A Cognitive Psychologist's Perspective on Consciousness

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The philosopher, Dennett, opens his book *Consciousness Explained*[1] by noting that human consciousness remains as one of the last surviving, true mysteries of our universe. Science has solved, or at least tamed, a number of other great mysteries, from the origin of the universe to the mystery of life, from the mystery of reproduction to the evolution of the earth's creatures. Although much remains unknown about these latter topics, science has removed at least most of their mystery and given us proper ways to think about them. But the mystery of consciousness has not yielded in the same way; it persists as a profound conundrum, surrounded by a confusing muddle of ideas and speculations. Instead of a single correct view, we merely have different perspectives, rather like those of the proverbial 10 blind men describing different parts of an elephant. So it is that we have different perspectives on human consciousness—the spiritual or religious, the evolutionary, the neurological, and the psychological.

I am a cognitive psychologist, and I will try to represent that perspective on the issue of consciousness. But to set the stage for my remarks, I first should tell you how cognitive psychologists view the mind and behavior.[2]

First, cognitive psychology has been called the "science of the mind." Cognitive psychologists accept the reality of mental phenomena and their connection to human behavior without bothering much about the mind-body problem.

They accept the hypothesis that mental events correspond to brain events—that perceptions, thoughts, desires, and actions have a neural representation in the brain. But cognitive psychologists believe that a more abstract level of analysis, higher than neurons, can be pursued to gain some understanding of human behavior. They call that more abstract analysis the *intentional functional* theory of behavior. The basic tactic is to characterize people in terms of the memories, beliefs, and desires that they have and the cognitive operations they carry out in solving their problems of living.

Mind as an Information-Processing System

Cognitive psychologists also believe that the mind is fundamentally a goal-directed, information-processing system. Information-processing systems can be characterized by their data structures that represent reality and the processes that operate on them. The mental data structures, or entities, that people process are a vast collection of perceptions, mental images, words, ideas, sentences, propositions, thoughts, memories, and actions. No one knows how such entities are represented in the brain, but presumably it is by complex patterns of neural activation in appropriate brain structures. In the same way, we presume that a train of thought is represented by a series of brain states, and that memories are represented by changes in the efficiency of synaptic connections that were active at the time that original experience occurred. But we do not really know how to fill in these correspondences.

Since we do not know much about the neural representation of ideas, for all practical purposes we might as well view this relationship abstractly and simply say that the mind operates with mental symbols that correspond to neural firing patterns. Thus, we try to understand the mind as though it were a symbolic system.

Symbols occur in interrelated systems, such as words or numbers, and they get their meaning from memory procedures that interpret

them. Some symbols, such as traffic signals or words in a language, are arbitrary, with meanings established by convention, by association of a symbol with situations it designates. But other symbols are not arbitrary, such as the internal representations that correspond to perceptions. Those images obviously bear a causal relationship to the sensory array produced by the perceived object, a causal relationship embodied in sensory systems that have evolved through natural selection. It is this hookup or correspondence of some internal symbols to aspects of perception or to our behavioral actions that links the cognitive system to the world. Those connections enable us to verify conjectures about the world—for example, to verify that I am wearing a necktie today.

An information-processing system also has a set of processes or cognitive operations that it can carry out on its data structures. To illustrate, think of the operations you can carry out on the documents in the word processor on your computer: you can create a new document and store it in memory; you can retrieve an old document, modify it, compare two documents to see if they match, and so on. Every word processor has only a small number of operations like these that it can perform. Cognitive psychologists believe that the mind, too, has only a small number of elementary cognitive operations it can carry out, such as to store an idea in memory, retrieve it, compare one idea to another, take different actions depending on the comparison, and so on.

So, to summarize, cognitive psychologists view the mind as a symbol-manipulating system and the brain as its physical embodiment. The viewpoint relies heavily on taking the digital computer as a metaphor for the mind. All the seductive parallels and analogies are there. As does the cognitive system, the computer has receptors or an input system for reading in data or instructions, and it has effectors or an output system for reading out behavioral actions such as printing something. Like people, the computer has a large memory bank for storing data and a central processor and working memory in which various information processes can be carried out on data structures that are brought into active memory.

There is also a metaphorical correspondence between different levels of description of how a program causes sequences of physical events in a computer and how a mental thought sequence might cause sequences of neural events in the brain. In this sense, some cognitive psychologists say that they try to understand behavior by theorizing about the mental programs that run on the brain and that generate behavior. However, I will not develop that analogy further here.

The Modular Architecture of the Cognitive System

Another major assumption is that the mind or brain has many partially autonomous information-processing components, parts, or modules that operate more or less simultaneously, in parallel, enabling us to do several things at once. The analysis of complex systems into functional components or modules is a familiar strategy. For example, consider a functional analysis of an automobile. We would decompose it into its motor, fuel system, electrical system, et cetera, along with the functions they perform. Each of these components can be decomposed further into its parts, such as the fuel system comprising the fuel pump, carburetor, and so on. A functional account of how an automobile runs would then consist of statements about these components, how they are interconnected, and how events in one component cause events in other components, all of them coordinated to make the car run.

So it is, too, when we analyze the mind into functional modules—for language, for visual and auditory perception, and so on. There is abundant evidence for such modular design. The localization of behavioral functions in the brain has been pursued vigorously for centuries. The most dedicated localist was Frans Joseph Gall, whose system of phrenology ascribed mental faculties to different areas of the brain based on his assessment of the personalities of people who he thought had unusually large protrusions of their skull in different places. More recent examples of brain localization of function are the many positron emission tomography studies that correlate glucose utilization in different parts of the brain with different kinds of cognitive activity—for example, contrasting passively listening or looking at visual words such as knife or

hammer with actively naming them or their use.

Psychological evidence for modularity comes from the fact that we can do several things at the same time, such as walk and talk, or drive a car and listen to a radio. This modularity claim can be carried to greater detail, since components can themselves be decomposed into subparts. For example, while comprehending a person speaking, we are simultaneously analyzing the speech-sound waves, segmenting the sounds into words, retrieving their meanings, identifying their grammatical relationships, constructing a meaningful interpretation, and wondering how to reply—all of this going on simultaneously, with the analysis at each level influencing the analysis at the other levels. Many such examples tell us that the mind/brain consists of a number of components, or modules, that act in parallel.

Hierarchical Organization of Modules

Now, one cannot have a whole collection of independent modules doing their own thing in parallel. That would be like a group of musicians playing different music at the same time, producing an awful noise. Their activities have to be coordinated.

It turns out that the most efficient way to organize numerous parallel modules is to arrange them into a hierarchy. You promote one module to be the leader, much as we make someone the conductor to lead the orchestra or the general to lead the army. The leader's job is to schedule, monitor, control, and coordinate the activities of the lower level modules that might conflict with one another.

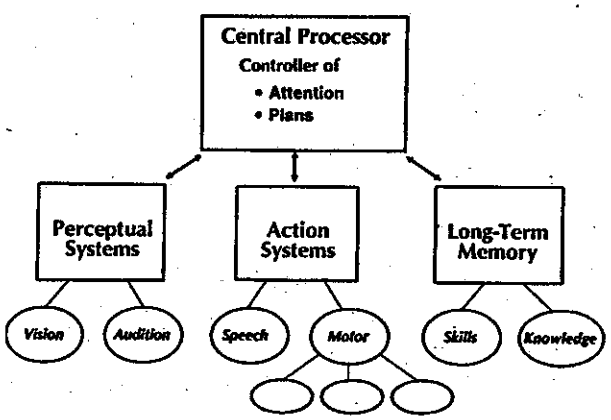

FIGURE 1.—Diagram of hierarchical control of different cognitive modules by a central processor that allocates attentional resources to different activities. The arrows indicate the flow of information and control.

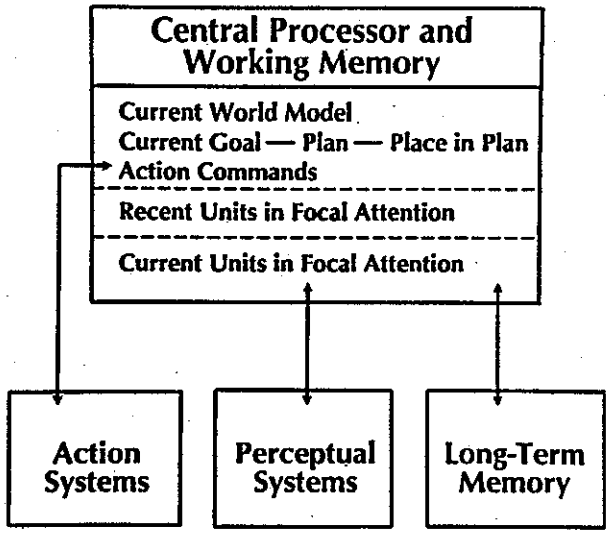

FIGURE 2.—Diagram of the central processor and a working memory that maintains a number of active items. See text for details.

In cognitive theories, this leader module is called the central processor. Figure 1 illustrates a central processor controlling and coordinating activities of a few modules, those devoted to perception, actions, and retrieving information from memory. The central processor chooses the goals the system is to pursue, perhaps in reaction to biological emergencies. It retrieves from memory known action plans to achieve those goals or it composes a new plan if an old one will not suffice, and it issues action commands to the lower modules to carry out those plans. We may think of these control commands in terms of the amount of attention or amount of computing resources that the central processor assigns to various tasks.

To work efficiently, the central processor must have a short-term, working memory to help it keep track of several things (see Fig. 2). It has to keep active its current goal, the plan it has selected to achieve the goal, and its current place in carrying out the plan. In order to guide actions, it also has to maintain a perceptual model of the current situation as it moves through the surrounding world. These several aims are achieved by the processor directing attention to different things; these current things as well as recent contents of

focal attention are held in a short-term memory.

Given the crucial role of attentional control in this model, one can appreciate the devastating consequences to mental life caused by brain disorders that disrupt attentional control. This happens most clearly in attention-deficit disorders in which the child is highly distractible and cannot concentrate on any one activity for more than a few minutes. Attention-control problems also seem prominent in some forms of schizophrenia, and this could cause the host of symptoms classified as thought disorders. Schizophrenics may have trouble concentrating on an external task such as conversing, because they cannot inhibit the emotionally charged memories and images that flood into their consciousness. Moreover, these intrusions can cause loss of the current goal and plan from short-term memory. For example, in a psychiatric interview, while reciting a story about his life, the schizophrenic may forget his goal and wander off track, following whatever chains of associations are triggered by the current words he is speaking. This kind of associative scatter results from poor attentional control, reflecting inability to keep active the conversational goal.

Conscious and Unconscious Contents

To return to our main topic, the cognitive architecture introduced above can be used to discuss conscious and unconscious processes. Recall that the central processor does its job by giving a certain amount of attentional resources to its several activities. But attentional resources are severely limited, just as an army general has only a limited number of soldiers or the director of a research department has only so much money to spend. Performance of a task worsens when it requires more resources than can be given to it. The amount of attention that a given activity requires depends on how complex it is—that is, upon how much information per unit time must be processed—and how well practiced the activity is. For example, driving a car or speaking in a foreign language is very attention-demanding for beginners, but with practice the skill becomes automatic and requires less attention.

To relate this cognitive architecture to consciousness, let us start by claiming that the units in the current focus of attention provide the core elements of our consciousness. These focal elements may come from the external world, as when we are totally absorbed in a physical activity like batting a ball in cricket; or the focal units may come from internally generated thoughts and images as occurs in daydreaming. In this case, the flow of associated images and ideas through the window of focal attention provides us with a "stream of consciousness."

Consciousness of our thoughts is not an all-or-none, black-or-white property; rather, thoughts have varying degrees of vividness, from very bright to very dark, depending upon the attentional resources invested in them at the moment. Cognitive psychologists use the neural metaphor of the *degree of activation* of an idea to express this degree to which it's being attended to or how active it is in consciousness. At one extreme are the critical elements of a focused scene, such as the ball that a cricket batter is watching. At the other extreme are the many inactive memories in long-term memory that we know but have not recently thought about, such as the image of our mother's face. That memory can be activated and brought into consciousness by my giving an associated cue, but it was not conscious before.

Between these extremes of fully active versus inactive ideas lies a range of mental contents having moderate activation that we react to only with moderate speed. Some elements in our working memory are at this moderate activation level, providing a background supporting the more highly focused activities going on in the foreground of our mind. For example, our current model of the external world is one of those partially active structures that is usually on the fringe of our consciousness. We do not often dwell upon it, but we can quickly direct attention to some part of the world if we detect sudden changes or if we simply direct ourselves to notice something, such as noticing the pressure on your backside as you sit in your chair. Other examples of differing degrees of consciousness are provided by the short-term memories we have of recent events of the past few seconds or minutes. These usually fade away as time passes and as attention moves on to more interesting events.

Short-Term Memory Provides Continuity

However, short-term memory is important for providing consciousness with a temporal bridge to connect our present experience to our recent past. This bridging supports our belief in the unity and continuity of ourselves and our experiences over time. The importance of this time-bridging can be appreciated by examining conscious experience in clinical patients who have suffered brain damage causing severe loss of short-term memory. One of the more dramatic cases of this kind is the neurological patient named Clive, who was formerly a distinguished medieval and Renaissance scholar and musicologist of some renown. Clive suffered a severe case of viral encephalitis that damaged his left frontal cortex, the temporal lobes, and hippocampal structures on both sides. He completely lost his ability to retain any information for more than a few seconds. He spends his time nowadays in a hospital room playing endless card games of solitaire and making entries in a notebook. The entries repeat again and again the same observation: "Now I am completely awake, for the first time in years." Curiously, he does not remember having written the identical observation just a few minutes before, claiming that someone must have forged it in his diary. His wife describes his mind as follows:

> Clive's world now consists of a moment, with no past to anchor it and no future to look ahead to. It's a blinkered moment. He sees what is right in front of him, but as soon as that information hits the brain it fades. Nothing makes an impression, nothing registers... he perceives the world as you and I do. But as soon as he perceives it and looks away, it's gone for him. So it's a moment-to-moment consciousness, as it were, a time vacuum. And everything before that moment is completely void. And he feels as if he is awakening afresh the whole time. He always thinks he has been awake for about two minutes.[3]

In the WNET film "The Mind" that depicts Clive, there is one scene that shows Clive greeting his wife with elation and enthusiasm; what is so sad about the scene is that this is the identical reaction Clive showed to his wife's appearance only a minute before—she had merely left his room for a minute to get a drink of water. Upon reentering, she was greeted again by Clive with this same fresh burst of laughter and happiness, as though he had not seen her in years.

Clive's is an extreme case of loss of short-term memory and new learning. As a consequence, the range of his consciousness is greatly diminished. Our normal sense of consciousness includes our feelings of personal continuity and awareness of ourselves existing through time, stretching from our past through the present moment and into our future. That subjective experience requires short-term memory. And it is that faculty that has been devastated by Clive's injuries.

Different Meanings of Consciousness

As is true with most true mysteries, discussions of conscious and unconscious processes are filled with semantic confusions, poorly defined words used to refer to rather different phenomena, and many inconsistencies of language. Therefore, it helps to distinguish a few of the different kinds of phenomena that are frequently lumped together and confused because they are called the same thing, namely, consciousness.

Figure 3 lists four different meanings of consciousness or the phrase "being conscious of" something. Let us begin by translating the word "consciousness" into "awareness", so that being conscious is treated as a synonym

Levels of Consciousness
(Awareness)

1. Awake, aroused, energized, reaction
2. Aware #1 of stimulus X: behavior takes account of X
3. Aware #2 of X: one could talk about X
4. Aware #3 of one's self: reflecting on one's behavior

FIGURE 3.—Distinguishing four different meanings of awareness that can be arranged from "lower to higher."

for "having the capacity to be aware of" things. This is the first meaning of the word "consciousness", the one that would be defined as "being awake, aroused, alert, or energized, as contrasted to being asleep or in a coma." This kind of consciousness in primates is probably dependent upon functional stimulation from midbrain structures such as the dopaminergic locus ceruleus and the serotonergic raphe nuclei that supply necessary neurotransmitters that arouse the cortex of the brain. These structures supply the arousal or energy that makes the mental system run, and these are the neurotransmitters that might be depleted in psychiatrically depressed individuals.

My next two senses of awareness can be illustrated by the example of driving a car for many miles on an uncongested highway while conversing with a passenger. At the end of the trip, we may say that we were so absorbed or so aware of the conversation that we were not aware of most of the highway during the trip. But awareness is being used in two different senses here. In one sense, we were fully aware of the conversation, who said what to whom; we could describe it at the time, and we can remember some of it later. On the other hand, we obviously had to be aware of the visual cues of the highway in order to steer our car around curves and avoid traffic. So our driving was revealing that we were well aware of, or taking account of, the cues along the highway.

So, to distinguish these meanings of awareness, let us say that people are "aware in sense #1 of some stimulus X" if they behave in such a manner that we can tell that they are being affected by it or guided by it, even though they may not be able to identify that stimulus or their reactions to it. It is like having part of their activities running on "automatic pilot."

For the other meaning, we will say that people will be "aware in sense #2" of some event if that event delivered information to the speech area of their brain that would enable them to express some proposition about it, perhaps describe the event or their reaction to it.

A simplification is to say that people are aware (in sense #2) of some fact about themselves or the world if they would be able to talk about it, and would be aware (in sense #1) of some other fact if they behave in such manner that an observer could claim that they were "taking account of" that stimulus event, even if they were not able to talk about it.

Typically, people are aware of many things in both senses—we can both respond to something and describe what it is that we are responding to. But the interesting cases philosophically arise from discrepancies between the two senses, when there is a disconnection or dissociation between the reacting self and the talking self.

Dissociations of Awareness

Such dissociations are frequently seen in psychology experiments. Many arise in experiments on sensory thresholds where observers will report verbally that they did not see or hear a weak stimulus, yet when forced to guess they select it from an array with an accuracy far above chance. Experiments on subliminal perception have this quality, wherein a weak stimulus below a threshold for conscious report nonetheless indirectly influences the person's conscious choices or interpretations. Other examples appear in what is called implicit or unconscious memory in which a second presentation of a word or a picture is perceived and reacted to more quickly than it was upon its first presentation, even though the person may not consciously recollect having seen it before.

Similar discrepancies of awareness are seen with psychiatric patients who have hysterical symptoms and conversion neuroses. Hysterical patients will swear that they are blind or that their arm or leg is numb and paralyzed, yet more subtle and indirect behavioral tests can reveal that the affected sense organ or limb is functioning more or less normally. Similar dissociations occur with hypnosis, wherein people may act out bizarre posthypnotic suggestions without being able to say why they did so. If pressed, they make up a plausible rationalization to explain why they carried out the bizarre action.

Famous cases of dissociations arose with the split-brain patients studied by Sperry[4] and Gazzaniga.[5] The commissures and corpus callosum are cut in such patients to disconnect the two cerebral hemispheres in order to reduce frequent epileptic seizures. If one quick-flashes a pair of words like "KEY RING", one on either side of a central fixation point,

the word "KEY" in the left visual field will be projected to the right, nontalking hemisphere, and the word "RING" in the right visual field will be projected to the left, talking hemisphere. If asked what they saw, the patients will report the word "RING", with no verbal awareness of the "KEY" stimulus. But if requested to use their left hand (guided by their right hemisphere) to reach under a blanket and pick up by touch the object corresponding to the flashed word, they will pick up the key. So, we could say that the left, talking hemisphere is aware in sense #2 of what it saw, whereas the right, nontalking hemisphere is aware only in sense #1 of what it saw. Curiously, when asked to explain what their left hand is doing, the left, talking hemisphere of these patients tries to make up a plausible justification for what they see themselves doing. This happens not only for motor actions but also for emotional reactions triggered by embarrassing words flashed to the nontalking hemisphere.

Split-brain experiments provide dramatic illustrations of somewhat independent, information-processing modules in our brain. Such results raise doubts about our subjective sense of the unity of our consciousness—the impression that there is only one "real me" who is running our mind and body. Perhaps our subjective impression of unitariness is simply a comforting illusion, a trick played upon us by part of our brain. To quote Gazzaniga:[5]

> The data suggest that our mental lives amount to a reconstruction of the independent activities of the many brain systems we all possess. . . . There is some final stage, or system, which I happen to think is in the left hemisphere, that pulls all this information together in a theory. It has to generate a theory to explain all these independent elements. And that theory becomes our particular theory of ourself and of the world.

Self-Awareness

To return to the distinctions among levels of conscious awareness in Figure 3, the fourth level is what is called self-awareness. This refers to our ability to focus attention upon ourselves, to view ourselves as perceiving, thinking, acting creatures. For example, we not only can converse with someone, we can also view ourselves as participants in that conversation, carrying on a sort of inner monolog about the quality of our participation. Similarly, a poet in composing a poem works back and forth between these two levels—alternating between generating poetic lines and then judging them. All of us have this capability to silently observe the operation of our own minds, to judge, comment upon, and edit what we are doing and come to some conclusions about ourselves and our attitudes. It may be this ability that most distinguishes people from other primates.

There is a limited recursive quality to this kind of self-reflection. Just as we can think about ourselves engaged in thinking about some problem, so can we jump up a level and think about how we are thinking as we try to solve problems in general, perhaps learning how to recognize dead-ends or how to prompt ourselves to canvas new perspectives on a problem, and so on. This recursion of thinking about our thinking cannot proceed beyond a few turns, because the limits of focal attention and short-term memory cut us off before the recursion gets very deep.

Types of Associated Knowledge

These different kinds of conscious awareness also tend to be associated with somewhat different kinds of knowledge. The rough correspondences are depicted by arrows in Figure 4, the left side of which repeats the levels of Figure 3. The lowest level of consciousness, in the sense of being awake or alert, simply yields the knowledge that one is alive. This is Descartes' dictum, "Cognito, ergo sum".

The awareness of type #1 is reflecting our largely unspoken, procedural knowledge, wherein our behavior demonstrates that we know how to do something even though we may be unable to notice or describe what we are doing. A large amount of expert knowledge is of this procedural type, say, for neurosurgeons interpreting x-ray pictures or chess masters playing chess. Such experts can recognize critical situations and know what effective actions to take but may have difficulty putting into words the critical elements they are reacting to.

The third level in Figure 4, that of talking

awareness, is associated with declarative knowledge—the thousands of facts that we can talk about. Although much of this is learned through language, it also comes through perception, since we can usually describe in general terms what we are seeing or hearing.

The last type of knowledge in Figure 4 is what I have called "metacognitive," meaning that it is knowledge that we have about ourselves and our knowledge—about our behavior, our abilities, our values and attitudes, and our usual modes of thinking and reacting. We learn a lot by observing ourselves and comparing ourselves to others. We can obtain a fair assessment of our relative standing on physical and mental abilities, about good or bad strategies for dealing with ourselves in difficult situations, about special biases or bad habits we should be trying to break. It is here that cognitive behavior therapy focuses, helping depressed or neurotic patients to reexamine some of their maladaptive assumptions and styles of thinking—such as overgeneralizing a single negative incident and magnifying it into a full-blown crisis of self-confidence.

Levels of Consciousness *(Awareness)*		Associated Type of Knowledge
1. Awake, aroused, energized, reaction	→	Know "I'm alive"
2. Aware #1 of stimulus X: behavior takes account of X	→	Procedural: Know how to do X
3. Aware #2 of X: one could talk about X	→	Declarative: Know that X is true
4. Aware #3 of one's self: reflecting on one's behavior	→	Metacognitive: Know that I know/am/can do X

FIGURE 4.—Types of knowledge that correspond to the different meanings or levels of awareness.

A further benefit of self-reflective knowledge is that it helps us construct models of other people's minds, working on the assumption that their minds are probably like our own. Because we can then predict the probable reactions of others, this process helps our social interactions proceed smoothly, especially with people who share many of our cultural values and assumptions about human nature.

Meditative Practices

Since we are in India, a place renowned for its mystics who attain altered states of consciousness through meditation, it is interesting to note how this theory of the mind describes meditative practices. Although practices vary somewhat, a common meditative exercise is to focus one's attention either upon a single object like a flower or upon one's breathing or upon the sound produced by a single nonsense syllable or mantra that is repeated endlessly. The meditator is instructed to put aside all distracting thoughts and to focus steadily upon the object of contemplation.

If we analyze meditation in terms of the model in Figure 2, we see that nearly everything is held constant. For example, the meditator sits still in a quiet environment, so he need not update his world model or attend to actions. Moreover, his goal and plan are kept constant, namely, to focus all his attention upon the flower and suppress all distracting thoughts. By locking attention onto one object, perceptual information is constant; furthermore, the constancy of the object in focal attention implies that the contents of short-term memory are constant and will habituate. The consequence of these maneuvers is that all the meditator's attentional resources are invested in one thing, and that is a very rare and unusual experience.

Now, meditative control of attention is very difficult to achieve, and many novices fail at the practice. Because the mind is so inherently active, it is difficult to focus attention on one thing for very long. Our eyes jitter nervously around the parts of the flower and begin scanning around the room, or our attention slides away from the habituated verbal mantra. Then memories come flooding in from long-term memory bringing chains of associations, parading them past the footlights of consciousness. It is this "inner chatter" that all meditators must learn to suppress, by detecting when attention has strayed from the object of contemplation and then drawing it back. Biofeedback of alpha waves can speed the learning process slightly, because it can sometimes inform meditators when their thoughts have wandered off the object of contemplation.

According to this model, the meditative state

and the central processor have been systematically reduced to one object to which full attention is devoted. But I do not understand why successful meditators find this to be especially refreshing, any more so than is a simple nap. Perhaps, by not having to shift attention rapidly amongst ideas for a prolonged period, the meditator builds up a surplus of attentional resources or energy, the better to work on new tasks after meditation. This analysis of the conscious experience of meditators is just a guess; its sole advantage is that it fits within the same framework that I used to describe the other varieties of consciousness.

I will end by returning to an earlier point regarding the value of self-reflection, of learning about one's nonconscious beliefs and value judgements. International conferences such as this provide an opportunity for scientists from different cultures to uncover and question some basic assumptions about their subject matter. The fact that we are all interested in the scientific study of mind, brain, and behavior suggests that we have a common grounding for our ideas in reality. On the other hand, I suspect that we have somewhat different conceptions of the nature of consciousness, of the mind, and its relation to the brain and to mental disorders. The value of this kind of conference is that by sharing our different ideas and theories, we can better identify our own cultural assumptions and perhaps thereby shed more light upon the nature of human consciousness.

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