The Gods Within

ON THE VEDIC UNDERSTANDING OF MIND AND NEUROSCIENCE

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1 The end of reductionism

Mind is the last frontier of science. We observe the physical universe through our mind, yet we have no clear idea how mind functions, how memories are stored and recalled and what is the origin of our subjective feelings. Is this level of ignorance a result of the reductionist nature of the tools that have been used in the study of mind and consciousness? If that is so, will an approach that has a different philosophical basis help? It is for this reason we turn to the Vedas, where the central concern is self and awareness.

The Vedic texts, which include the Upaniṣads, consider reality to transcend the duality of matter and mind. This non-dual reality is termed *Brahman*. Although seen to be present in all its material manifestations, Brahman is understood best as the knowing subject within us. The space of this knowledge is called *cit*, consciousness. Later literature, like the Yoga Vāsiṣṭha and the Tripurā Rahasya, self-consciously describes itself as dealing with the nature of consciousness.

The Vedas, and later the yogic and tantric texts, speak of the cognitive centers as individual, whole entities which are, nevertheless, a part of a greater unity. The vocabulary used in these texts challenges the modern reader, but once one has learned the definitions of the operative terms, the structure soon becomes apparent. Vedic mythology is often an explication of understanding of consciousness, and so mastering the Vedic vocabulary provides us a means of unlocking the hidden meaning behind the myths.

In the Vedic discourse, the cognitive centers are called the *devatās* or *devas*– deities or gods, or luminous loci. The Atharvaveda (10.2.31) calls the human body the city of the *devas*. This passage also speaks of the

body consisting of eight cognitive centers which, other references suggest, are hierarchically organized.

The *devas* are visualized in a complex, hierarchical scheme, with some being closer to the autonomous processes of the body and others being nearer *creative* centers. In analogy with outer space, inner space of consciousness is viewed to have three zones: the body (earth), the exchange processes (*prāṇa*, atmosphere), and the inner sky (heavens). The number of *devas* is variously given, the most extravagant passages count 3.3 million. The Bṛhadāraṇyaka Upaniṣad (3.9.1) remembers a hymn that praises 3306 of them, arguing there are 33 major deities, distributed in three groups of eleven among the three zones. All these devas are taken to embody the same light of consciousness. The mind consists of discrete agents, although it retains a unity.

Since each *deva* reflects primordial consciousness, one can access the mystery of consciousness through any specific *deva*. Thus there is a *deva* for reading and learning, one for recognition, one for one for friendship, one for generosity, and so on.

When the cognitive centers nearer the sense-organs are viewed in anthropomorphic terms, they are called *ṛṣis*, sages. The Yajurveda (34.55) declares that the seven sages (*ṛṣis*) reside within the body; the same is mentioned in the Atharvaveda (10.2.6). The Bṛhadāraṇyaka Upaniṣad (2.2.3) says, "The ṛṣis (sages) are the senses." The next section names the left eye Jamadagni, the right Viśvāmitra; the left ear Bharadvāja, the right Gautama; the right nostril Vasiṣṭha, the left Kaśyapa; and the tongue as Atri. Elsewhere, the specific names used are somewhat different. For example, the Śatapatha Brāhmaṇa (4.1.5.1) calls the Aśvins the organ of hearing. The names in the early literature do not always correspond to what we find in the later texts.

The Vedic texts also divide the capacities of the mind in various dichotomies, such as high and low, left and right, and masculine and feminine. The Śatapatha Brāhmaṇa (11.1.6.7-8) speaks of the *devas* as being created from the sky and the *asuras* from the earth of the inner space. So the *devas* are the higher or spiritual functions and the *asuras* represent the lower or bodily functions. The dichotomy of the left and right is between emotion and reason. The dichotomy of gender is between potential (male) and energy (female). Thus the *devas* are represented diversely.

Sri Aurobindo, the great modern yogic sage, described the dichotomy between the left and right in the following way:[1]

> The intellect is an organ composed of several groups of functions, divisible into two important classes, the functions and faculties

> of the right hand, the functions and faculties of the left. The faculties of the right hand are comprehensive, creative, and synthetic, the faculties of the left hand critical and analytic . . . The left limits itself to ascertained truth, the right grasps that which is still elusive or unascertained. Both are essential to the completeness of the human reason.

It is noteworthy that Aurobindo wrote this in 1910 in a manner that would also be considered quite accurate from the point of view of brain hemisphericity. In Haṭha-Yoga, one technique of meditation consists of breathing in turn through the alternate nostril (*prāṇāyāma),* apparently to "synchronize" the activities in the two hemispheres.

Physics and the Vedas agree that reality is consistent only in its *primordial, implicate* form.[2] The Vedas insist that speech and sense-associations cannot describe this reality completely.[3] In quantum physics, use of ordinary logic leads to paradoxes such as the present can influence the past! At a less technical level we may ask: How do we reconcile the determinism of science to the subjective sense of free will?

The modern discoveries that are based on a study of consciousness states and the deficits caused by lesions, stroke, injury, or surgery that disrupts the normal functioning of our senses and cognitions appears to uphold the Vedic view. These discoveries suggest that the mind is a complex structure of various localized functions held together by a unitary awareness. Should a *deva* be seen at each cognitive center?

This essay presents a summary of the Vedic views on cognitive centers, and also an overview of the relevant findings from neuroscience. This should help the reader see the connections between the *devas* and cognitive centers. I hope this work will help further our understanding of Vedic psychology and yoga.

2 States of consciousness

There exist several states of consciousness: wakefulness, sleep, dream-sleep, coma, hunger and thirst, love and anger, interest and boredom, which have distinct neurochemical signatures. These different states may be taken to be modifications to a universal state that are caused by the individual self.

Another aspect of consciousness is the circadian rhythm, an adaptation to the solar cycle of light and dark. The circadian rhythm is run by genetic

clocks, as are other rhythms representing the vestigial memory of interactions with a far older environment. The most fundamental rhythms are matched to the periods of the sun or the moon. There are quite precise biological clocks of 24-hour (according to the day), 24 hour 50 minutes (according to the lunar day since the moon rises roughly 50 minutes later every day) or its half representing the tides, 29.5 days (the period from one new moon to the next), and the year. Monthly rhythms, averaging 29.5 days, are reflected in the reproductive cycle.

Sleep is circadian, occurring once a day, but there are rhythmic variations in physiological activity that occur throughout the night. In 1953, Aserinsky and Kleitman discovered rapid eye movement (REM) sleep.[4] They found that there was an 80-120 minute oscillation between two distinct stages of sleep, those of rapid eye movement (REM) and non-rapid eye movement (NREM). The period of eye movement is correlated with increases in heart rate, changes in muscle tonus, the presence of desynchronous electroencephalographic activity and an increase in the probability of obtaining a dream report following awakening. REM sleep is also called active, dream, or paradoxical sleep. There is heightened cortical activity in REM sleep as compared to NREM sleep.

Sleep shows a propensity for an approximately half-day appearance with a major sleep period at night and a secondary period in the mid-afternoon. This and other harmonics of the fundamental period, namely 6, 3, and 1.5 hours are reflected in the metabolic activity.

Further classication of sleep is done using EEG record. For classifying EEG activity, the number of waves from peaks per second are counted and labeled as delta (.5-2 Hz), theta (4-8 Hz), alpha (8-12 Hz), sigma (12-16 Hz), and beta (16-30 Hz). REM sleep is characterized by relatively low-voltage, desynchronized, mixed-frequency EEG accompanied by binocularly symmetrical eye movements with low-voltage electromyographic (EMG) activity or muscle tonus.

NREM sleep is classified in four stages 1,2,3,4. Stage 1 is the transitional stage where there is a changeover taking place from the initial alpha waves to the slower theta waves. Two indicators that appear short while later are the K-complexes and sleep spindles. The K-complex is a single high-amplitude wave, some four times stronger than the background activity of the theta waves. The sleep spindle is burst of electrical activity at 12 to 14 waves per second with the same amplitude as theta waves and a shape reminiscent of the spindle of a loom. The stage characterized by theta background activity and episodic appearances of sleep spindles and K-complexes is Stage 2. Some

10 to 15 minutes after tha appearance of K-complexes and sleep spindles, delta waves, of higher voltage than the alpha and theta, appear heralding deep sleep. Stages 1 and 2 are light sleep and Stages 3 and 4 are deep sleep. Stage 3 is characterized by a moderate (20-50 percent) amount of delta activity whereas Stage 4 has a predominance of delta.

Dreams often have a bizarre or unreal element, and they may be incongrous with the surrounding contextual elements, or they describe events that violate the laws of nature. But nocturnal dreams and daydreams also have marked similarity which shows a continuity of thought across sleep and wakefulness.

In lucid dreaming, the subject is conscious enough to be aware of the dream. Subjects have been known to perceive and respond to environmental stimuli without awakening from the lucid dream. It has been suggested that one sense may remain functional and awake while others fall asleep. In one view:[5]

> [T]he question—awake or sleep—is not a particularly useful one. Even though we have two discrete words—sleep and wakefulness—this does not mean that the behavior associated with the words can be forced into two discrete categories. By any variable or operation available to us, not only do sleeping and waking shade gradually into one another but there is only limited agreement among the various physiological and subjective operations that discriminate between sleeping and waking. At a given moment, all systems of the organism are not necessarily equally asleep or awake.

Subjects can also awaken themselves at precisely chosen hours. How does the abstract notion of a certain time reading get translated into the appropriate signals to rouse the subject?

Experiences in dreaming produce effects on bodies that are remarkably similar to the ones produced by the corresponding awake experience. The imagery of the dream is produced by the same brain systems that produce the corresponding wakeful perceptions.

Attention and Arousal There are limits to the capacity of attention. In perception, it is easier to attend to different aspects of the same object than attending to those same aspects when present in different objects. Storage of recent information and old memories interfere with the detection

of new signals. Therefore, much of perceptual input goes unattended while some aspects become the focus of attention. If attention is exercized by an executive network, this raises the issue humunculus and that of infinite regress.

Certain strokes cause the patients to have a striking deficiency in lateralized orienting which is called unilateral neglect. When presented a single object, they orient to the left or right showing that they are not blind in either field. But when there are two different objects in the two fields the patient will report both of them. But if they are of the same type, the patient may neglect the object, say on the left side, and report only the one on the right side. Such patients often fail to eat food on one side of their plate or to shave or apply makeup to only one side of their face.

The brain has mechanisms of attention and orientation behavior that supersede individual sensory modalities.

Arousal is what provides the background for attention. It varies in a continuum from the low level (sedation) to hyperactivity. The "fight or flee" response, accompanied by sweating, increase in the heart rate, cessation of digestion of food, and diverting of blood to the vital organs to meet their demands for oxygen, is an extreme example of arousal. In the REM sleep the brain is more aroused than in non-REM sleep.

There exist states, as in dreaming, when there is arousal without consciousness. So, in addition to arousal, consciousness requires more ingredients. But it is not clear why the spread of activity to a group of neurons should lead to a corresponding consciousness.

The brainstem regulates the automatic control of heartrate and respiration. Up from the brainstem arise pathways of neurons which reach the thalamus and beyond into the cortex. It is known that resonance of activity between the thalamus and the cortex occurs when the brain registers patterns. But we do not know whether that is sufficient to correlate with awareness. Nevertheless, synchronous thalamocortical activity has been proposed as the "seat" of consciousness, a result of a dialogue between the thalamus and the cortex that generates subjectivity. Others claim that 40-Hz synchronous oscillations in various thalamocortical loops will, under certain conditions, give rise to consciousness. But these theories do not explain why synchronous activity should lead to consciousness. Neither do they explain why consciousness can give a feeling of a graded experience.

Field of Activation or Witness One may presume that the difference between waking and sleep states is due to the difference in the degree of cortical activation. When the activity is below a certain threshold, all the contextual circuits do not function to provide checks to define realistic imagery; this is the dream state. There can be a whole continuum of the extent of the spreading activation to provide a corresponding variety in the nature and the feel of dreams.

But there is a fundamental difference between the dream and the waking states. In the dream state the subject sees himself detached or apart from his putative self as a witness. The degree of the detachness varies through the course of the dream.

From this point of view, the difference between the dream and the waking states will be a continuum corresponding to the degree of detachment. The detachment is measured by the loss of muscle tonus.

A certain specific of the activity in the brain represents consciousness. But it must be expressed along with other components related to memory, language, visual perception, and so on to create the inner world.

The Russian psychologist, Alexander Luria, described a remarkable case of amnesia in 1972 in his book *The Man With a Shattered World*.[6] The subject was a young man, Sublieutenant Zazetsky, who had received a bullet through the top of his head in an engagement during the Second World War. The injury damaged the convergence or association areas in his cortex, which is where an integration of the various sensory information streaming in takes place. Zazetzky was unable to combine his impressions into a coherent whole. He was aware of his body, but he could not combine his impressions into a coherent whole. According to Luria, "A person with such an injury finds his inner world fragmented; he cannot think of a particular word he needs to express an idea; he finds complex grammatical relationships unbelievably difficult; he forgets how to add or use any of the skills he learned in school. Whatever knowledge he once had is broken down into discrete, unrelated bits of information. On the surface his life may appear no different but it has changed radically; owing to an injury to a small part of his brain, his world has become an endless series of mazes."

In 1953, William Scoville operated on the 27-year patient HM, suffering from serious, recurrent epileptic seizures. He removed, from both brain hemispheres, many deep structures including the hippocampus, the amygdala, and adjcent areas of the temporal cortex. HM's condition improved but it was also found that his capacity to remember had been destroyed. His personality was unchanged and his IQ actually rose from 101 to 112, pre-

sumably because of the reduction in the frequency of seizures. His memory of early life was normal excepting for a retrogade amnesia covering a vague period of one or two years prior to the operation. Long-standing skills such as reading, writing, and elements of his old trade of motor-winder were retained, but he was unable to learn new materials or remember abything that happened to him after the operation.

Although HM's retention of early memories helped him understand new impressions, it may be that there can be consciousness without memory.

3 Anomalous abilities

Idiot savants, or simply savants, who have serious mental handicaps, either from developmental disability or major mental illness, perform spectacularly at certain tasks. The ability has been noted in the areas of mathematical and calendrical calculations; music; art, including painting, drawing or sculpting; mechanical ability; prodigious memory (mnemonism); unusual sensory discrimination or "extrasensory" perception.

The abilities of these savants and of mnemonists cannot be understood in the framework of a monolithic mind, although we know that the final cognition is done by a unifying agency as stated in an Upaniṣad (Bṛhad=araṇyaka 1.5.3), " 'I was elsewhere with my mind, therefore I did not see; I was elsewhere with my mind, therefore I did not hear,' so it is said; for only with the mind do we see, and only with the mind do we hear." If each cognitive function is essentially *stand alone*, it is easy to see how its capacity would depend upon neural hardware.

Oliver Sacks, in his book *The Man Who Mistook His Wife for a Hat* (1985), describes two twenty-six year old twins, John and Michael, with IQs of sixty who are remarkable at calendrical calculations, even though "they cannot do simple addition or subtraction with any accuracy, and cannot even comprehend what multiplication means." More impressive is their ability to factor numbers into primes since "primeness" is an abstract concept.[7]

> A box of matches on their table fell, and discharged its contents on the floor: '111,' they both cried simultaneously; and then, in a murmer, John said '37'. Michael repeated this, John said it a third time and stopped. I counted the matches—it took me some time—and there were 111.
>
> 'How could you count the matches so quickly?' I asked. 'We didn't count,' they said. 'We saw the 111.'

> 'And why did you murmer "37," and repeat it three times?' I asked the twins. They said in unison, '37, 37, 37, 111.'

The claim of the twins that they saw the 111-ness all at once is simply astonishing. If there is something distinct and unique about 111-ness, other numbers may likewise have their distinctiveness that can be taken in at one go. Numbers could then be seen at a glance like whole objects. No machine can do that. This feat lies outside the pale of any scientific explanation. A skeptic may say that Sacks overlooked the possibility that the twins had previously counted the matches in the box. Or perhaps, all such boxes contain 111 matches, and the twins knew this.

Sacks was also amazed that the twins found the number 37, which is a prime factor of 111. But then the twins may have done nothing more than divide 111 into three groups, one each for the two of them and one for Sacks.

But Sacks describes another instance which confirms that the twins did understand primeness. On one occasion, he found them sitting in a corner playing a numerical game where they exchanged six-figure numbers. He noted down these numbers and found later that they were all primes. Armed with a book of primes, Sacks joined them the next day at their play. He ventured an eight-figure prime and after a long pause they smiled and nodded that it belonged to the same class. Next he went to nine-figure and ten-figure primes and although it took the twins considerable amount of time they seemed to take them in their stride:[8]

> John, after a prodigious internal contemplation, brought out a twelve-figure number, I had no way of checking this, and could not respond, because my own book—which as far as I know, was unique of its kind—did not go beyond ten-figure primes. But Michael was up to it, though it took him five minutes—and an hour later the twins were swapping twenty-figure primes, at least I assume that this was so, for I had no way of checking it. Nor was there any easy way, in 1966, unless one had the use of a sophisticated computer.

The only explanation here could be that the twins had created and memorized a list of primes. And with repeated play with numbers they had somehow internalized an algorithm for computation of primes. But was this algorithm of the same kind as is used in mathematics.

If we consider this question from an evolutionary perspective, it appears hard to believe that performing abstract numerical calculations related to

primes would provide an advantage? But it must be acknowledged that abstract computations are an everyday part of human, as well as animal, cognition. When we recognize a tree or an individual face abstract generalization is involved. Animals are very good at many advanced cognitive tasks.

Darold Treffert describes Leslie Lemke and Ellen Boudreaux, both blind and severely mentally handicapped, who can play back any piece of music, howsoever long and complex, without error.[9]

Is there a common thread in the above stories of extraordinary mathematical and musical ability? As Leibniz said: "The pleasure we obtain from music comes from counting, but counting unconsciously. Music is nothing but unconscious arithmetic."

For quite some time there have been two schools of thought regarding intellect. Those who view it as one piece have been called "hedgehogs" as opposed to the "foxes," who see it fragmented into several components. (The hedgehog has just one trick to protect itself while the fox has many.) Similarly, in intelligence theory there are the two views that it is holistic and that it is localized. The holists believe in the general factor of intelligence; against this are the localizers who believe in a set of primary mental abilities, none of which is pre-eminent. The abilities of savants tells us that cognitive abilities must be considered to be largely localized.

4 Scripts

If reality exists in a coded, implicate form, the senses *unpack* it in chunks of familiar associations, which look like scripts of a movie. The remarkable observations of the neurosurgeon Wilder Penfield nearly forty years ago,[10] in which the patients undergoing brain surgery narrated their experience on the stimulation of the outer layer of the cortex at different points, may be interpreted as showing how the brain works in terms of gestalts. The stimulation appeared to evoke vivid memories. Subsequent stimulation of the same site did not necessarily produce the same memory, while stimulation of some other site could evoke the same memory. Furthermore, there was no evidence that these memories represented actual experiences in the patient's past. They had a dreamlike quality, as if they consisted of generic scripts out of which real memories are combined. When the patients heard music they could not generally recall the tune or they saw individuals who they could not identify and so on. The events did not appear to have a specific

space-time locus.

For example, the patient G. Le. said upon stimulation, "Something coming to me from somewhere. A dream. . . The scenery seemed to be different from the one before. I think there were people there, but I could not swear to it. . . I see people in this world and in that world too, at the same time. . . Something flashed over me, something I dreamt. . . I keep seeing things—I keep dreaming things."[11]

Another patient, S. Be., "Someone was there in front of me right where the nurse is sitting. . . I am trying to find the name of a song. . . Someone was speaking to another and he mentioned a name but I could not understand it. . . It was just like a dream."[12]

It appears that generic scripts of this kind taken together form the stuff of real, waking experiences. The workings of the mind may be described in terms of the scripts and their relationships. The architecture of the brain itself provides clues to these relationships. The fact that one of the two hemispheres is dominant for speech is just part of the fact that asymmetry is fundamental to this architecture.

The connection between damage to the left hemisphere and impairment of speech was first made by Marc Dax in 1836 and also by Paul Broca in 1861. The latter differentiated between the loss of speech due to a paralysis of the muscles required to produce speech and a more fundamental loss of speech. Writing in 1864, Broca said, "I have been struck by the fact that . . . the lesion always lay not only in the same part of the brain but always the same side—the left. . . It seems from all this that the faculty of articulate language is localized in the left hemisphere, or at least that it depends chiefly upon that hemisphere."

About 90 percent of all people are right-handed. The probability of two right-handed parents having a left-handed child is 0.02. It rises to 0.17 if one parent is left-handed and to 0.46 if both are left-handed.[13] Over 95 percent of all right-handers have speech and language controlled by the left hemisphere. A majority of the left-handers (about 70 percent) also have left-hemisphere speech. Roughly 15 percent of the left-handers have speech in the right hemisphere, and 15 percent show evidence of speech control in both the hemispheres. Since the patient can only communicate through speech, neuroscience as we know it is essentially a record of the workings of the left brain.

5 Aphasia

Consider aphasia where injury to the brain impairs language function. One would expect that such impairment would be are taken to accompanied by a general reduction in the capacity to talk, understand, read, write, as well as do mathematics and remember things. One might also suppose that the ability to read complex technical texts would be effected much more than the capacity to understand simple language and to follow commands.

In reality, the relationship between these capacities is very complex. In aphasia, many of these capacities, by themselves or in groups, can be destroyed or spared in isolation from the others. Historically, several capacities related to language have been examined. These include fluency in conversation, repetition, comprehension of spoken language, word-finding disability, and reading disturbances.[14]

Broca's aphasia In expressive or Broca's aphasia there is a deficit involving the production of speech. There is deep subcortical pathology as well as damage to the frontal cortex. It is caused by injury to the Broca's area which is located just in front of the primary zone for speech musculature. These speech motor areas are spared in the case of classic Broca's aphasia. When the speech musculature itself is partially paralyzed leading to slurred speech that is called dysarthria.

In Broca's aphasia speech patterns are reduced to "content" words and the usage of the simplest, non-inflected froms of verbs. The production of speech is severly impaired but comprehension is relatively intact. Such speech is often telegraphic or agrammatic.

Table 1 summarizes the basic language characteristics of Broca's aphasia. A significant abnormality of repetition is a requirement to make this diagnosis. There is a selective inability to repeat the same syntactic, grammatical, and linguistic structures omitted from spontaneous speech. For example, the patient may repeat "the boy and the girl are at home" as "boy-girl-home."

Table 1 (Broca's aphasia)
Conversational speech: Nonfluent
Comprehension of spoken language: Relatively normal
Repetition of spoken language: Abnormal
Confrontation-naming: Abnormal
Reading aloud: Abnormal
Reading comprehension: Normal or abnormal

Writing: Abnormal

Wernicke's aphasia A lesion in the posterior portion of the left temporal lobe, the Wernicke area, causes a receptive aphasia in which the speech production is maintained but comprehension is much more seriously effected. Depending on the extent of damage, it may vary from being slightly odd to completely meaningless (Table 2).

Table 2 (Wernicke's aphasia)
Conversational speech: Fluent, paraphasic
Comprehension of spoken language: Abnormal
Repetition of spoken language: Abnormal
Confrontation-naming: Abnormal
Reading aloud: Abnormal
Reading comprehension: Abnormal
Writing: Abnormal

The Wernicke patient may speak at a abnormally fast pace and augment additional syllables to the end of words or additional worlds or phrases to the end of sentences. The speech is effortless, the phrase length is normal, and generally there is an acceptable grammatical structure and no problems of either articulation or prosody. But the speech shows a deficiency of meaningful, substantive words, so that despite the torrent of words ideas are not meaningfully conveyed, a phenomenon called empty speech.

Paraphasia is another characteristic of Wernicke's aphasia. Here words from the same general class may be inappropriately substituted, or syllables in the wrong order generated, or an utterance produced which is somewhat similar to the correct word. For example, the patient may call a table a "chair" or an elbow a "knee" or butter as "tubber" and so on.

Other aphasias Word-finding difficulty (anomia) accompanies many aphasic disorders. But here we speak of a "pure" anomia caused by injury to the angular gyrus. The resulting anomic (or nominal, semantic, or amnesic) aphasia manifests in the face of relatively intact spontaneous speech and comprehension of written and spoken language. Shown an object, the subject has great difficulty in producing its name; told the name, the subject is uncertain what it refers to. Since some sort of naming difficulty attends any aphasia, there is disagreement whether the disability is confined to the linguistic sphere. The conversational speech in anomia is fluent but empty.

Specific words are replaced by generalizations or words or phrases of less exact meaning and it has a characteristic rambling and vague nature.

When all the major language functions including speaking, comprehension, repetition, naming, reading and writing are severely affected, this represents "global" aphasia. Nevertheless, considerable variation exists amongst the patients. In addition, there are other rare syndromes which indicate the involvement of further cognitive centers. In one, the subject has good comprehension but little spontaneous speech; in another, there is fairly spontaneous speech but little comprehension. But in both cases, the subject can repeat excellently, sometimes better than a normal person. In a third variety, the patient can neither speak spontaneously nor comprehend appearing oblivious of the goings on. But upon hearing a message, the patient will parrot back verbatim what was spoken.

Alexia In alexia, the subject is able to write while unable to read; in alexia combined with agraphia, the subject is unable to write or read while retaining other language faculties; in acalculia, the subject has selective difficulty in dealing with numbers.

Alexia has been known for a long time, but its first clinical description was made by Dejerine in 1891 and 1892. One of these patients had suffered a cerebral vascular accident after which he could no longer read. Originally, the patient also suffered from some aphasia and agraphia but the aphasia cleared in due course. The other patient suddenly lost the ability to read but had no other language deficit. This patient, although unable to read except for some individual letters, could write adequately.

Three major varieties of alexia have been described: parietal-temporal, occipital, and frontal. In occipital alexia, there is no accompanying agraphia. In this spectacular condition, there is a serious inability to read contrasted with an almost uncanny preservation of writing ability.

Agraphia This is a loss or an impairment of the ability to produce written language. According to Benson, "The clinical abnormalities of writing are complex and have resisted rigid anatomical-psychological correlations. Nonetheless, data are available that demonstrate a number of distinctive variations within agraphia and at least crude anatomical correlations can be suggested."

The complex manner in which these aphasias manifest establishes that language functioning is a very intricate process. More specifically, it means

that at least certain components of the language functioning process operate in a yes/no fashion. These components include comprehension, production, repetition, and various abstract processes. But to view each as a separate module only tells half the story. There exists very subtle interrelationships between these capabilities which all come into operation in normal cognitions.

But the attempts to find neuroanatomical localization of individual language functions have not been successful. In fact the critique of the approach of the localizationists led to a holistic attitudes to brain's function. The anatomical centers, such as the areas of Broca or Wernicke, for the various syndromes are to be viewed as "focus" areas at a lower level and not exclusive processing centers. The actual centers are defined at some higher levels of abstraction.

Apraxia Our daily movements are almost automatic. These movements involve a whole sequence of intermediate steps which are performed in the right order with the correct timing. These movements may be considered an expression of a body language and, therefore, in parallel with aphasia, one would expect to see disorders related to body movements. Apraxia is the inability to perform certain learned or purposeful movements despite the absence of paralysis or sensory loss. Several types of apraxia have been described in the literature.

In kinetic or motor apraxia there is an impairment in the finer movements of one upper extremity, as in holding a pen or placing a letter in an envelope. This is a result of injury in the premotor area of the frontal lobe on the side opposite to the affected side of the body. Kinetic apraxia is thought to be a result of a breakdown in the program of the motor sequence necessary to execute a certain act.

In ideomotor apraxia the patient is unable to perform certain complex acts on command, although they will be performed spontaneously in appropriate situations. Thus the patient will be unable to mime the act of brushing the teeth though the actual brushing will be easily done. It is believed that this apraxia is caused by the disconnection of the center of verbal formulation and the motor areas of the frotal lobe.

When the sequence of actions for an act are not performed appropriately, this is called ideational apraxia. The individual movements can be performed correctly, but there is difficulty in putting these together. Rather than using a match, the patient may strike the cover of a matchbox with

the candletip. The general view is that this apraxia arises from lesions in the parietal lobe of the dominant hemisphere or in the corpus callosum.

Constructional apraxia is the loss in the ability to construct or reproduce figures by assembling or drawing. It seems to result from a loss of visual guidance or an impairment in visualizing a manipulative output. This apraxia is a result of a variety of lesions in either one or both of the hemispheres.

6 Blindsight

There are many old anecdotal accounts of blind people who can see sometime and deaf people who can likewise hear. In the 1970s, Larry Weiskrantz was working with brain-damaged subjects who could not consciously see an object in front of them in certain places within their field of vision. Yet when asked to guess if a light had flashed in their region of blindness, the subjects "guessed" right at a probability much above that of chance.

In a typical case the subjects is completely blind in the left or right visual field after undergoing brain surgery yet he performs very well in reaching for objects. "Needless to say, [the patient DB] was questioned repeatedly about his vision in his left-half field, and his most common response was that he saw nothing at all. . . When he was shown the results, he expressed surprise and insisted several times that he thought he was just 'guessing.' When he was shown a video film of his reaching and judging orientation of lines, he was openly astonished."[15] Obviously, blindsight patients possess visual ability but it is not part of their conscious awareness.

Blindsight has been explained as being a process similar to that of implicit memory or proposing that consciousness is a result of a dialog going on between different regions of the brain. When this dialog is disrupted, even if the sensory signals do reach the brain, the person will not be aware of the stimulus. In visual processing, it appears that motion and form are processed separately, in parallel. Semir Zeki[16] has shown that two critical parts of the cortex, regions V1 and V5, are involved in motion and its perception. If V5 is damaged there is no perception of motion. If V1 is damaged but V5 is intact, then signals in V5 are correlated with the stimulus, but the subject has no conscious awareness of that fact.

Zeki has proposed that the crucial factor for conscious vision is that the two areas V1 and V5 should be able to interact, carry on a dialog. The neurons in these two regions do not only respond to the motion of the object, but actually fire in synchrony, oscillating at the same frequency. So

this oscillation has been taken as a correlate of the conscious perception of movement.

Susan Greenfield[17] has proposed that blindsight might be a result of the incoming signals being too weak due to some inhibitory chemical process. This is why patients can be frequently conscious of objects moving at speeds greater than before. Flohr[18] has suggested that consciousness depends not so much on the extent of neurons recruited but, rather, on the the rate at which the recruitment occurs. This rate of recruitment may be inhibited due to some inhibitory process.

These explanations of blindsight in terms of the dialog within the regions V1 and V5 or neurons recruited therein do not exclude the possibility that simultaneous activity in other regions is essential for the feeling of consciousness. These simultaneous activity elsewhere need not be synchronized with the oscillations in the V1 and V5 regions.

Susan Greenfield summarizes:[19] "We have two clues about the phenomenology of consciousness; first, that it depends on a focus that is literally or psychologically strong, and second, that it might depend spatially and/or temporally on the extensive, rapid recruitment of a population of brain cells. These brain cells would span different brain regions or different parts of the cortex to constitute a temporary working assembly where all member neurons resonated or discharged in the same way. The more powerful the recruiting signal, the greater the likelihood that such assemblies would be established and consciousness ensue."

This model is quite attractive but it has fundamental difficulties. First, the blindsight patient *is* conscious, although he may not be conscious of certain images in his field of vision. Second, there are activities which are performed automatically of which we are not conscious. Some of these can be brought under the ambit of conscious control with varying degree of difficulty. As examples consider breathing or heartbeat, of which breathing is easily controlled and heartbeat can be controlled only by yogic adepts.

Why not consider that the injury in the brain leading to blindsight causes the vision in the stricken field to become automatic? Then through retraining it might be possible to regain the conscious experience of the images in this field. In the holistic explanation, the conscious awareness is a correlate of the activity in a complex set of regions in the brain. No region can be considered to be producing the function by itself, although damage to a specific region will lead to the loss of a corresponding function.

7 Agnosia

Agnosia is a failure of recognition that is not due to impairment of the sensory input or a general intellectual impairment. A visual agnosic patient will be unable to tell what he is looking at, although it can be demonstrated that the patient can see the object. In visual agnosia, the patient is unable to recognize objects for reasons other than that of loss of visual acuity or intellectual impairment. In auditory agnosia, the patient with unimpaired hearing fails to recognize or distinguish speech. The patient can read without difficulty, both out loud and for comprehension. If words are presented slowly, the patient may comprehend fairly well; if presented at a normal or rapid speed, the patient will not comprehend. Other patients perceive vowels and/or consonants but not entire words, or some words but not vowels or consonants. These patients have little difficulty with naming, reading or writing; all language functions except auditory comprehension are performed with ease. Astereognosis is a breakdown in tactile form perception so that the patient cannot recognize familiar objects through touch, although the sensations in the hands appear to be normal.

Prosopagnosia literally means a failure to recognize faces. Prosopagnosic patients are neither blind nor intellectually impaired; they can interpret facial expressions and they can can recognize their friends and relations by name or voice. Yet they do not recognize specific faces, not even their own in a mirror!

Prosopagnosia may be regarded as the opposite of blindsight. In blindsight there is recognition without awareness, whereas in prosopagnosia there is awareness without recognition. But there is evidence that the two syndromes have underlying similarity. Electrodermal recordings show that the prosopagnosic responds to familiar faces, although without awareness of this fact. It appears, therefore, that the patient is subconsciously registering the significance of the faces.

Prosopagnosia may be suppressed under conditions of associative priming. Thus if the patient is shown the picture of some other face it may trigger a recognition.

8 Split Brains

The two hemispheres of the brain are linked by the rich connections of the corpus callosum. The visual system is arranged so that each eye normally

projects to both hemispheres. By cutting the optic-nerve crossing, the *chiasm*, the remaining fibers in the optic nerve transmit information to the hemisphere on the same side. Visual input to the left eye is sent only to the left hemisphere, and input to the right eye projects only to the right hemisphere. The visual areas also communicate through the corpus callosum. When these fibers are also severed, the patient is left with a split brain.

A classic experiment on cat with split brains was conducted by Ronald Myers and Roger Sperry in 1953.[20] They showed that cats with split brains did as well as normal cats when it came to learning the task of discriminating between a circle and a square in order to obtain a food reward, while wearing a patch on one eye. This showed that one half of the brain did as well at the task as both the halves in communication. When the patch was transferred to the other eye, the split-brain cats behaved different from the normal cats, indicating that their previous learning had not been transferred to the other half of the brain.

Experiments on split-brain human patients[21] raised questions related to the nature and the seat of consciousness. For example, a patient with left-hemisphere speech does not know what his right hemisphere has seen through the right eye. The information in the right brain is unavailable to the left brain and vice versa. The left brain responds to the stimulus reaching it whereas the right brain responds to its own input. Each half brain learns, remembers, and carries out planned activities. It is as if each half brain works and functions outside the conscious realm of the other. Such behavior led Sperry to suggest that there are "two free wills in one cranial vault."

But there are other ways of looking at the situation. One may assume that the split-brain patient has lost conscious access to those cognitive functions which are regulated by the non-speech hemisphere. The other view is that nothing is changed as far as the awareness of the patient is considered and the cognitions of the right brain were linguistically isolated all along, even before the commissurotomy was performed. The procedure only disrupts the visual and other cognitive-processing pathways.

The patients themselves seem to support this second view. There seems to be no antagonism in the responses of the two hemispheres and the left hemisphere is able to fit the actions related to the information reaching the right hemisphere in a plausible theory.

For example, consider the test where the word "pink" is flashed to the right hemisphere and the word "bottle" is flashed to the left. Several bottles of different colors and shapes are placed before the patient, and he is asked

to choose one. He immediately picks the pink bottle explaining that pink is a nice colour. Although the patient is not consciously aware of the right eye having seen the word "pink" he, nevertheless, "feels" that pink is the right choice for the occasion. In this sense, this behavior is very similar to that of blindsight patients.

9 Modular circuits and unification

The brain has many modular circuits that mediate different functions. Some of these functions are not a part of conscious experience whereas others are. When these modules related to conscious sensations get "crosswired," this leads to synesthesia. One would expect that similar joining of other cognitions is also possible. A deliberate method of achieving such a transition from many to one is a part of some meditative traditions. Nevertheless, each of the primary senses has a unity. And as we have seen from our discussion of aphasia, agnosia and other similar disorders that cognitive tasks are likewise endowed with unity.

It is significant that patients with disrupted brains never claim to have anything other than a unique awareness. The reductionists opine that consciousness is nothing but the activity in the brain, but this is mere semantic play that sheds no light on the problem. If shared activity was all there was to consciousness, then this would have been destroyed or multiplied by commissurotomy. Split brains should then represent two minds just as in freak births with one trunk and two heads we do have the case of two minds.

As we have seen, consciousness, when seen as a non-material entity characterized by holistic quantum-like theory, can be understood much more naturally. The various senses represent projections of the mind function along the different directions. Injury to a specific location in the brain destroys the corresponding hardware necessary to reduce the mind function in that direction.

Another important point is that the mind function may be represented in terms of a variety of bases. While this chapter has considered specific deficits like the various aphasias and agnosias, one could as well have talked in terms of other sets of behaviors.

The architecture of mind is constantly adjusting to the environment. This ability to adjust makes it possible for the mind to compensate for the deficit with time.

The most significant argument against the reductionist and the neuronal

connectionist views of the mind is that on commisurotomy, when the brain has been split into two separate, unconnected parts, the cognitive or the verbal intelligence of the patients is not disrupted. One might grant that the connected hemispheres, by some processes of dominance and emergence of higher function, are able to maintain a feeling of unity which manifests as consciousness. In the words of Gazzaniga[22] "consciousness is a feeling about specialized capacities." But why should this feeling of unity continue on when the hemispheres are severed?

The argument that one of the two hemispheres does not have language and consciousness is uniquely associated with language fails when we consider split-brain patients who had language in both the hemispheres. Gazzaniga suggests that the right hemisphere, although possessing language, is very poor at making simple inferences. He reasons that the two hemispheres have very dissimilar conscious experience. But the fact that both the hemispheres have speech mitigates against that view. Furthermore, one would expect that the separated hemispheres will start a process of independent reorganization to all the sensory inputs. If the patient still is found to have a single awareness, as has been the case in all tests, then the only conclusion is that the mind remains whole, although the brain has been sundered.

The identity of the neuronal activity and the workings of the mind is called into question by the persistence of the feeling of unity in the awareness of the split-brain patients. As the neuronal connections have been severed, the unity must be maintained through a field associated with the brain.

But why should mere localization of cognitive function, even under the influence of a field, make it different from a mechanistic computation? This must be because of a quantum basis to the underlying process in the elementary cognitions. Basically, the argument is that if nature at its deepest level is quantum mechanical and if mind is able to understand this description, then mind itself must have a quantum mechanical substratum.

Let us summarize the main findings from neuroscience:

- There is a witness in the mind, detached from our personal self, who is most clearly seen in research on dreaming. Split brain experiments confirm that we have a single mind, even though our cognitive centers have autonomy.

- The senses do not all operate in unison, as in lucid dreaming and in non-alert waking states.

- Reality is constructed in the domain of our consciousness by fragments of past experience that are joined together.
- Cognitive abilities have components that are inaccessible to the conscious mind.

10 Vedic ideas of consciousness states

Having presented relevant neuroscientific findings as background, we look at the Vedas for similar material. We confine ourselves to the passages that speak about consciousness directly, leaving out the enormous Purāṇic and other mythic literature which deals with the same subject, albeit in a cryptic form.

The Vedas speak of the "witness" within the mind through the image of the tree to which two birds cling. One of the birds eats fruit and the other only watches (Ṛgveda 1.164.20). This is explained in Bṛhadāraṇyaka 3.1.2 as, "On the same tree man sits grieving, immersed, bewildered by his own impotence. But when he sees the other lord contented and knows his glory, then his grief passes."

The two birds of this image are very different. The one who grieves (the conditioned self) is limited with access to only a part of the tree; the other bird sees everything. The conditioned self is the conscious witness, the other self is puruṣa. The conditioned self does not have access to all memories. Some of these memories can be retrieved by hypnosis. Yoga is the discipline by which one can do the same, and more.

It is further said that the ātman, infinitesimal, yet occupying the whole body, is revealed in progressively greater measure in the sequence of four states: wakefulness (*jāgaran*), dream sleep (*svapna*), deep sleep, (*suṣupti*), and the fourth state *turīya*.

The waking state has another name, *vaiśvānara*, which emphasizes that it related to the physical world, *viśva*. In the dreaming state the mind withdraws from the outer senses and creates its own worlds by means of its own light, *tejas*, which is why it is called *taijasa*. According to Bṛhadāraṇyaka 4.3.9-10, the dream state is intermediate to the waking and the deep sleep states where the "evils and the blessings" of both are found. Furthermore,

> When he falls asleep, then having taken away with him the material from the whole world, destroying and building it up agin,

> he sleeps (dreams) by his own light. In that state he is self-illumined.
>
> There are no chariots in that state, no horses, no roads, but he himself sends forth chariots, horses, and roads. There are no blessings there, no happiness, no joys, but he himself sends forth blessings, happiness, and joys.

In deep sleep, the self is detached from its outer form and it is by itself as pure knowledge, *prajñā*, and so it is called *prājña* ātman.

The outer forms of the mind are affected by the individual's mix of *guṇas*, sattva (transparence), rajas (energy or activity) and tamas (inertia). This means that they determine the waking and the dream behaviors. In contrast, in the deep sleep state, the "witness" has withdrawn rendering the *guṇas* ineffective and "just as a youth or a great king or a great scholar, having reached the summit of happiness, might rest, so does he then rest" (BU 2.1.19). This true rest and experience of bliss replenishes the body.

The fourth state, *turīya*, is reached by achieving a union of the conditioned self with the witness (the watching bird on the tree) in a state of heightened wakefulness. Dreaming and deep sleep are physiologically determined by the the body seeking union with Brahman to rejuvenate itself; the *turīya* is a movement in the opposite direction for the same end. If one is lapsing into Brahman, the other is an ascent to it. In yogic practice, the fourth state is called *samādhi*.

The mind is also viewed in a hierarchy, with the lower mind consisting primarily of the senses, and the higher mind consisting of ahaṃkāra (ego), buddhi (intelligence), and citta (consciousness, thought, memories). In the higher mind, and transcending it, is the ātman (universal mind). Ātman is declared to be identical to Brahman in the Upaniṣads.

The Ṛgvedic hymn 10.129 describes how prior to a separation between the subject and the object neither space or time existed. It goes on to say:

> In the beginning desire arose, born of the mind, it was the primal seed. The seers who have searched their hearts with wisdom know the connection (*bandhu*) between being and non-being.
>
> A cord stretched across them; what was above, and what was below? Seminal powers made mighty forces, below was strength and above was impulse.[1]

The connections (*bandhu*) between the outer and the inner are affirmed. Next, there is mention of the dichotomy between puruṣa and prkṛti, the impulse and the strength.

In Ṛgveda 10.90, puruṣa is the cosmic person out of whose dismembered body the living and the inanimate worlds emerge. Here too a dichotomy, expressed through the symbols of male and female, marks the paradoxical beginning of empirical existence. Puruṣa is born out of *virāj*, "the shining one," and she out of him. This marks a distinction between puruṣa as transcendent reality and its manifestation in terms of individual consciousness.

Further on in the same hymn, several categories related to existence, such as space, sky, earth, directions, wind, metres and so on are created. Such an enumeration is described at greater length in the dialogue in the Bṛhadāraṇyaka Upaniṣad (4.5.12-13) between Yājñavalkya and Maitreyī:

> As all waters find their goal in the sea, so all touches in the skin, all smells in the nose, all taste in the tongue, all forms in the eye, all sounds in the ear, all deliberations in the mind, all knowledge in the intellect, all actions in the hands, all enjoyment in sex, all elimination in the excretory organs, all movement in the feet, and all the Vedas in speech.

> As a mass of salt has neither inside nor outside, but is altogether a mass of taste, thus indeed has that Self neither inside nor outside, but is altogether a mass of knowledge; and having risen from these elements, vanishes again in them.

These include the five material elements, the five organs of sense, the five organs of action, the *buddhi*, in the form of *vijñāna*, *ahaṃkāra*, and mind. The only categories of the late Sāṃkhya which are not explicitly mentioned in the Bṛhadāraṇyaka Upaniṣad are the *tanmātras*, but the *bandhu* between the gross and the subtle, which is emphasized again and again in the Ṛgveda, indicates the implicit recognition of the corresponding subtle *tanmātra* for the five gross elements. This subtle representation of the outer in terms of *mātrā* is described explicitly in the Kauṣītaki Brāhmaṇa Upaniṣad (3.5), where the specific abstract correspondences for certain outer functions, such as speech, breath, order, and so on, are listed in terms of *bhūtamātrā*. The word *mātrā* here refers to the essence in the same manner as in the notion of tanmātra. Ahaṃkāra is described in the Chandogya Upaniṣad (7.25.1) as the one who sees the universe.

In other words, all the elements of Sāṃkhya seem to be in place in the Vedic literature. We also have a proper scientific system with its cosmic order and corresponding laws (ṛta), entities and relationships. Even the workings of the human mind are subjected to logical analysis.

According to the these ideas, the creation of the universe may be seen in the following sequences of creation that leads from prakṛti (matter) to puruṣa (universal consciousness):

> prakṛti, intelligence, ego
>
> ākāśa, air, light or fire, water, earth (*as tanmātras or subtle elements*)
>
> ākāśa, air, light or fire, water, earth (*as gross elements*)
>
> hearing, touch, sight, taste, smell
>
> speech, grasping, walking, procreation, evacuation
>
> mind, puruṣa

Such creation is viewed to occur recursively at various levels: cosmic, embryological, mental. The elements that precede in this sequence interpenetrate the ones that come later.

In the process of absorption into Brahman, the sequence is reversed. Such absorption is supposed to occur in death, in deep sleep, and in yoga.

This absorption sequence is often viewed in yoga in a shorter sequence of eight. The Bhagavad Gīta (7.4) gives the list: earth, water, fire, air, ākāśa, mind, intelligence, and ego. The first five of these, the elements that are traditionally seen as centered up the spine in yoga, are the lower mind. Once these elements, together with their senses, have been absorbed into the higher mind, the yogi is able to gather in his mind, intelligence, and ego to a one-pointed union with prakṛti and puruṣa. The nature of the experience until the ascent to prakṛti is determined by the guṇas of the yogi, leading to a variety of absorption states.[23] Beyond this variety lies the apprehension of puruṣa, which is identical for everyone. This sequence is Sādmkhya yoga.

Yogis are aware that time delays are involved in conscious perception, a result that surprised neuroscientists when experiments showed this in the late 70s. This delay–of the order of a half-second or so–appears to be necessary for the mind to put the sensory inputs together. I was told about this delay by my father, a doctor but also a yogi, when I was a eight-year old boy, in the 50s. I used to see a frightening dream about falling in a chasm

soon after going to bed every night, which would wake me up. When I asked my father about it he watched me next night and then explained that this dream was a response to my foot slipping off the other foot. Because of the mind's delay the script of my unpleasant dream could be played, providing a "justfication" to the physical event.

This story tells us that we cannot just consider the citta operating on the sensory input, and mind has a definite agency.

11 The support of the gods

Modern neuroscience has established that specific centers in the brain are dedicated to different cognitive tasks, and each cognitive ability is holistic. The Vedas see the mind constructed out of five elements, various senses, intelligence, ego, and citta (consciousness) undergoing continual change, owing to the evolution of the guṇas.

But mind is not a plenum. The Vedas see it teeming with gods who literally hold up mind's sky, *cidākāśa*.

We don't know whether the cognitive centers, identified by the Vedic ṛṣis through contemplation, are identical with those found by modern neuroscience. If we accept the proposition that each localized cognitive ability is to be equated to a *deva*, how do we proceed with the process of aggregation to determine how the larger *devas* are constituted? When the Indic texts say that the cosmos is mirrored in the mind (as in the Śiva Saṃhitā, chapter 2), the mirroring is not only in respect of nature-like organization and periodic processes but also in the specialized functions of society. The Vedic texts have many *devas* such as Dyaus, Varuṇa, Mitra, Viṣnu, Uṣas, the Aśvins, Indra, Trita Āptya, Apāṃ Napāt, Mātariśvan, Ahibudhnya, Aja ekapād, Rudra, the Maruts, Vāyu, Sarasvatī, Agni, Bṛhaspati, Soma, Dhātṛ, Tvaṣṭṛ, Manyu, Śraddhā, Aramati, Vāc, Pṛṣni, the Ṛbhus, and so on. Some of these are clearly of astronomical inspiration, but there are some amongst these that represent cognitive categories, and others that have both astronomical and cognitive function. To find which of these *devas* represent specialized cognitive function will require careful study of the textual evidence. We must also remember the advice of Yāska, who in his Nirukta (7.4-11) notes that the functions of the *devas* are not clearly delineated. This shadowyness is owing to the mutual interconnections that also are a fact of cognitive function.

The characterization of the *devas* becomes clearer in the later literature,

as in the case of *devatā*s such as Sarasvatī or Gaṇeśa. Thus the wisdom goddesses (Mahāvidyā) Kālī, Tārā, Tripurā Sundarī, Bhuvaneśvarī, Bhairavī, Chinnamastā, Dhūmāvatī, Bagalāmukhī, Mātaṅgī, Kamalātmikā represent the personification and control of several aspects of learning and wisdom. The 108 or 1,008 names of the great god (Viṣṇu or Śiva) or goddess (Devī) are a representation of the attributes of consciousness, and these are to be seen as more than just an enumeration of qualities.

Obviously, the names symbolize the loci of awareness, and the meditative process that led to their identification is nothing but an illuminating of the inner space of mind. But can we find appropriate categories from the neuroscience literature as correlates of these meditational points of concentration? It appears we will have to use the material in the Purāṇic, Yogic and Tantric literature, which contains extensive descriptions in parable and myth of awareness states, to make further progress in this endeavor.

Since cognitive abilities are localized, the idea that a contemplative discipline can help a subject further these abilities becomes plausible. The Vedic texts insist that such furtherance has been observed. A modern understanding of this phenomenon is that the subject, by means of the meditative discipline, changes the organization of the cognitive center. This belief is open to experimental refutation.

Modern physics has shown the idea that the subject is forever apart from what it surveys to be wrong. The Vedic view goes further and claims that consciousness provides a means for subject and object to become one, a process in which the cognitive centers are transformed into doorways of holistic perception.

Notes

1. Quoted in Springer and Deutsch (1985).
2. Bohm (1980), Pribram (1987), d'Espagnat (1995), Kak (1996).
3. Kak (1997, 1997-98); for a background to the Vedic and Yogic material see Feuerstein (1998) and Frawley (1997).
4. Aserinsky and Kleitman (1953).
5. Antrobus and Fisher (1965).
6. Luria (1987).
7. Sacks (1985), pages 199-200.
8. Sacks (1985), page 203; see also Sacks (1995) for further examples.
9. Treffert (1989).
10. Penfield (1963).
11. Penfield, page 635.
12. Penfield, page 640.
13. Chamberlain (1928).
14. Benson (1979).
15. Weiskrantz (1974).
16. Zeki (1993).
17. Greenfield (1995).
18. Flohr (1991).
19. Greenfield (1995).
20. Myers (1953).
21. Gazzaniga, Bogen, Sperry (1962).
22. Gazzaniga (1997).
23. See Frawley (1997) for elucidation of the variety of yogic states.

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