

The World Simulation Process in Waking and Dreaming: A Systems Analysis of Structure

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Questions about the reality and production mechanisms of nocturnal dreaming can be illuminated by a systems approach. Any state of consciousness, ordinary or altered, is an integrated, stabilized system. A primary function of ordinary waking consciousness is to create an accurate simulation of the physical environment. The consequences of this world simulation process are constantly compared with sensory world data, thus providing strong constraints on the simulation. In nocturnal dreaming these constraints are largely inoperative. Thus, the dream world is constructed by the same simulation process as the ordinary waking world, but with much higher variability. It is just as real to the experiencer as ordinary reality.

Is a dream "real"?

This is one of the first questions children ask about dreams, and one that is still asked by some adults, even though our cultural conditioning inclines us to dismiss the question as silly: Dreams are just subjective fantasies in the night, not real at all! And yet they sometimes seem so real. . . .

At one philosophical extreme, a dream is real in the sense that anything that can be realized, experienced, is real. Thus, dreams, thoughts, fantasies, hallucinations, are all real, although they may differ in terms of experienced quality and intensity, and in their consequences on your life. At an opposite philosophical extreme, where only what is material is real, dreams become an epiphenomenon, a subjective will-o-the-wisp, hardly worthy of scientific attention. Between these extremes of conceptualization, we recognize that a dream can certainly seem real to the dreamer, and may have psychological effects on the dreamer's later life. This note on the nature of dreams will work in this middle ground, and focus on questions of the degree of reality of a dream at the time it is experienced and on the mechanisms by which the dream world is created.

The Nature of Ordinary Consciousness

To understand dreaming, we must examine some general features altered states of consciousness. To understand altered states, we must examine the state we all too often take for granted, ordinary consciousness. Let us briefly look at the nature of ordinary consciousness and at the nature of altered states of consciousness, as background for examining the nature of dreams.

Figure 1 is a relationship diagram developed in my systems approach to understanding altered states of consciousness (Lee, Ornstein, Galin, Deikman, & Tart, 1975; Tart, 1974, 1975, 1976, 1977a, 1977b, 1978a, 1983). We will use it here to illustrate the major processes constituting consciousness which are recognized by contemporary psychology. The named blocks represent processes or subsystems of the overall system of consciousness, the arrows represent major channels of information flow. The heavier the arrow, the more information flows under ordinary conditions.

Let me briefly describe each process. Each deserves at least a chapter and preferably a book in and of itself, but space limitations call for brevity. The interested reader will find a full exposition of the systems approach to altered states in my *States of Consciousness* (Tart, 1983) and the other references cited above.

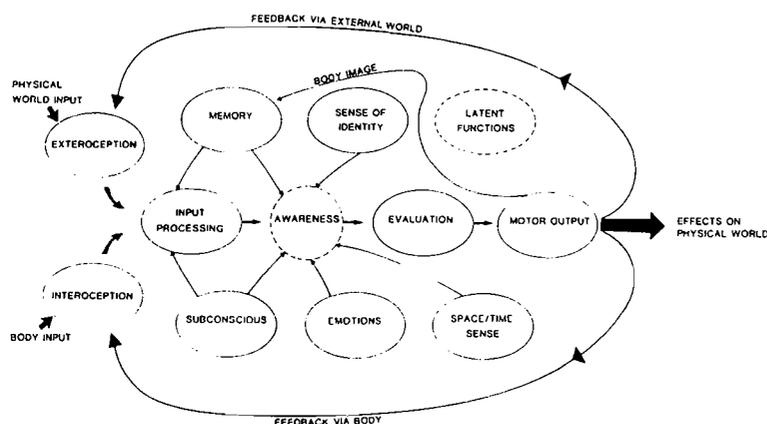


Figure 1. A state of consciousness as a system, showing major subsystems of consciousness, primary information flow routes and major feedback stabilization loops.

Subsystems of Consciousness

Exteroception refers to the receptors we have for sensing the world external to our body, our ordinary senses. You read right now with an exteroceptor, your eyes.

Interoception is the class of processes that gives us information about the internal state of our bodies. Noticing a cramped muscle, sensing your

balance or feeling the stance of your body are examples of interoception.

Input processing refers to the fact that our perception is not just given by the nature of the sensations reaching our exteroceptors and interoceptors; perception is a *construction*, a complex process whereby the input from our receptors is shaped, modified, added to, and subtracted from, until it becomes a percept of something familiar. The beliefs and prejudices of our culture, as well as individual biases and defenses, result in many semi-arbitrary habits of perception. These complex processes have all become fully automated in the course of enculturation, so we normally aren't aware of the steps in the process; it seems as if we just naturally see, hear, feel, etc. In reality, there is a complex, automated, almost totally unconscious processing of information going on that results in the apparently simple act of perceiving.

The fact that input processing produces something more complex than a simple carbon copy of the world we see is readily illustrated by illusions. Recall some time when you caught a clear glimpse, from the corner of your eye, of a person partly hidden in the brush, but when you looked again you saw it was just an oddly shaped bush. In *retrospect*, once you have looked more closely and clearly identified it, it was an illusion. At the moment you saw the person, though, you did not see a vague object associated with cognitive content of the sort, "Unresolved object in quadrant X with vaguely man-shaped characteristics, tentative identification as a person"; you saw, you perceived a person. Input processing rapidly and automatically created/constructed a percept of a person from the sense data available.

Memory refers to the many ways in which information about previous experiences, thoughts, and feelings is stored. For simplicity, we will ignore the many important types of memory processes distinguished in modern psychology and treat it as a unitary system here. Input processing relies heavily on memory for direction in its construction process. The "illusory" (in retrospect) person in the bushes in the previous instance was drawn from memory as a "best fit" solution on the problem of something man-shaped in your peripheral field of vision.

Awareness is the central component in this systems understanding of states of consciousness, but it is really beyond definition in words, as words are only a small subset of the total functioning of mind. Awareness loosely refers to our ultimate ability to know that something exists or is happening.

In ordinary consciousness awareness is usually almost totally absorbed in perceptions, emotions, and words. By words I mean internal talking to ourselves (which is what we usually mean by "thought"). But awareness per se is far more basic than words, as meditative experience can reveal. The systems diagram shows information from input processing feeding into awareness, as does information from most of the other processes shown in Figure 1.

Sense of identity refers to a special quality of information that is added to certain contents of awareness, a feeling (kinesthetic and emotional) quality as well as a cognitive quality that "This is me!", an "I!" quality that gives whatever it is added to special priority for attracting awareness and energy. The perception that "John Smith has a spider crawling toward his leg" doesn't have the same special feeling quality of the perception that "I have a spider crawling toward *my* leg!" Input from your body, via the interoceptors, is normally an important part of your sense of identity.

Emotions are the various ordinary (and not so ordinary) feelings that we experience, such as excitement, fear, anger, love, depression, sexual excitement, disgust, contentment, etc. Because emotions are so common we presume we understand them.

Space/time sense is, like input processing, part of the process of constructing our perceptions of our self and our world. It provides a space and time reference frame to effectively organize ongoing experience and records of past experiences. Experiences usually don't just happen, they happen *now, here*.

Evaluation refers to the various processes of evaluating information: Given what I am perceiving and what I already know, what does it mean? If action is called for, what should I do? Evaluation includes formal, conventionally logical reasoning processes and illogical as well as illogical processes. The emotional processes are also evaluation processes, but have been separated out in this diagram because of their special qualities.

Subconscious processes are the normally invisible yet hypothesized intelligent processes we invoke to explain organized experiences and behavior that don't make sense in terms of what a person consciously experiences. When someone claims he is quite calm, for instance, yet shows classical signs of fear, we suspect unconscious mental processes work. I include positive processes here as well as the conventionally negative, Freudian hypotheses about the unconscious.

Finally, *Motor output* refers to processes for controlling our behavior and our bodies (muscular and hormonal, e.g.) that take the results of evaluations and decisions and allow us to act on them.

Stabilization of a State of Consciousness

Figure 1 implies a far too static view of what is really an interlocking, mutually supportive collection of dynamic processes. Ordinarily the overall outcome of this dynamically acting and interacting system is *me*, my state of consciousness. Despite constant change in the subsystems of consciousness, though, we usually (but not always) remain recognizably ourselves. The functioning of our consciousness is *stabilized*: It generally maintains its overall pattern, its integrity, its "state," in spite of constant changes in our external world and our body.

A sudden noise can occur, I can have a mild stomach ache, etc., but I

remain me. Like any well engineered system, changes are generally compensated for so they don't push the system out of its range of optimal functioning. If you went into a state of mystical ecstasy whenever there was a flash of light, you might enjoy it for a short while (by ordinary temporal standards), but you might not stay alive for long. The sunlight glancing off the grill of the truck bearing down on you should not send you into ecstasy, but be interpreted by ordinary state standards as a warning that you should get out of the street!

Much of the stabilization of ordinary consciousness comes about through the load, the work, that all these psychological subsystem processes impose on awareness. Because doing this work is almost completely automated, we ordinarily don't feel like we're working hard to maintain our ordinary state; we just seem to be in it. When much of that load is removed, as is typically done in inducing altered states of consciousness (relax, don't evaluate what's happening, just float along, etc.), the nature of conscious experience can change drastically.

Another major source of the stabilization of any state of consciousness (ordinary or altered) occurs through *feedback*: Information about results is sent back to processes that intended to bring about those results. I want to push a heavy box across the room, but not hit the furniture. I don't just throw all my muscle power into a shove, I shove gradually, I perceive how well the box is moving. Is it too slow, can I shove a little harder? Is it too fast, will I lose control and run into something?

Figure 1 shows two major feedback loops which are essential in stabilizing our ordinary consciousness. The upper one, feedback via the external world, refers to the fact that we use our exteroceptors to monitor the results of our actions, as with the example of shoving the box. I see where the furniture is in relation to the box, I hear a sound if I hit a piece of furniture with the box. The lower one, feedback via the body, refers to the fact that sensations in our bodies also tell us about the results of our actions. If I feel a pain starting in my lower back as I begin shoving the box, I had better heed that feedback and work out a different way of moving the box if I don't want to injure myself.

To summarize, ordinary consciousness is a semi-arbitrary construction. In the course of growing up we have built up huge numbers of habits: habits of perceiving, of thinking, of emoting, of acting. The pattern of automated functioning of these habits in our ordinary environment constitutes a system, the pattern and inner experience we call our "ordinary consciousness." This ordinary consciousness is stabilized, so it holds itself together in spite of varying circumstances. Forgetting the work that went into constructing this as children, and not realizing the cultural relativity and arbitrariness of much of it, we take it for granted as "ordinary" or "normal" consciousness.

Consciousness As World Simulator

Modern understanding of our sensory systems and of the nature of the physical world shows us that we do not perceive the world directly. Light waves reflect from objects in our environment, for example, and the reflected light waves stimulate the rods and cones in our retina to produce a pattern of neural firings. These neural impulses in turn stimulate other neurons to fire, relaying the original impulses from the retina. In the course of these relayings, some impulses die out, some are actively inhibited, some are enhanced, other neural impulses from other parts of the brain may be added, integrations may occur, etc. The final pattern of neural impulses in the visual cortex and higher nervous system levels is the final neurological stage we know about before awareness intervenes and the final, mysterious act of conscious perception occurs. From the point of view of the mind, the "object" we perceive is actually an elaborately constructed pattern of neural impulses, a *simulation* of external reality. In spite of its apparent physical reality, it is really an *inference*, a *hypothesis*, about external reality. And it is several stages removed from the inferred external object.

This final neural firing pattern is much more than a simple copy of the original pattern of neural firings in the retina. Input processing, at both neurological and psychological levels, has occurred outside our awareness, and this processing has produced a simulation of the object that reflected the light rays that struck the retina. This is true of all our exteroceptive modalities. The apple you see, touch, taste, and smell, the position of your hand you sense through your interoceptors as you hold it up, the sense of effort in your jaw muscles as you bite into it, all these are really patterns of neural impulses far removed from whatever is out there in the hypothesized external world. The now that you sense the apple in, the here that you sense it in, are also aspects of the simulation generated by the space/time sense subsystem. Our modern view of the brain declares that consciousness "lives in," or is "located in" a *simulation of reality*, not in reality itself.

Taking this a step further, the "you" that sees, touches, tastes, smells, grips, and bites the apple is also partially¹ a simulation. "You" are, in many ways, a pattern of neural firings that simulates/represents your body, your memories, your values, your self-concepts. It is the sense of identity subsystem/process operating as the core organizational framework for experience.

¹I say partially, as I do not totally equate mind and body in theorizing about the nature of consciousness. There are aspects of mind whose nature is not reducible to contemporary physical concepts or any straightforward extension of them. The issue is discussed more fully in my presentation of an emergent, dualistic interactionist theory of consciousness (Tart, 1978b, 1979, 1980, 1981). It is not necessary to elaborate on this for the present discussion of the nature of dreaming.

In terms of your bodily survival, it is vital that this simulation of external reality be a "high fidelity" simulation, that the simulations perceived by consciousness bear a close and lawful resemblance to what is actually present in the physical world. If my nervous system simulates the taste of the apple as something disgusting, I overlook a valuable source of nourishment. If input processing is always turning ambiguous objects in the periphery of my visual field into threatening figures, and I run without further looking, I am going to be exhausted, and /or attract predators by the noise of my running. This is overorganization of ambiguous sensory input. If, on the other hand, input processing is too conservative and under-organizes ambiguous input, I may not see that there really is a person hidden in the brush who may be an enemy.

This need for high fidelity simulation is why I describe ordinary consciousness as a *semi*-arbitrary construction. You must adequately simulate basic physical realities to survive. Once physical survival has been achieved, however, we live primarily in a social reality, where different cultures structure reality in quite different ways. If you had been born in certain cultures, you would find the sight of a woman's face sexually provocative: That is why women are required to be veiled in public. Obvious "common sense." Input processing automatically adds a sexually provocative quality to the sight of a woman's face once you have been acculturated and reached puberty. In another culture the sight of a woman's face would seldom be sexually provocative. Input processing does not add the sexually provocative quality as a "natural" aspect of the percept. The automated processes dealing with social reality, then, can be fairly arbitrary compared with those for dealing with the physical world. For the individual to adapt successfully to the consensus reality of his or her culture, however, requires that the social world simulation match the norms of the culture well.

The simulation of "I!" is also subjected to constraints. Part of this simulation consists of the body image. How much space do I take up? How wide am I? Will I fit through this opening? How much do I weigh? Will this branch support my weight? The simulation must show a high fidelity match to the physical world here or you may suffer. When we deal with aspects of the simulation relevant to cultural reality, however, we have different constraints. Am I attractive? Do I weigh too much? Am I authentic? Am I tough? Am I sophisticated? These answers to these sorts of questions may be highly culture specific and/or personal and/or ambiguous.

Altered States

Every one of the psychological processes which form the subsystems of a state of consciousness can undergo drastic changes. To mention just a few: An ordinary face can be seen as that of an angel or devil. I don't mean *interpreted* here, I mean the actual perception. Your heart can be felt as a

glowing mass of radiant energy instead of only a barely perceptible pulsation in your chest. Your memories can seem like those of someone else, or you may "remember" things that intellectually you know could not be known to you, yet they are obviously your memories. Totally new systems of thought can come into play for evaluating reality. What is most dear to you may change drastically. Space and time can function in whole new ways, as in experiencing eternity. Or your body may function and move in new ways.

Sometimes one of these radical changes can occur in isolation, in the context (state) of ordinary consciousness, and we just see the change as an oddity or temporary malfunction. Sometimes several may occur rather randomly in a disorganized way, as in fever delirium. Sometimes many of these sorts of changes occur simultaneously, and seem to have a coherence in their relationships, a new gestalt of consciousness forms. When this occurs, we talk about experiencing an "altered state of consciousness." The change is too radical to see it as a variation of your ordinary state, it is qualitatively as well as quantitatively different, and it is too organized to dismiss as delirium.

The Dream State

Now let us look at the most commonly occurring altered state, nighttime dreaming. Modern sleep research has shown that we all spend about 20% of our sleep time in a specific brain wave state, stage 1 EEG. There is a very strong association of stage 1 EEG and concurrent rapid eye movements (REMs) with the mental activity of dreaming, whether we remember the experience of dreaming or not.

Figure 2 illustrates major variations in the functioning of the subsystem of consciousness that occur in nighttime dreaming. The irregular lines indicate that a process functions significantly differently than in ordinary waking consciousness. We will look at the major processes or subsystems of consciousness in the same order as before to look at the nature of the

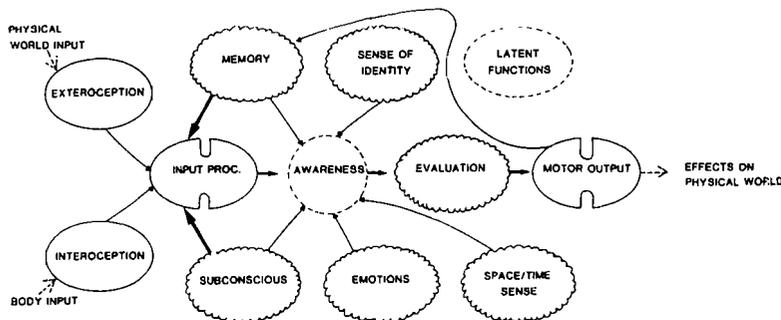


Figure 2. Major alterations in the state of consciousness system during nocturnal dreaming.

altered state of dreaming.

To dream, we must go to and remain asleep, that is, we must induce an altered state of consciousness. To be safe, we should eliminate our need to deal with the external world, and thus our need to keep up an accurate, ongoing simulation of it. Then we can proceed with the induction. Usually this means reducing exteroception and interoception to very low levels. We turn out the lights and close our eyes, eliminating visual input, for example, and we relax our bodies and don't move, eliminating interoceptive kinesthetic input. Thus, Figure 2 shows little input, represented by small arrows, to the extero- and interoceptors, compared to the ordinary waking state.

Further, we now know that there is an active neural inhibition of the external input that does reach our sensory receptors. Thus, the input processing subsystem is shown as "squeezed tight" in the middle. If you deliberately stimulate a sleeper, but not intensely enough to wake him, and then awaken him and get a dream report, you find that most stimuli do not make it through into the dream world. The few that do are usually distorted so they fit in with the ongoing dream. Calling the dreamer's name, for example, could become another dream character asking him about the state of his health.

Memory functions in a quite different way in dream consciousness. In our waking state we usually know when we are drawing information from storage: There is a nonverbal "This is a memory" quality attached to it. This quality usually disappears in dreams. The conventional view of dreams is that all the objects in the dream world are constructed from memory images, yet dreaming is experienced as *perceiving*, not as *remembering*. Occasionally we experience something as "remembering" in dreams (it has the "This is memory" quality attached), but it seems highly improbable that this is something that happened in our waking life. This may be a pseudo-memory, a further alteration in the way the memory subsystem functions. It might also be a genuine memory but of some earlier dream experience that has not been recalled in the waking state. Dreams may show *state-specific memory*, that is, certain information is retained from dream to dream in an aspect of memory that is accessible in the dream state but not in a waking state.

Similarly our sense of identity, our emotions, and our evaluation processes can operate quite differently, as if the dream were of someone else with different emotional reactions and a different style of thinking. What is sensible by dream standards may be outrageous by waking state standards.

The functioning of the space/time subsystem is drastically changed: Instead of "accurately" putting our experiences in their "real" context of you lying in bed at night, you may be at a palm-lined oasis in the next century. The space/time subsystem is still functioning well: Experience is not random and disorganized. There is a spatial framework and a temporal framework to organize and make

sense out of it. This framework is simply not restricted to local physical space/ time any longer.

Consider another common characteristic of dreams: They usually seem to just happen to us, rather than feeling like our active creations. Who or what is creating this dream world and these actions? Where does the scenery come from? How do the various actors know when to come on stage?

The subconscious is given the credit for the intelligent and active creation of dreams in most theories of dreaming, since the dreamer declines credit. This is not a terribly good explanation of course, but it is the best we have at this time, and a good reminder of how little we understand about our minds. The subconscious subsystem is shown as functioning in an altered manner in Figure 2, and in a more important manner (heavier information flow arrows).

Finally, note that the motor output processes are shown as squeezed tight in the dreaming state of consciousness, as input processing is. This reflects the fact that you perform all sorts of physical actions with what you take to be your physical body in your dreams, yet an outside observer sees that you lie almost absolutely still. Modern research has shown that neural signals for movement are indeed sent to our muscles during dreaming, apparently in a manner identical to when we are awake. If you dream of lifting your arm, for example, all the necessary neural impulses are sent from the brain to make your arm move that way. But, there is an active paralysis of your muscles during nighttime dreaming. Inhibitory signals are sent down the spinal cord to the neural end plates on the muscles so they will not respond. A good thing, too: It would be dangerous to be physically moving about while your consciousness was in the dream world!

The major exception to this overall inhibition is your eyes, which do move to follow the dream world imagery, just as if you were awake and actually looking at it. There is no practical danger in moving your eyes around while you sleep, so no inhibition is needed here. It might also be that feedback signals from the muscles that move the eyes amplify imagery, whether the eyes are looking at an external physical world or not.

No External Feedback in the Dream State

I emphasized earlier that a state of consciousness is a dynamically interacting and *stabilized* system. Ordinary waking consciousness is especially stabilized by two major feedback routes, feedback via the external world and the exteroceptors and via the internal world, the body, through the interoceptors.

In dreaming, these major stabilization routes are lost, and so are shown as light, dotted lines in Figure 2, in contrast to their importance in Figure 1. In your dream you raise your arm and move a gigantic boulder, weighing tons. There is no actual input from the interoceptors in your physical arm to contradict the *idea*, your mental simulation of doing this. There is no external perception, via your physical eyes, that there is no boulder there

to contradict the *idea*, the mental *simulation* of moving a gigantic boulder.

What little apparent “feedback” there is comes from your body *image*, an internal simulation of your body, rather than your actual physical body. This includes a simulation of exteroceptors and much (but not all) of the usual kinds of feedback you usually get from them that makes your physical world actions congruent and lawful. This simulated feedback is often sloppier and less consistent than the genuine feedback we get from ordinary physical world actions: thus, some of the incongruities of dreams. The *idea* thus has far more power to affect your construction of “reality,” the experience you realize, in the dream state than in the waking state because there is almost no input from a fixed, lawful external reality and physical body that your internal ideas and simulations are forced to be consistent with.

The question of what factors do stabilize the dream state, given the loss of the major effects of the exteroceptive and interoceptive feedback loops, is an important question for future research.

Dreaming World Simulator = Waking World Simulator

We can now make a major statement about the nature and reality of dreaming: *Dreams are just as “real” as waking experience*. I propose that the neural patterns that awareness perceives/cognizes as its world, the simulated world the mind perceives, involve essentially the same brain areas and neural patterns that are involved in waking state perception of the external physical world. What the mind perceives is thus of equal reality/intensity/substance in both states.

In both dreaming and waking, an active, complex world simulation process is going on, basically identical in kind. What is different in the two states is that *in waking the world simulation process must constantly adapt to and be consistent with a steady inflow of sensory information originating in the external physical world and the physical body*. The world simulation process has criteria to match its simulation activities to. If I simulate a log lying in my path and simulate walking around it, my physical body should behave in such a way as to be consistent with this simulation; namely, I do not feel a bump from walking into the object. *In dreaming, on the other hand, there is almost no physical world input or physical body input that the world simulation process needs to adapt to or be consistent with, so the kind of world, body, and self that can be simulated/experienced is vastly richer and more varied than in the waking state*. The log lying in your path can change into a demi-god with whom you have a wonderful adventure, and you needn't be bothered that in the ordinary physical world logs aren't allowed to change into anything else, much less demi-gods!

On some occasions the dream world is constructed similarly to the ordinary physical world because habits of perceiving and thinking operate with little alteration. Short periods of dreaming might be indistinguishable

from short periods of waking life if we did not have the memory of waking from sleep associated with them. On rare occasions some features of the construction of the dream world are veridically parallel with the ordinary physical world, as when a sensory stimulus or telepathic impression is accurately incorporated into the ongoing dream scene (van de Castle, 1977). But, in general, the main constraint on the dreaming process' simulation of a world is waking state habit.

Thus, a dream is just as "real," at the time it is being experienced, as a waking experience is "real" right now. The reasons we dismiss a dream as "unreal" in retrospect, from a waking state perspective, are varied, but not inherent in the world simulation process of dreaming itself. Reasons for dismissal of a dream's reality include (a) cultural conditioning to that effect; (b) rapid forgetting of dreams, involving an implicit belief that what is real must be lasting; (c) incongruence of the dream content with consensus reality standards (you shouldn't think/feel/act like that!); (d) incongruence of the dream with accumulated knowledge of the physical world, again implying a belief that what is real should be permanent, consistent, and unvarying; (e) apparent inconsistency of the dream world from dream to dream, given our preference for consistency of the "real"; and (f) personal psychodynamic reasons.

Lucid Dreaming

Lucid dreaming, where the dreamer remains experientially and sensorily located within the experienced dream world but "wakes up" in terms of the general qualities of his consciousness, is especially interesting.

Many conventional theories of dreaming assume, implicitly or explicitly, that the "higher" functions of consciousness, especially logical reasoning, are necessarily degraded in order for dreaming to occur. Because you can't reason clearly you then accept the inferior simulation of reality that a dream is conceived of as reality.

Occasionally lucid dreamers note that the dream world is a poor imitation of ordinary physical reality, but most of the time they find the sensory qualities of the dream world are just as real or "realer" than ordinary physical reality. The lucid dreamer feels about as capable of reasoning about the nature of reality and testing it as he does in ordinary waking consciousness. This further indicates that the world simulation process that creates the dream world is essentially the same process as creates waking reality. Further, this world simulation process operates largely independently of our reasoning abilities in both ordinary and lucid dreaming. While our reasoning ability may commonly be degraded by waking standards (or at least altered) in dreaming, it does not have to be for the dream world to be created.

Summary

Much work remains to be done on describing the exact ways in which the subsystems of the dream state vary in their function from their waking mode function. Exactly how does the memory system alter its functioning, for example, both in terms of experienced remembering within a dream and in terms of the contribution of memories to the construction of the dream world? How will classic theories about the meaning of dream content dovetail with this structural view? Meanwhile, I hope that this overall theory of dreaming and waking as world simulation processes will aid our understanding of dreams. This focus on simulation may also be usefully applied to various kinds of psychopathology, for lack of fidelity of our waking world simulation to the actual physical world will lead to maladaptive behavior. It may also be used as a way of understanding various spiritual systems that speak of the world as a dream or illusion (see Tart, 1986, e.g.)

Is the dream "real?" Yes. As "real" (and sometimes "realer") as ordinary experience. But definitely different.

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