etc.

In this sense metaphor is not a rhetorical trope, not even an aspect of language, but a basic way our thinking is structured. Admittedly not all our thinking is metaphorical. It becomes increasingly metaphorical as we move down our continuum from focused thought to dreaming. When we are calculating for instance or engaging in a straightforward over-learned activity such as typing a manuscript (the 3 R's), there is little metaphor involved. As we stop and let our thoughts drift we begin to think in metaphoric pictures; this occurs even more in dreams. Dreams as we have seen are deficient at calculating and reading, but they are loaded with (another metaphor — I can't help it) pictured metaphor. In fact, this is not a new idea. Ullman for instance, wrote an entire paper, called Dreams as Metaphor in Motion, in 1969 (23).

Individual differences: some people function more "dreamily" than others

There are great individual differences related to dreaming but these need not concern us here unless they can shed some light on the connecting and contextualizing aspects of dreaming that we have discussed above. I believe
individual differences relating to thickness of boundaries may be relevant in this sense. I have discussed elsewhere in great detail individual differences along a dimension known as thin versus thick boundaries (24). In general people with thick boundaries keep everything in their minds separate; they tend to be solid, well-organized, sometimes rigid; they have relatively little investment in fantasy; they think in black-and-white terms. People with thin boundaries have the opposite characteristics: they tend to merge thoughts and feelings; they have vivid fantasies not always kept separate from reality; they are less defended; they think in shades of grey, without black or white.

We have demonstrated that there is a highly significant correlation between the amount of dream recall and thinness of boundaries; and in fact persons with thin boundaries not only report more dreams but their dreams are scored as more vivid, detailed, emotional, bizarre, "dreamlike", and with more interaction between characters compared to dreams of those with thick boundaries (25). Furthermore, those with thin boundaries have more "dreamlike" characteristics even in their waking lives. In a preliminary study a group of students were asked to write down a recent dream as well as a recent daydream. Reports were scored for bizarreness and for "dreamlikeness". Overall dreams were scored as much more bizarre and more "dreamlike" than daydreams, but there was a shift between subjects so that those subjects who scored thin on the Boundary Questionnaire had daydreams that were just as bizarre and almost as "dreamlike" as the dreams of those with thick boundaries (26). In other words the continuum we have discussed running from focused waking mental functioning at one end to dreaming at the other end is somehow related to the continuum we have studied across individuals running from very thick boundaries to very thin boundaries. Those with thin boundaries live more on the "dreaming" end of the continuum.

Dreaming may have a function in cross-connecting or "weaving in" new material — not so much consolidating material but rather increasing the connections

The above is an outline of my views on the fundamental characteristics of dreaming and how dreaming differs from waking. But is this simply the way things are or does dreaming have a function? Starting again with my collection of dreams after trauma as the trauma resolves, it sometimes appears that the contextualization of emotion and making of multiple connections with past similar emotional material might have a function in terms of connecting or weaving-in new and difficult material. The initial reaction to a severe trauma may be something like "HELP! THE WORLD IS ENDING", "THIS IS THE MOST HORRIBLE THING THAT HAS EVER HAPPENED", "HOW CAN ANYONE SURVIVE THIS", but then as connections are made there may be a gradual increase of "YES, THIS FEELS BAD BUT IT'S A BIT LIKE....", "I'VE EXPERIENCED SOMETHING LIKE THIS, I'VE WORKED ON THESE FEELINGS", or "I'VE DEALT WITH SOMETHING SIMILAR; IT'S HARD BUT IT'S POSSIBLE TO CONTINUE".

In this sense dreaming may have a quasi-therapeutic function: the making of connections in a safe place. I have reviewed many similarities between dreaming (whether or not remembered) and the process of psychotherapy, especially after trauma (27). Both good psychotherapy after trauma and dreaming first provide a safe place for work to be done. In therapy the safe place is much more than the physical setting; it involves the safe "boundaries" of the therapeutic situation and the gradual trusting alliance formed between patient and therapist. In dreaming — especially in REM sleep — the safe place is provided by the well-established muscular inhibition which prevents activity and the acting out of dreams. Once a safe place is established the therapist allows the patient, especially the traumatized patient, to go back and tell her or his story in many different ways, making connections between the trauma and other parts of the patient's life — overall making connections and trying to integrate the trauma. As connections are made between the terrible recent event and other material, the emotion becomes less powerful and overwhelming and the trauma is gradually
integrated into the rest of life. Dreaming may perform at least some of these same functions. Dreaming and psychotherapy both can be conceptualized as "making connections in a safe place". Thus dreaming may have a quasi-therapeutic adaptive function which can be seen most easily after trauma though I believe again that trauma is a paradigm and that dreaming has the same function, though less easily discernible, at other times.

In terms of the nets of the mind, the spreading out of excitation or reduction of "computational energy" is useful in presumably allowing the net to function better, in a more harmonious state. But the effect is not purely "energetic"; the spread of excitation forms increased connections and cross-connections which inevitably alter the future functioning of the net. The trauma, or any disturbance, is cross-connected, "woven in" by dreaming as numerous new connections and contexts are provided. This process is likely to be useful for future functioning since a new trauma or disturbance will be less serious, will produce less "storm-waves" since appropriate contexts and cross-connections are already present.

In this broad sense I see dreaming — making of broad connections and contextualizing — as having a function which can be seen both as restorative/adaptive in an immediate sense (spreading excitation, calming the storm) and as producing changes in memory networks which are adaptive for the future. This change in networks is not a consolidation of memory but a broadening of memory through cross-connections — an increase in connections, a weaving in of new experience.

This possible function of dreaming can be called quasi-therapeutic or adaptive and I would call it a contemporary theory of the function of dreaming rather than my own theory since others have suggested very similar functions starting from very different data bases. Thus French and Fromm (28) and Palombo (29) using clinical data, Breger, et. al. (16) studying acutely stressful situations, and Cartwright (30) in research on people under a prolonged stress (divorce), have all proposed versions of an adaptive function of dreaming. Jones (31) made an analogy between dreaming and effective psychotherapy. Koula (32) has proposed a complex functional theory which at least in part involves "mastery of stress". Fiss (33) has proposed that dreams function to maintain "self structures". Greenberg and Pearlman (34, 35) have suggested several versions of an adaptive problem-solving function. Milton Kramer (36) has proposed a "selective mood regulation" function of dreaming which derives from very different studies but is similar to what I have been discussing in terms of a calming of stormy seas or spreading out of excitation.

Although dreaming should not be confused with REM sleep, since most dreams come from REM sleep any hypothesis on the nature and functions of dreaming should at the very least be compatible with what we know of the nature and functions of REM sleep. As we saw above, the present view of dreaming is very compatible with low norepinephrine availability at the cortex during REM sleep providing less "inhibitory sharpening". Concerning function, although the functions of REM sleep are still unknown, the present views of the functions of dreaming in terms of cross-connections is certainly compatible with two related views on the functions of REM sleep. It fits well with the view by Roffwarg, et. al. (37) that REM sleep, especially in young organisms, helps to "develop the nervous system" — evidently by making new connections. It is also compatible with the view that REM sleep functions in the "repair, reorganization, and formation of new connections in amine-dependent forebrain systems" summarized as "knitting up the raveled sleeve of care" (3).

Critics skeptical about any function of dreaming often question how dreams can be important if most of them are forgotten. I suggest that remembering or not remembering an individual dream image is not what is important in terms of function. What is probably most important is the making of broad cross-connections in the net, the redistribution of weights, etc., all of...
which can occur whether or not the actual dream content is remembered. Of course, when a dream is remembered, then in addition to this basic function, dreams can be useful in any number of other ways — in problem solving, self- knowledge with or without a therapist, and occasionally in helping with artistic and scientific discovery. And although I do not believe the essential function of dreaming requires recall, yet it must of course be admitted that all our conjectures about dreaming — including the present one — are necessarily based on examination of the subset of dreams that are remembered.

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**European Sleep Research Society Meeting**

**Madrid, Spain**

**September 9-12, 1998**

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**2nd Congress of the Asian Sleep Research Society**

**August 24-29, 1997**

**Jerusalem, Israel**

Further Information: Congress Secretariat

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THE HOUSE I LIVED IN 50 YEARS AGO

A FAMILIAR HOUSE

A HOUSE

Figure 1A. WAKING

THE HOUSE I LIVED IN 50 YEARS AGO

A FAMILIAR HOUSE

A HOUSE

Figure 1B. DREAMING
Figure 2