The Gods Within

This book is a pioneering study that reconciles the traditional understanding of the Vedic gods, taken as the constituents of the individual's consciousness, with new discoveries of neuroscience. Using a variety of sources, the book argues that the gods may be seen as the cognitive centres in the brain or the archetypal projections of an objective consciousness on the subjective mind. This book will be useful to scholars of religion, psychology and the emerging new science of consciousness.

Some comments on this work:

- Professor Subhash Kak always manages to surprise with his highly original scientific forays into ancient Indic wisdom. In this book, he does away with the flimsy indological model of viewing the Vedic deities as representing natural phenomena. In place of this lopsided interpretation, he offers a more sophisticated understanding based on neuroscience. In doing so, he has opened a promising new door in the East-West dialogue. – Georg Feuerstein, Ph.D., Founder-president of Yoga Research and Education Center, author of *The Shambhala Encyclopedia of Yoga* and *The Yoga Tradition.*

- For centuries the history of India has been offered up to us by European scholars in search of the origins of their own civilizations. India was a place largely unknown to them, and, by their reckoning, too far away to have had any real impact on what they considered to be their own cradle of intellectual life. Professor Kak is among a group of scholars now attempting to redress this imbalance by providing a new theoretical structure for examining the origins of Indian scientific

> knowledge. This book will reopen old controversies and help reshape this debate in ways that we can all welcome. – A. David Napier, Professor of Anthropology, Middlebury College, author of *Masks, Transformation, and Paradox* and *Foreign Bodies*.

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The Gods Within

The Vedic Tradition and Consciousness

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Preface

The notion of the *devas*, the Vedic gods, is widely misunderstood. The Vedas insist on a oneness behind appearances, then what is the role of the gods?

Some people take these gods to be representation of nature and its processes like rain, lightning, thunder, Sun, Moon, ocean. But within the Indian tradition the gods are first and foremost the constituents of the individual's consciousness, and only secondarily the outer processes. They may be seen as the precognitive and cognitive centres in the brain, or the archetypal projections of an objective consciousness on the subjective mind.

Consciousness is awareness of the external world, of the self as an entity, and of one's inner thoughts and feelings. These three aspects lead to outer sciences, spirituality, and psychology, respectively. The Indian tradition has investigated all the three aspects of consciousness, whereas in the West spirituality has been generally derided.

The Vedic view of the gods, obtained by meditation and examination of the self, directly addresses the mystery of the mind. Since the method at the basis of this view seems contrary to materialism, many in the West have rejected the Vedic view viscerally. But materialism is in retreat and new findings of neuroscience make it possible to appreciate the Vedic material, while maintaining an attitude consonant with the spirit of contemporary science.

We know now that mind is not to be viewed as a

computer that responds reflexively to stimuli. The brain has considerable plasticity, and it reorganizes itself in response to inner and outer processes. Since each one of us has unique experience, the mind constructs a reality that is unique for each individual.

This inner reality may change with time and it need not conform to outer reality. This is seen most dramatically in the case of the individual's body image. Thus amputees have phantoms of their limbs that they have lost, which can be a source of real pain.

The inner world evolves with the continuing reorganization within the brain. In the phantom limb syndrome, the region in the somatosensory cortex corresponding to the amputated hand can get signals from the side of the face, causing a stimulation of the face to be felt as sensation in the missing hand.

Mind's agency expresses itself in many unexpected ways. As a result of injury to the brain, a person may lose the capacity to see colours, recognize faces, comprehend speech, read maps and, most astonishingly, to read while still managing to write – so long as he is not looking at the paper.

It is now generally believed that there exist separate cognitive centers for different capacities. This is similar to the Vedic idea that the devas are the lords of the senses. This raises hope that the Vedic approach will provide useful signposts for modern investigations of the mind. It is with this motivation that, in this book, I examine the points of convergence between neuroscience and the Vedic tradition of consciousness.

This book is the culmination of a project that has engaged me for many years. My journey began with research on intelligence – artificial, natural or creative –, and it has led through the hallways of neural circuits, quantum theory, Vedic texts, temple architecture, con-

sciousness, and creativity in art and music. Preliminary reports of this work were published by the Adyar Library Bulletin in Chennai and the Arsha Vidya Gurukulam in Saylorsburg, Pennsylvania.

I thank Georg Feuerstein and Vamadeva Shastri for encouragement and advice.

Baton Rouge, December 1, 2001 Subhash Kak

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Introduction

Looking out through our minds, we have made spectacular progress in understanding the physical universe. But, we have no clear idea how the mind functions, how memories are stored and recalled, and what is the origin of our subjective feeling.

Our world is strangely split. On the one hand, we have the machine-like physical universe which is subject to laws; on the other hand, we have freedom of spirit and action. A part of our understanding is based on a consideration of the past, of efficient causes, but as individuals with hopes and aspirations, we do not dismiss insight that emerges out of a consideration of final causes related to the future. These two sides are complementary to our experience of the universe. One side is that of conventional science, and the other is that of spirituality. Mind, the instrument of our knowledge and experience, straddles these two sides of reality, and so if we did understand it we will be able to broaden the arena of science beyond its current limitations.

Brain and mind may not be equated because of the special value we attach to subjective states of awareness. The significance of our experience to us is described very well by Fyodor Dostoevsky for the experience of epileptic seizure through the character of Prince Myshkin in his novel, *The Idiot*. Dostoevsky, an epileptic himself, spoke with authority in this passage:

> He remembered that during his epileptic fits,

> or rather immediately preceding them, he had always experienced a moment or two when his whole heart, and mind, and body seemed to wake up to vigour and light; when he became filled with joy and hope, and all his anxieties seemed to be swept away for ever; these moments were but presentiments, as it were, of the one final second (it was never more than a second) in which the fit came upon him. That second, of course, was inexpressible.

Myshkin ponders on how the beauty of his experience makes it more than just an abnormal process of the brain:

> What matter though it be only disease, an abnormal tension of the brain, if when I recall and analyze the moment, it seems to have been one of harmony and beauty in the highest degree - an instant of deepest sensation, overflowing with unbounded joy and rapture, ecstatic devotion, and completest life?

To the epileptic, the experience is worth everything, as in these further words of Prince Myshkin:

> Since, in the last conscious moment preceding the attack, he could say to himself, with full understanding of his words: "I would give my whole life for this one instant," then doubtless to him it really was worth a lifetime.

Although Dostoevsky is describing the aura of the epileptic's seizure, this experience is not that extraordinary. Almost all of us have witnessed similar overwhelming joy, that was triggered by the most ordinary happening. This joy is not in the brain's activity itself, for such joy is experienced also by those who depend on hearing

or visual aids, where part of the brain processing is done by machine. Experience lies beyond the instrumentality of brain circuits.

Consciousness may be taken to be an awareness of the surrounding world, of the self as an entity, and of one's thoughts and feelings. It cannot be denied to a prelinguistic infant or to a deaf-mute, making it clear that language is not essential to it. But subverbal awareness is different in quality to one that is accompanied by language and inner dialogue, indicating that consciousness is an extensive property, that is, it has form, quality and degree associated with it.

During ordinary awareness we take our consciousness so much for granted that we are unable to comprehend its true nature. It is when we pay attention to those whose consciousness is different from ours that the majesty of it becomes apparent. When we look at the ways of children and the very old, or of those from different cultures, with different beliefs, and of those whose minds are "broken" or, more accurately, put together in a way different from our own, we become aware that we know so little about it.

The reality of conscious experience may be explored at different levels, such as its states, memories, feelings. The broadest questions that one may ask are:

1. What is the ontological nature of consciousness?
2. Is consciousness intentional?
3. How is cognition itself cognized?
4. What *form* does cognition have?

It is to get answers to these questions that we turn to neuroscience and to the Vedas. Neuroscience offers

us one kind of lesson regarding the nature of the mind, a lesson related to its working as a complex machine. More specifically, we learn what happens if parts of this machine are missing, and this lets us infer mind's character and, strangely enough, it turns out to not to be machine-like at its core. It also provides understanding of the stages in the development of the minds of children.

The Vedas offer us a different kind of lesson. Cryptic tracts on Self and awareness, they consider reality to transcend the duality of matter and mind, calling this non-dual reality Brahman. Although seen to be present in all its material manifestations, Brahman is understood best as the knowing subject within us.

According to the Upaniṣads, Brahman has two aspects: one devoid of qualifying characteristics (nirviśeṣa, parā) and the other with qualities (saviśeṣa, aparā). The two forms are contrasted as being subtle and gross, immortal and mortal, and unlimited and limited. About the unqualified Brahman it is said, "It is neither gross nor minute, neither short nor long, neither redness nor moisture, neither shadow nor darkness, neither air nor ākāśa, unattached, without savour or odour, without eyes or ears, without vocal organ or mind, non-luminous, without vital force or mouth, without measure, and without interior or exterior" (BU 3.8.8). On the other hand, the qualified Brahman is he whose "body is spirit, form is light, thoughts are true, nature is like ākāśa, and from whom all works, desires, odours and tastes proceed" (CU 3.14.2).

Brahman, as Pure Consciousness, is the eternal subject. "You cannot see that who is the witness of vision, you cannot hear that who is the hearer of hearing, you cannot think of that who is the thinker of thought, you cannot know that who is the knower of knowledge" (BU 3.4.2). "He is never seen, but is the witness; he is never

heard, but is the hearer; he is never thought of, but is the thinker; he is never known, but is the knower. There is no other witness but him, no other hearer but him, no other thinker but him, no other knower but him" (BU 3.7.23).

Brahman is also called Saccidānanda, where sat (existence, reality, or being), cit (consciousness, or knowledge), and ānanda (bliss) show how its knowledge requires that the experiencing subject bridge the divide between knowing and feeling.

A direct study of consciousness and knowledge is not limited to the Vedas and the Upaniṣads alone. Later literature also – like the Yoga Vāsiṣṭha, the Devī Bhāgavata Purāṇa, and the Tripurā Rahasya – self-consciously describes itself as addressing the mystery of consciousness.[1]

The Vedas, and later texts of Yoga and Tantra, speak of the cognitive centres as individual, whole entities that are, nevertheless, a part of a greater unity. The vocabulary used in these texts challenges the modern reader, but once the meaning of the operative terms is mastered, the structure turns out to be reasonable and logical. Vedic mythology describes this understanding of consciousness, and learning its grammar helps unlock its hidden meaning.

Devas, Ṛṣis

Vedic narrative deals with separation and identity of the observer and the observed. Ordinarily apart, subject and object fuse into the same entity at a transcendental level. In the Vedic discourse the cognitive centres are the devatās or devas – deities, gods, or luminous loci. The Atharvaveda (10.2.31) calls the human body the city of the devas. This passage adds that the body consists of

eight cognitive centres which, other references suggest, are hierarchically organized. This reference is not to the primary senses but to the finer levels of the mind which are often represented in terms of the *cakras* of Yogic practice.

The devas may be visualized in a complex scheme in which some embody the autonomous processes and others embody the creative centres. In analogy with the outer world, the inner space of consciousness has three zones: the body (earth), the exchange processes (prāṇa, atmosphere), and the inner sky (consciousness, heavens). The number of devas is variously given, with the most extravagant passages counting 3.3 million. The Bṛhadāraṇyaka Upaniṣad (3.9.1) has a hymn that praises 3,306 of them, explaining that there are only 33 major deities who are distributed in three groups of eleven among the three zones. Embodying the same light of consciousness, mind's discrete agents are like the reflections off the facets of a diamond.

Since each deva is illuminated by primordial consciousness, one may access its mystery through any one of them. There is a deva for reading and learning, and others for recognition, friendship, generosity, and other capacities. The devas may be identified for recognition of time, space, balance, states of mood, touch and other senses, although it is customary to speak of the senses in themselves in terms of *tattvas*, primary constituents, that combine to form higher cognitions. These cognitions may appear distinct, but they are also interdependent, each sitting on top of all others.

When the cognitive centres nearer the sense-organs are viewed in anthropomorphic terms, they are the ṛṣis, or sages. The Yajurveda (34.55) declares that the seven sages reside within the body, and the same is stated in the Atharvaveda (10.2.6). The Bṛhadāraṇyaka Upaniṣad

(2.2.3) says, "The ṛṣis (sages) are the senses." The left eye is Jamadagni, the right Viśvāmitra; the left ear Bharadvāja, the right Gautama; the right nostril Vasiṣṭha, the left Kaśyapa; and the tongue Atri. The naming is not always consistent, for the Śatapatha Brāhmaṇa (4.1.5.1) calls the Aśvins the organ of hearing.

Although the devas for the three zones are ordinarily distinctly named, they may be projected across the regions. For example, the Bṛhad-Devatā of Śaunaka speaks of the three forms of Agni: Agni Pavamāna on earth, Agni Vanaspati in the middle region, and Agni Śuci in the celestial world. "In this world he is extolled by seers with praises as being Agni, in the middle world he is praised as Jātavedas, in heaven he is praised as Vaiśvānara. He is called Indra because, accompanied by Vāyu, he takes up fluids with his rays which he rains upon the world. Agni in this world, Indra and Vāyu in the middle, and Sūrya in the heavens are to be recognized as the three deities" (BD 1.66-69).

This projection across regions represents a mutual mirroring between the microcosm and the macrocosm as mediated through the interface of the mind. This is how the same ṛṣis are the cognitive centres, mythical progenitors of ancient families, and stars. The narrative of the myths sometime conflates the three zones, and we need to be aware of recursion and self-reference to properly understand these stories.

Dichotomies

The Vedic texts divide the capacities of the mind in various dichotomies, such as high and low, left and right, and masculine and feminine. The dichotomy of the left and right is between emotion and reason, while that of gender is between potential (male) and energy (female).

A different dichotomy is that of the devas and the asuras. The Śatapatha Brāhmaṇa (11.1.6.7-8) says the devas were created from the sky and the *asuras* from the earth of the inner space, suggesting that the devas are the higher or spiritual functions and the asuras represent the lower or bodily function. This opposition between the devas and the asuras shows itself at many levels, and it leads to the distinction between freedom and automatic behaviour. In Parkinsonian patients we see this distinction between the free 'I' and the mechanical 'It' of the body at the level of motion.

Sri Aurobindo, the great modern yogic sage, spoke of the dichotomy between the left and right in the following way:[2]

> 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.

Remarkably, what Aurobindo wrote in 1910 would be considered quite accurate from the point of view of brain hemisphericity, an understanding that was to arise five decades later. 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. Techniques of meditation bridge other polarities as well.[3]

It is not only the mystical literature that describes

this striving for synchronization and harmony, for we find it in the neurological literature as well. The neuropsychologist Oliver Sacks writing in his book *Awakenings* speaks about the *two* persons who reside in each one of us thus:[4] "It is the function of art, of living contact, of existential medicine, to call upon the latent will, the agent, the 'I', to call out its commanding and coordinating powers, so that it may regain its hegemony and rule once again – for the final rule, the ruler, is not a measuring rod or clock, but the rule and measure of the personal 'I'. These two forms of medicine must be joined, must co-inhere, as body and soul."

Neuroscience, physics and the Vedic tradition agree that reality is consistent only in its *primordial, implicate* form.[5] The Vedas insist that speech and sense-associations cannot describe this reality completely.[6] Language has four forms of which the human has access to only three, or the gods know four kinds of language and the humans only one, stressing in each case the limitation of ordinary language.

The Muṇḍaka Upaniṣad (1.1.2) says that knowledge is of two types: lower (aparā) and higher (parā). Knowledge expressed through ordinary language is lower, the "higher knowledge is that through which one knows the changeless reality, that is Brahman" (MuU 1.1.5).

Modern physics has independently reached the insight that not all knowledge is paradox-free. At a basic level one may ask: Is it possible to reconcile the determinism of science with the subjective sense of free will? What existed before the beginning of time? How did life emerge out of inert matter? How do mind and matter interface?

Paradoxes are especially troubling in quantum mechanics. In Schrödinger's Cat paradox, the poor animal is simultaneously dead and alive. An electron can be either a wave or a particle. There is a limit to the knowl-

edge that one can obtain about the microworld due to the uncertainty principle. Effects appear to propagate instantaneously. Most astonishingly, if we insist on using traditional logic, what we do in the present may influence the past![7]

It has now become clear that the reductionist or the materialist view of the world is wrong even for outer reality. The evolution of the new understanding has taken less than a century since the theories of relativity and quantum physics brought the observer centrestage to physics.

Philosophy and physics have helped each other in the development of the new paradigm. The Vedic idea of Brahman, as a representation of all things (*prajñānaṃ brahma*), was an inspiration to Erwin Schrödinger in the conception of the quantum-mechanical wavefunction defined as the sum of all possibilities.[8]

Although modern physics has been successful in explaining the nature of the physical world, it has been unable to deal with the problem of consciousness. At the meeting point of physics and biology, we confront basic questions regarding the mind. If mind emerges from matter, how does it obtain autonomy? If the world is governed by laws, how do we have free will? If our autonomy (free will) is an epiphenomenon, then are we walking shadows? Is consciousness the ground-stuff of reality? What is the connection between consciousness and the physical world? These happen to be old questions of the Indian tradition.

Although the Vedas recognize the centrality of the outer world and its laws, they claim that knowledge, to be complete, must include a science of the subjective world. This may appear self-evident now, but until a few years ago mainstream Western science sought explanations for mind in matter alone, and the subject of consciousness

was taboo.

Modern discoveries based on study of consciousness states, developmental psychology, and deficits caused by lesions, stroke, injury, and surgery disrupting normal functioning of senses show that mind is a complex structure of various localized functions held together by a unitary awareness. Conscious cognitions occur at the end of a hierarchy of precognitions where judgments regarding form, object and context are made.

The Vedic view agrees with this general scheme. However, it is articulated not in the vocabulary of brain function, but rather in that of loci of cognition. In neuroscience brain processing is primary, whereas in the Vedic view mind is the primary reality.

This book is an introduction to the Vedic science of consciousness. We will show that the Vedas provide an understanding that complements that of neuroscience. We begin with a survey of the relevant findings from neuroscience that establish a background against which Vedic ideas on the nature of mind may be appreciated. In particular, we review results on states of consciousness, anomalous abilities, scripts of behaviour, language impairment, blindsight, and hemispheric specialization to show that brain is not to be viewed as a monolithic computing device and much of its processing is counterintuitive and decentralized. Vedic insight and neuroscientific findings help outline connections between the devas and cognitive centres.

Vaiśeṣika and Sāṃkhya are systems that bridge the divide between the physical and the cognitive. They provide a framework in which consciousness is seen as constructed out of primitives. Next, we conceptualize one as the heart of consciousness through the traditional mythology of Śiva and Viṣṇu.

It is said that gods are evoked by music. There is

inner music within us which sustains and heals us. We see this most dramatically in the therapeutic effects of music on stroke victims and its power of inspiration for all. But why is music so effective? To understand this, we take up the question of sound primitives. Finally, we discuss Indian aesthetics and art and the representation of the inner and the outer cosmos in the Indian temple.

It is my hope this work will encourage a further examination of the neuroscientific correlates of the Vedic gods for a deeper understanding of Yoga and Tantra. This dialogue between Indian wisdom and neuroscience is likely to benefit the emerging fields of consciousness studies and mind-body medicine as well.

2

States of Consciousness

Consciousness is not just awareness either in its passive form or as a feeling of freedom that comes with intentionality, it has a body that may be inferred from its many different projections. But it is a shadowy body whose outline appears to pulsate and transform in strange ways. It gets small sometimes, shrinking and turning inwards; on other occasions it is expansive, seeming to go beyond the physical self; sometimes it is clouded, and other times it is bright and full of light.

Its changes with mood and attention (ālocana) are somewhat like a shower in cold or warm water. In cold water, we adjust by becoming more aware of our sensations, drawing inwards to minimize the effect of the water spray; in warm water, we let go, and our physical being appears to have a larger presence. Our consciousness in interactions with other people responds to the adjustment of our social boundaries.

These different states may be taken to be modifications caused to the individual self. The idea of a correspondence between the microcosm and the macrocosm emerges as soon as one accepts that there is a unity behind all conscious experience. It is like the relationship between the water drop representing the individual self and the lake which stands for all the different selves, the examination of a single drop revealing the properties of the entire mass of water.

There are many senses in which the individual sees itself. Of these, the sense of the physical self comes from "proprioception" – a sixth sense beyond seeing, hearing, smelling, tasting, and touching – that tells us that our bodies belong to us. If proprioception is lost, the body appears disembodied. There are other states where one has difficulty seeing the outer properly, and others where one has difficulty to know things about oneself. These different states may be taken to be modifications caused by the individual self.

The several states of consciousness: wakefulness, sleep, dream-sleep, coma, hunger and thirst, love and anger, interest and boredom, have distinct neurochemical signatures. But in our subjective experience, we see a common thread running through these diverse states. For those who do not accept the reality of this individual self, the common thread is an artifact of the persistent electrical activity of the brain. In our view, the common thread is a fundamental property of reality.

The individual behind conscious states has the capacity to meditate on itself. The self's activity is directed to obtaining an experience where the senses come together to bring the person into harmony with processes going on within the body and outside it. The person's sense of equilibrium with the universe fills him with a feeling of mastery. Creative writers and artists speak of their strivings for this peak experience, bemoaning the fact that they achieve it on just a few occasions in their life. Athletes speak of how they cannot do anything wrong when they are in the "zone".

In the Vedic view, the different states of consciousness are the result of the interplay of the three guṇas of sattva (light), rajas (activity), and tamas (inertia). The combination of these in the subtle self (liṅga) of the individual comprising of manas (mind), buddhi (intelli-

gence), ahaṃkāra (I-ness), together with their interaction with the processes within the body and outside, defines the individual's state of consciousness. The rhythms of the universe are projected into the three ordinary states of awareness: waking, dream sleep, and dreamless sleep. Beyond these lies the fourth state (turīya), where a perfect union of the subject with Brahman takes place.

The mind constructs its reality, even in the waking state. The Upaniṣads say that the self going between waking and dreaming is "untouched by whatever he sees in that state, for this Infinite Being is unattached" (BU 4.3.16).

In the dreaming state, he "takes a little of this all-embracing world (waking state), himself puts the body aside, and creates (a dream body in its place), revealing his own lustre by his own light and creating dreams. In this state the man himself becomes the light. There are no chariots, no animals to be yoked to them, no roads there, but he creates the chariots, animals, and roads. There are no pleasures, joys, or delights there, but he creates the pleasures, joys, and delights. There are no pools, tanks, or rivers there, but he creates the pools, tanks, and rivers; for he is the creater" (BU 4.3.9).

In the dreamless, deep sleep, the ātman is united with the consciousness that is Brahman (BU 4.3.21). "In this state a father is no father, a mother no mother, the worlds are no worlds, the Vedas no Vedas. In this state a thief is no thief, the killer of a noble Brahmin is no killer... He is untouched by good works and untouched by evil works; for he is beyond the woes of his heart" (BU 4.3.22).

Consciousness states have an ebb and flow, a movement, which is often beyond the control of the self. In part, these states reflect the rhythms of the physical world which are related to astronomical cycles. These cycles embody the connection between the microcosm and

the macrocosm.

Rhythms of Sleep

The rhythmic aspect of consciousness is clear from the circadian rhythm, an adaptation to the solar cycle of light and dark. This 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.

Other rhythms, matched to more subtle astronomical periods, are also found in the animal and the vegetable kingdoms, providing proof for the connection between the inner and the outer worlds.[1]

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.[2] 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 remembering a dream upon 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 metabolic activity.

Further classification 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. A short while later appear 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, whereas 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. Stage 2 is characterized by theta background activity and episodic appearances of sleep spindles and K-complexes.

Some 10 to 15 minutes after the 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

Dreams may have a bizarre or unreal element, incongruous with the surrounding contextual elements, or they may describe events that violate the laws of nature. But nocturnal dreams and daydreams also have marked similarity which shows a continuity of experience 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, suggesting that one sense may remain functional and awake while others fall asleep. In one view:[3]

> [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 behaviour 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 awaken themselves at precisely chosen hours. But how does the intention of getting up at a certain time get translated into the appropriate signals to rouse the subject? If this process is like the alarm clock where the information regarding the chosen time is

stored in the circuitry of the clock, then there must be a continually awake self watching the activity of the brain.

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

There are limits to the capacity of waking attention. Perceptually, it is easier to attend to different aspects of the same object than attending to those same aspects when present in different objects, because storage of recent information and old memories interfere with the detection of new signals. Consequently, much of perceptual input goes unattended when some aspect become the focus of attention. If attention is exercized by an executive network (the awake self), this raises the issue of humunculus and that of infinite regress.[4]

Certain strokes cause 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 on only one side of their face.

Mechanisms of attention and orientation behaviour that supersede individual sensory modalities are the reason why we fail to listen even though we may be hearing, and fail to observe even though we may be looking.

Arousal is the basis for attention, varying in a continuum from the low level (sedation) to hyperactivity. The "fight or flee" response, accompanied by sweating, increase in 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 REM sleep the brain is more aroused than in non-REM sleep.

There exist states, as in dreaming, when there is arousal without consciousness. This tells us that consciousness must require many ingredients, and it must be based on more than just the spread of activity to a group of neurons.

The brainstem regulates the 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 on the assumption that it is a result of a dialogue between the thalamus and the cortex that generates subjectivity.

But such theories do not explain why synchronous activity should lead to consciousness. Neither is it explained why consciousness gives a feeling of a graded experience.

The Witness

It may be presumed 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, and the contextual circuits do not provide realistic imagery, it is the dream state. There can be a whole spectrum of spreading activations, providing a corresponding variety in the nature and the feel of dreams.

But a fundamental difference between the dream and the waking states is that in the dream 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.

The continuum between the dreaming and the waking states appears to correspond to the degree of detachness, whose one correlate in normal state is a loss of muscle tonus. But there are other extraordinary states of detachness where the physiological response is different.

If a certain specific of the activity in the brain is a correlate of consciousness, it must be expressed along with other components related to memory, language and visual perception 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*. The subject was a young man, Sublieutenant Zazetzky, 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 incoming sensory information takes place.

Zazetzky was aware of his body, but he could not combine his impressions into a coherent whole. According to Luria,[5] "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 adjacent 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, presumably because of the reduction in the frequency of seizures. His memory of early life was normal excepting for a retrograde 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 anything that happened to him after the operation.

It is certain that HM's retention of early memories helped him understand new impressions, because consciousness without any permanent memory would be reflexive, like the consciousness of an animal, and memories construct the feel of the inner world, the flavour of awareness.

In its elements the experience of the brain-injured is not all that different from the experience of the normal person. There are times normal people are so absenaminded that they cannot even recall who they are and where they are, as may happen immediately upon awakening.

The inner world of the mystic provides a different kind of a lesson. Sri Ramakrishna (1836-1886), whose life is described masterfully in *The Gospel of Sri Ramakrishna*, narrated several experiences of mystical rapture. In the words of Swami Nikhilananda, the translator of his biography,[6] "When he sat to meditate, he would hear strange clicking sounds in the joints of his legs, as if some-

one were locking them up, one after the other, to keep him motionless; and at the conclusion of his meditation he would again hear the same sounds, this time unlocking them and leaving him free to move about. He would see flashes like a swarm of fire-flies floating before his eyes, or a sea of deep mist around him, with luminous waves of molten silver. Again from a sea of translucent mist he would behold the Mother (Goddess) rising, first Her feet, then Her waist, body, face, and head, finally Her whole person; he would feel her breath and Her voice." On another occasion Ramakrishna says: "The Divine Mother revealed to me in the Kāli temple that it was She who had become everything. She showed me that everything was full of Consciousness. The image was Consciousness, the altar was Consciousness, the water-vessels were Consciousness, the door-sill was Consciousness, the marble floor was Consciousness – all was Consciousness. I found everything inside the room soaked, as it were, in Bliss – the Bliss of God."

3

Strange Powers

We have all heard anecdotal accounts of strange powers that some people have over their own body and over other people. Anthropologists tell us that a curse placed by a witch-doctor on a fellow tribesman works without fail. The victim, informed of the curse, simply lies down and dies, and no medical intervention can save him.

Similar to this are diseases such as bulimia and anorexia nervosa in which the patient starves to death. At the other extreme, there are the morbidly obese who, to live, must get their stomach stapled, because they don't know when to stop eating.

Unlikely predictions have turned out to be true, but these are dismissed as coincidence. Yet, the probabilities of the occurrence of these events may be so small so as to amaze us.

Unusual abilities of certain individuals do merit serious consideration. But the difficulty with the evaluation is that we lack scientific study, excepting where the subject was under supervision because of mental handicaps.

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

The abilities of these savants and of mnemonists cannot be understood in the framework of a monolithic mind. The abilities appear localized even though the final cognition is done by the same higher mind. The distinction between lower function and the higher mind is expressed with clarity in the Upaniṣad (Bṛhadāraṇyaka 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 were essentially *stand alone*, one could understand how performance is determined by the neural hardware for that function. But higher cognition depends upon several capacities, and this makes the achievements of the savants so paradoxical. They have difficulty doing things that would be considered easy and great facility with other things that are manifestly hard, making clear that the inner world of the savants is different from that of the ordinary person.

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:[1]

> A box of matches on their table fell, and discharged its contents on the floor: '111,' they both cried simultaneously; and then, in a murmur, 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 murmur "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 must likewise have their distinctiveness that can be recognized, and numbers may be seen at a glance like whole objects. Clearly, no machine can do this, and such a feat could never be explained by science. A skeptic may think 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 amazed that the twins found the number 37, which is a prime factor of 111. But the twins may have done nothing more than divide 111 into three groups, one each for the two of them and one for Sacks.

Sacks describes another instance which confirmed that the twins understood primeness. He found them sitting in a corner playing a numerical game in which they exchanged six-figure numbers. Sacks noted down the 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 in acknowledgement that it was a prime. Next he went to nine-figure and ten-figure primes and although it took the twins considerable amount of time they did not fail:[2]

> 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 rational explanation 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. If this were true, was this algorithm of the same kind as is used in modern mathematics?

From an evolutionary perspective, it is hard to believe that abstract numerical calculations related to primes would provide an advantage, even if it is admitted 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 indeed involved, and animals appear to be as good as humans at this kind of processing. Animals are very good at other advanced cognitive tasks and if we believe that these capacities are reflexive, they must have become hardwired in the brain during evolution. But the ability to recognize primes is too esoteric to be included in this class.

Many savants are gifted at music. Darold Treffert describes the abilities of 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.[3] The common thread in the stories of extraordinary mathematical and musical ability was illu-

minated by Leibniz who said:[4] "The pleasure we obtain from music comes from counting, but counting unconsciously. Music is nothing but unconscious arithmetic."

Creative Discoveries

Mind possesses many positive powers. Many artists and scientists believe that they came to their discoveries by accident – in a flash. It is as if the result was already there in the unconscious and one merely had to seize it, and bring it to the conscious.

Is it the idea itself that is fully present in the unconscious or is it an aesthetic of beauty that leads to the discovery? Hadamard, writing about the psychology of scientific discovery, thought that a sense of beauty provides the answer,[5] "No significant discovery or invention can take place without the *will* of finding. But with Poincaré, we see something else, the intervention of the sense of beauty playing its part as an indispensable means of finding. We have reached the double conclusion: that invention is choice, that this choice is imperatively governed by the sense of scientific beauty."

Others believe that discovery need not have anything to do with beauty. My own discovery of the long-forgotten Vedic astronomy[6] came suddenly while I was reading a literary essay which had nothing to do with either the Vedas or astronomy. The essay had a passing reference to the fact that the sun and the moon have the same angular size seen from the earth. When I read this, I went into a state of strange excitement feeling sure this had something to do with the organization of the ten books of the Ṛgveda. From that point on the discovery of the details did not take much time. The *recognition* occurred at an extraordinary moment that took me beyond my

ordinary self.

Scientists speak of states of consciousness where they appear to transcend personal self, becoming part of a larger presence in which they see objective truths. These creative states are transformative, and the person is never the same again. The Vedas recognize these states, calling the transformation they produce as *sacrifice*.

The British mathematician Roger Penrose believes to have seen the solution to the non-periodic tiling problem while crossing a street, when he was talking about something else to a colleague. I personally know this mathematical problem, and I am certain that this discovery could not have had anything to do with denying credit to any other scholar. This is how Penrose remembers it:[7]

> A colleague had been visiting from the USA and he was engaging me in voluble conversation on a quite different topic as we walked down the street approaching my office in Birbeck College in London. The conversation stopped momentarily as we crossed a side road, and resumed again at the other side. Evidently, during those few moments, an idea occurred to me, but then the ensuing conversation blotted it from my mind!
>
> Later in the day, after my colleague had left, I returned to my office. I remember having an odd feeling of elation that I could not account for. I began going through in my mind all the various things that had happened to me during the day, in an attempt to find what it was that had caused this elation. After eliminating numerous inadequate possibilities, I finally brought to mind the thought that I had had while crossing the street – a thought

which had momentarily elated me by providing the solution to the problem that had been milling around at the back of my head!

Dreams That Changed The World

There exist several accounts of prophetic dreams. The Rāmāyana, the Mahābhārata, and the Jātakas describe several prophetic dreams, as does literature from other parts of the world. Dreams have provided impetus for action to heroes and spiritual leaders. Some claimed to have been instructed in their dream.

Perhaps, the most dramatic case of a prophetic dream is Abraham Lincoln's dream of his own assassination, two weeks before the event. In the dream, Lincoln heard subdued sobs, as if people were weeping. "Curious about the origin of these sobs, he left his bed and wandered downstairs from room to room, continuing to hear the same mournful sounds along the way. When he returned to the East Room, he saw a coffin lying on the platform. The corpse was wrapped in funeral vestments. Soldiers, acting as guards, were stationed around it and there was a throng of people. Some gazed mournfully upon the corpse, whose face was covered. When Lincoln demanded of one of the soldiers, 'Who is dead in the White House?' the soldier replied, 'The President. He was killed by an assassin!' The loud burst of grief from the crowd, when they heard this, woke Lincoln from his dream."[8]

Mahatma Gandhi's response to the harsh Rowlatt Act of 1919, which permitted the British government to imprison suspects without trial and crush civil liberties, was suggested by a dream. Gandhi saw that he should offer Satyagraha, where people stopped their activities for

twenty-four hours and devoted this time to fasting and prayer.[9] Satyagraha became the method which compelled the English to grant freedom to India.

There are many examples of scientists reporting that solutions came to them in their dreams. One of the best known examples is Elias Howe who, about 150 years ago, was trying to invent a sewing machine.[10] He had the idea that he needed something that would repeatedly jab a needle through cloth pulled across the workspace, but he was stuck. Then he had a dream that a missionary was caught by cannibals in some far away land, and they danced around him waving their spears. He noticed something unusual about the dance – the spears had holes through the tips. When he awoke he realized this is just what he needed for his invention: if he placed a hole through the tip of the needle, the thread could be then caught after it went through the cloth and his sewing machine.

The French chemist August Kekulé claimed to have discovered the ring structure of the benzene molecule inspired by a dream where he saw a snake holding its own tail in its mouth:[11]

> I turned my chair to the fire and dozed. Again the atoms were gamboling before my eyes. This time the smaller groups kept modestly in the background. My mental eyes, rendered more acute by repeated visions of the kind, cound now distinguish larger structures of manifold conformation: long rows, sometimes more closely fitted together, all twining and twisting in snake like motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke; and this time also I spent the rest of

> the night in working out the consequence of the hypothesis.

Such stories are hard to judge because we only have the word of the dreamer, and it could have been fabricated in order to deny credit to other scientists.[12] But true discovery is always a departure beyond the current paradigm. Machines cannot make discoveries and, therefore, one must credit the unconscious for conceptual advances.

Many artists and writers have been inspired by their dreams. The best known examples from recent times are the painters A. Dürer, F. Goya, Henri Rousseau, Salvador Dali; the writers William Blake, Samuel Taylor Coleridge, Robert Louis Stevenson, W.B. Yeats, Franz Kafkai, Graham Greene; the composers Giuseppe Tartini and Mozart; and film directors Louis Buñuel, Ingmar Bergman, Robert Altman, and Akira Kurosawa.

Yogic Powers

The Yogic and Tantric texts speak of special powers (siddhis) that are attained by the adept. The Yogasūtra of Patañjali in its third book, Vibhūtipāda, describes the powers that are achieved by the yogi through yogic practice. These powers include knowledge of different kinds as well as strength of body.[13]

Yogic practice helps to break the wall that separates the profane from the sacred. It makes it possible to enter the realm of Nature as the innermost core of all beings. Later texts speak of eight great powers that yogis attain by recital of seed mantras and concentration on yantras and other methods: animā (becoming small), mahimā (becoming large), laghimā (becoming light), prāpti (ex-

tension and projection), prākāmya (exertion of will without obstruction), vaśiva (mastery over the elements), īśitā (lordship over the elements), kāmāvasāyitva (fulfillment of all desires). Some commentators take these siddhis literally, which I believe is a mistake.

The idea that knowledge can be obtained by concentration on the mind is a consequence of the identity of microcosm and macrocosm, taken to apply across time and space. The yogic tradition asserts that dreams can foretell events and animals and humans can display extraordinary abilities.

4

Fragments of Reality

Mind orders reality according to cultural constructs, which explains why people from different cultures appear to have different belief systems. Some people accept religious myth as fact, others take metaphors to be literal truth. The way our minds build up the world also varies with time and mood, creating the labyrinth of experience. Part of the inner dialogue is the marking of signposts amongst its alleys and acknowledgement of paths travelled before.

The example of savants tells us that the accident of biological inheritance – of good or bad genes – influences understanding. Reality is projected from its "original" form by our nature, modified by cultural experience. This projection process gives ever new form to the experience.

The true implicate form of reality appears to be coded as a puzzle, or rather as form that is different in its essential nature from the experience of it. The senses appear to *unpack* this reality in chunks of familiar associations that are like fragments of a book or scripts of a movie. These scripts relate to memory, action, feeling and other experience, making the recollection of an event depend on mood. The same event may also be perceived differently by different people.

The remarkable experiments of the neurosurgeon Wilder Penfield nearly forty years ago,[1] in which patients undergoing brain surgery narrated their experience on the stimulation of the outer layer of the cortex at dif-

ferent 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 result, while stimulation of some other site could evoke the same memory.

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. 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."[2]

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."[3]

Such generic scripts form the stuff of real, waking experience also. Mind is a glue machine for scripts, and its *active* role is to provide rationale for joining of the fragments and the manner of the joining depends on the

emotional state of the subject.

Memories and Cognition

The understanding of memory has the promise to answer many questions regarding the nature of mind. The Indians see *citta*, the memory-bank, to be a part of a mind which is distributed over the entire brain and yet is capable of being localized. In modern times, the question whether the memories are localized or distributed has had a long history. On the side of localization were Broca, Fritsch, Hitzig and Ferrier; on the opposite side were Flourens, Franz and Lashley. This debate has yet not been settled and the fortunes of the two sides have waxed and waned. If neither of these views is completely right then the question arises whether the dichotomy of localized versus distributed is inapplicable here. "Localized" and "distributed" could then be like shadows from different illuminations of a much more complex reality.

The study of brain-damaged patients with lesions who have specific memory deficits makes it possible to investigate processes and structures that are essential to the retention of memories. It is generally accepted that the limbic system, including the hippocampal structures, plays a critical role in the formation of memories. A possible mechanism is long-term potentiation (LTP), which was discovered in the 1970s. While studying the hippocampus of the rabbit, neuroscientists found that with intense electrical stimulation of connected areas, the hippocampal cells responded more strongly to stimuli than before. This enhanced response lasts for weeks and longer suggesting that it might be a mechanism for long-term memory. Since then it has been shown that other brain regions also exhibit LTP.

In language comprehension, arithmetic, and motor

tasks there is a need for the temporary storage of information to execute various steps of processing or motor activity. A separate short-term memory serves this function, with sub-systems which are specialized. These sub-systems are collectively called *working memory* and they play a fundamental role in the tasks requiring comprehension, remembering and planning.

But this shift in emphasis does not bring us closer to the question of how memories are stored. The circuit models only address the question of the intermediary process necessary for the memories to become stable. It does not explain the nature of the storage of short-term and long-term memories.

The models used to conceptualize the problem tend to reflect the prevailing ideas in other fields related to information storage. Before the advent of the computer, the commonly used metaphor was that of a house with its rooms devoted to various subjects, or that of a notebook with different sections, and this lead to the view of the phrenologists of the late 19th century. Later, the localized and the distributive models of memory paralleled the particle and field models in physics. With the dawning of the computer age, the reductionist, localized models again gained prominence. The swing back to integrative models is a reaction to the lack of progress achieved by the localization paradigm.

In research on memory in the laboratory also, we see distinct phases. The first phase, belonging essentially to the pre-computer era, was the period of verbal learning. Here the emphasis was on the basic phenomena of learning and forgetting of serial and paired-associate lists of verbal items. The second phase, inspired by the information processing ideas of the computer, dealt with questions such as short-term and long-term memories, levels of processing, context and context-effects. The third

phase, driven by neural network models of the brain, has been called the cognitive neuroscience of memory. This has included the study of learning and retention in memory-impaired patients, psychopharmacological studies and the use of neuroimaging techniques.

Recent research has addressed questions like the types of memory and the neurological correlates of specfic function and impairment, but it remains a reductionist approach. For a highly interconnected system, the correlation of a certain area with a specific impairment using neuroimaging techniques does not facilitate further inferences. If a lesion in a certain location causes an impairment, it could either mean that the function resides there or that the location only carries information related to the function.

In the quantum paradigm, which may be seen as a generalization of the classical field view, memories constitute a universal field. The neural hardware then represents the classical apparatus which interacts with the field and reduces the memory wavefunction to a specific realization. The capacity for the brain to retrieve memories depends on its ability to reorganize itself so as to create the necessary circuitry.

Memory structures may be seen from a variety of viewpoints to be either hierarchical, connected, context-related, temporal, and spatial. The measurement apparatus will map these relationships in its three-dimensional organization, and some of these measurement structures may very well be localized. In other words, localization and distribution are two of the many ways memories are stored in the brain.

This view is different from the one advanced by some scholars such as Hameroff, Penrose and others[4] where the brain itself is viewed as a quantum mechanical machine.

Our quantum view is not simply a restatement of the

network model of memory although its operational basis is classical structures. The recall of a classical (network) memory is governed by the limits of classical computer science, and the retrieval of classical memories cannot be as quick as that of quantum memories. Therefore, experiments can be devised to distinguish one from the other. We believe there is sufficient evidence which establishes that actual memory recall goes counter to a classical model.

In a model where the associations presented to the subject help organize the circuitry of the brain to reduce the "ever-present" memory wavefunction to a specific realization, one would see fairly complex dynamics associated with the process of memory formation.

Multiple Forms of Memory

Although, in reality, all memory types appear to be interrelated in a fundamental manner, there are differences amongst them. The classification of memory types can be done in a variety of ways.

First, note that we have many different kinds of sensory memory systems that help us in our perceptions of the world. For example, visual memory includes components which allow a memory trace to persist for about one-tenth of a second. This persistence is what makes it possible for us to see continuous motion in the discrete frames of a television broadcast. There is another component to this memory, more sensitive to shape than brightness, which integrates information coming in from the two retinas. Like visual persistence, there is a memory related to auditory persistence, as an echo which lingers on after the item has been spoken. This explains why the later words in a series are better remembered if they are heard than read.

We have memories about facts, events, skills, and habits. Some of these memories are based on language, others are not.

Fact and event memory is distinct from other kinds of memory behind skills and habits. Declarative (explicit) memory refers to facts and events. Such memory may be formed after single events. Nondeclarative (implicit) memory is generally acquired across several presentations of the stimulus. In situations such as taste aversion, it may be acquired after a single event. Declarative knowledge is flexible and it can be readily applied to novel situations. Nondeclarative memory, on the other hand, tends to be inflexible and defined in the context of the learning situation. Implicit knowledge is not readily accessed by response systems that did not participate in the original learning.

The idea of implicit memory is the effect on ability to recall, make judgments about words, objects, and images without any conscious recall of prior experience. Not being a component of conscious recall, it shows why memory cannot be seen as something that is stored somewhere. Rather, it should be viewed as part of a process of reorganization of the brain.

When a word or object is seen or heard several times, it will be seen or heard more readily on second or later occasions. This phenomenon is called priming and it operates across a wide range of sensory and motor systems at various levels of processing. Implicit memory is a manifestation of priming.

The procedural memory systems are action systems, whereas the other systems in the table below are representation systems. Thus motor skills are examples of procedural memory.

Table 4.1: *Different Memory Types*

Procedural: Nondeclarative; motor and cognitive skills; implicit.

Perceptual representational: Priming; structural, visual and auditory words; implicit.

Semantic: Factual knowledge; spatial and relational; implicit.

Primary: Working memory; visual and auditory; explicit.

Episodic: Personal and autobiographical; event memory; explicit.

In perceptual representational learning, the experience of an object on one occasion facilitates the perception of the same or a similar object on a subsequent occasion.

Semantic memory represents the individual's general knowledge of the world, whereas episodic memory structures our personal experiences. Semantic memory includes meaning of words or formulas of different kinds, or geographical knowledge, whereas episodic memory deals with particular incidents such as visit to the doctor last week.

If we consider the distinction between short-term and long-term memory, we note that in human amnesia, short-term memory is usually intact. This indicates that the problem is in relation to the storage of the information and not an impairment in perception or rule learning.

What is the capacity of working memory? This was examined by Jacobs in 1887 who looked for what he called the digit span. The subject is presented with a sequence of digits which are to be repeated back in the same order. The length of the sequence is increased until a point where the subject always fails. The sequence at which

the subject is right half the time is the digit span. For most people the digit span is seven digits plus minus two, with the actual values distributed from four or five to ten or more.

If the digits are parcelled into chunks, then the number of digits memorized can be increased greatly. It appears that the capacity of immediate memory is determined by the number of chunks rather than the number of digits. By clever chunking of the parts of a sequence of digits, one can memorize a very large sequence running into thousands of digits.

If there are many components of the immediate memory, there must be a central executive where the processing by the subsystems is brought together. The central executive is an attentional system which controls various visual and auditory subsystems and relates them to long-term memory. One of these auditory systems is the phonological loop, which involves some process of rehearsal via subvocal speech to maintain the memory trace. Likewise, there appears to be visuo-spatial sketch pad that helps the memorization of images.

This ability to remember depends on mood and the level of physiological arousal. The performance appears to improve as arousal increases up to some peak, beyond which it deteriorates. Different tasks are optimally performed at different levels of arousal.

Memories are lost with time. While learning appears to be linearly related to time, forgetting has a logarithmic relationship where the information loss is very rapid at first and then it slowly levels off. Short-term retention is influenced by events experienced during the retention interval (retroactive interference) and those occurring prior to the event that is to be remembered (proactive interference). Retroactive interference is seen in impairment caused by events between learning and testing. So a new

memory may supersede or otherwise impact an older one. In proactive inhibition, which is the reverse process, an old memory makes it hard for the new information to be learned. This explains why I continue to take an old path, which was closed off months ago, unless I remind myself consciously.

Amnesia

Sudden brain injury can lead to retrograde or anterograde amnesia. In retrograde amnesia, the loss of memories that were acquired prior to the onset of amnesia is usually temporally graded. The more recent memories are lost more easily than the remote memories. In anterograde amnesia there is a deficit in the long-term storage of new information. Patients with Korsakov's syndrome, who have a long-term history of alcohol abuse, show a profound loss for recent memories, a likely result of thiamine deficiency linked to alcoholism. These patients pass through two stages. In the first one, they are severely confused and beset by motor and visual deficits. In the second stage, there is retrograde amnesia and inability to learn new materials and form fresh memories, and reduction in spontaneity and initiative. In the full blown situation, the patient loses desire for alcohol as well.

Results from experimental animals suggest that there is a gradual process of organization and consolidation whereby memory eventually becomes independent of the medial temporal lobe. Therefore, either long-term memories are stored in the medial temporal lobe or this lobe is critical to the binding of a memory's many disparate elements into a coherent trace which can be accessed in a variety of ways.

Patients with frontal lobe lesions have deficits in short-

term or working memory, but the acquisition of long-term memory is not significantly impaired. Lesions involving the medial temporal lobe (e.g. hippocampus) or diencephalic midline (e.g. thalamic nuclei) seem to lead to anterograde amnesia. Neurological disorders such as anoxia (oxygen loss), ischemia (loss of blood flow), viral encephalitis, and Alzheimer's disease can damage the medial temporal lobe and also cause anterograde amnesia.

Amnesia has been viewed as a disconnection syndrome in the network models of memory. These models postulate bottlenecks for information flows and therefore if there is injury near or at a bottleneck then it is assumed that the information is not transferred to the appropriate networks.

Network models cannot explain the structures in the memories and the multifarious ways these structures are expressed. Table 4.1 showed a somewhat arbitrary division into five categories, and such a division can be made much more intricate.

Studies have suggested that in amnesic patients recall and recognition were proportionately impaired, but episodic memory (autobiographical) was disproportionately impaired compared to memory regarding facts.

It has been found that priming is usually preserved in amnesic patients, and many such patients are able to learn new motor skills.

Korsakov in his 1887 description of the amnesia now named after him said, "Memory of recent events is disturbed almost exclusively; recent impressions apparently disappear soonest, whereas impressions of long ago are recalled properly, so that the patient's ingenuity, his sharpness of wit, and his resourcefulness remain largely unaffected."

Oliver Sacks speaks of his Koraskovian patient Jim-

mie thus:[5] "I found an extreme and extraordinary loss of recent memory – so that whatever was said or shown to him was apt to be forgotten in a few seconds' time. Thus I laid out my watch, my tie, and my glasses on the desk, covered them, and asked him to remember these. Then, after a minute's chat, I asked him what I had put under the cover. He remembered none of them – or indeed I had ever asked him to remember. I repeated the test, this time getting him to write down the names of the three objects; again he forgot, and when I showed him the paper with his writing on it he was astounded, and said he had no recollection of writing anything down, though he acknowledged that it was his own writing, and then got a faint 'echo' of the fact that he had written them before."

Recall of memories

How memories are recalled can be answered only if we knew how they are stored. If the lessons of implicit memory are taken as a starting point, then we must look at how the associations with a variety of factors facilitates the recall process. By extending this notion, we might say that memories are the logical intersection of a variety of cues, and in this sense they are not stored anywhere specifically.

Consider lexical items. The search for one out of a total of n unsorted memories will, on an average, take about $n/2$ comparisons where each memory is considered localized. An indexed memory, on the other hand, can be recalled relatively quickly using the index. Many of our memories are effectively indexed by time, place and context, but many other memories like the basic vocabulary of a speaker may be considered to be unindexed.

Some neural network based distributed memory mod-

els recall very quickly, but they are not at all reliable; such models have exponentially many more spurious memories than good ones.[6] Such massive unrealibility is completely at odds with biological reality. Furthermore, these models assume that the information is stored in the brain in a "passive" process without regard to the content. In reality, the brain stores information in a very active manner so that the "recalled" information is almost never identical to what was learnt before. Each recall is a reconstruction, and in truth, there are no fixed memories.

Savants and mnemonists do remember great amounts of information and reproduce it virtually unchanged, but even here we must speak of reconstruction, although the degree of plasticity of the remembered past is much reduced.

Luria describes the fascinating case of the mnemonist, Shereshevskii (S.), who had an astonishingly large memory, recalling random numbers or words or mathematical equations after a gap of years.[7] He seemed to require about 35-40 seconds to remember a table consisting of twenty numbers and 2.5-3 minutes to remember a table of fifty numbers. Having memorized the numbers by examining them closely several times, he could recall the numbers by rows, columns, diagonals, or backwards. For example, consider the case of a table of 52 items shown below.

Table 4.2: *Random Numbers*

6 6 8 0
5 4 3 2
1 6 8 4
7 9 3 5
4 2 3 7
3 8 9 1

1 0 0 2
3 4 5 1
2 7 6 8
1 9 2 6
2 9 6 7
5 5 2 0
x 0 1 x

It took S. 40 seconds to reproduce all the numbers in direct succession. It took him 80 seconds to reproduce the numbers in the third column, 25 seconds to reproduce the numbers in the second column and 30 seconds to reproduce this column in reverse order. He read off the zigzagging diagonals through the table in 35 seconds, and he needed 50 seconds to run through the numbers as horizontal rows.

S. claimed that he continued to see the numbers in his mind and he was merely reading them off as one would numbers written on a blackboard or a sheet of paper.

Luria realized that S. possessed a marked degree of synesthesia, where the perception of the senses is not separate. Each word summoned up a graphic image in his mind. These images were linked with synesthetic components – sensations of colored splotches, splashes, and lines – which reflected the sound structure of a word and the voice of the speaker.

Even when we speak of the metaphor of fixed memories, we must note that each remembrance causes it to be rewritten in ways which are different, even if only minutely, to the previous forms, so that memories are really palimpsests.

Considering memories which are independent of context, it is estimated that young adults have at least 60,000 words in their "mental dictionaries," words which often have arbitrary forms and are not morphologically ana-

lyzable. Nevertheless, given a word in this list, there is a near-instantaneous recognition of its meaning.

The response time of the neuron is in milliseconds – perhaps tens of milliseconds, but the response to a word is within a few hundred milliseconds. This means that the "dictionary search" in the brain is completed within a few hundred "processing steps." This would be impossible if the memories are stored in specific locations and then retrieved using a classical computing algorithm or even in a connectionist model.

But if memories are stored using a quantum basis,[8] then a particular memory can be recalled in about square root of 60,000 or roughly about 240 steps. That is perfectly consistent with the time of actual recall.

Development, Critical Stages

Piaget argued that there exist three major stages in cognitive development: the sensory-motor stage, during which cognition is based on action; the stage of concrete operations, during which cognition is based on the symbolic understanding of concrete objects and the relations between them; and the stage of formal operations, during which cognition is characterized by hypothesis testing and scientific thought. A process of accommodation and assimilation underlies the incremental changes.[9] The learning of words in a language is also a developmental process.

In spite of obvious differences in vocabulary and grammar, there is a basic commonality in all languages. This makes a child innately predisposed to learn all human languages, and one may speak of a universal grammar.

This universality may be a result of the mapping of basic brain structures to language. The general features of this organization may represent the universal grammar

and the variability in the interconnections represent the specific features of the language.

If brain reorganization is a continual adjustment to the sensory input, then it may reflect the structures of the physical, social, and cultural world in some form. The sensory world has some invariant features determined by the shape of our visual world and the common evolutionary ancestory of the species and it may be that these invariant features are the ones that get expressed in the universal grammar.

The language areas of the human brain appear to be anatomically and functionally asymmetrical before birth. Development of the cortical regions that serve language in the left hemisphere lags behind the development of homologous regions in the right hemisphere.

Specific language impairments (SLI) provide insight into the complexity of the language system. Imaging techniques have shown that the brains of SLI children do not have the lesions typical of patients with acquired aphasia. There also exists the state called "hyperlexia" where mentally retarded children have "an unusual command of language." Lesions acquired during infancy result in transient, minor linguistic deficit while similar lesions acquired during adulthood result in permanent language impairment. Prior to puberty, the right hemisphere can take over the language functions of the left hemisphere.

Experiments have established that while ability to see is innate, it is essential for the person to be visually simulated during a critical period of development for normal vision. Likewise, exposure to language during childhood is necessary for normal language development, and this critical period for language is believed to end sometime before puberty. Native speakers of one language are able to pick another language with proficiency in syntax, mor-

phology and nuances of accent, if exposed to it before puberty.

Children seem to remember very little before the age of five or so, a phenomenon which is called infantile amnesia. It may be because the brain, specifically the hippocampus, is not yet mature in young children. Another explanation is that the young child before this age is yet to learn language, which will provide the tools and the ability to structure the experienced events. It is as if it provides the child with the capability to catalog, just as an indexing scheme allows the librarian to catalog books which can then be easily retrieved.

Speed of Recall

There are limits to the rate at which information can be processed by the brain. Assuming that physiological processes appear to work at an optimal rate, one may take this to be of the same order as the typical speed of information processing for speech and images.

Humans appear to be able to process episodic information at the rate of about a few hundred words a minute. At the rate of 400 words a minute and six letters to a word, this amounts to about 2400 letters per minute or 40 letter per second. According to an information theoretic analysis of English text the information per letter is about 2 bits. So, as a rough estimate, after rounding, one may assign about 100 bits per second to the processing of speech.

The rate associated with the processing of images is much harder to estimate. Images contain an enormous amout of data. But our ability to recall such information accurately is extremely limited. This may be verified by asking adults to recall of the top of a penny, an image seen by all thousands of times. Most people do very poorly at

this test.

It is easy to reproduce auditory memories and very hard to reproduce images. The difference arises from the fact that the auditory signals undergo a time evolution which isolated images do not. Auditory signals are reproduced in an inner dialogue, which is different from how images are generated within the mind. The great amount of information in each image is reduced to a sparse inner representation which may be just black-and-white. Such "inner visions" have been put on canvas by painters or described in verse or prose by writers.

The time evolution of the auditory signal provides cues that makes it possible for the signal to be remembered easily, since we know that the information within the phonemes is well within the capability of the brain to process. But, we don't understand how the time element interjects itself into the memory system.

The consistency of the features of the inner world bind the memories into a tapestry where an individual memory can be retrieved from a multitude of cues. As William James said[10]: "Of two men with the same outward experience and same amount of mere native tenacity, the one who thinks over his experiences most and weaves them into systematic relations with each other will be the one with the best memory."

Superposition and Projections

If memory fragments emerge, bubble-like, from the reservoir of experience in the mind, can we know the nature of this reservoir? A first hypothesis is to take a memory to be an associative response to a stimulus and to assume that the reservoir consists of all possible memory fragments. But since the stimulus elicits different response based on the state of the subject's consciousness,

it may be better to view the memory as a projection of something much richer in possibility.

Many years ago, Neils Bohr said that we know what we are thinking only when pause to take stock. He suggested that the activity of the mind is a superposition of great many possibilities. When the conscious self focuses on this ongoing activity, it accesses only memory fragments-like shadows of it.

This is analogous to the superposition of quantum mechanics and its collapse upon observation, a parallel Bohr liked to emphasize to point out the universal sweep of quantum ideas. It is because of its simultaneous passage over two different paths that a photon projected at two slits forms bright and dark fringes on the screen. Such fringes are formed not only with light but also by massive particles such as electrons and protons. An electron becomes a particle if you follow its motion, otherwise it will be a wave.

Commonsensical notions of time and place do not always correspond with the reality of being. One may expect, however, that physical reality and mind have similar structure. Our ability to understand may be a consequence of this similarity; paradox experienced and paradox as a fact of physical law is another consequence.

The act of creation may be viewed as a consequence of the withdrawal of the observing self and becoming one with the flow of events. This withdrawal is like an expansion of the experiencing self into an awareness that envelopes a much wider reality.

Saṃskāras

Chunks of experience may be compared to saṃskāras (normative happenings which become the memory fragments for future action), shadows or impressions of mem-

ory which assembled together create the template of reality.

Since neuroscience shows that the organization of our brain changes based on experience, with sense impressions causing connections between neurons to become strong or weak, a sacred theatre or saṃskāra performance where all the senses are engaged could facilitate the mind's development in a chosen manner.

To contextualize the complexity and richness of behaviour, one may use the orthogonal colures of Agni and Soma. Agni is called Vāk (speech) in Śatapatha 6.1.2.28 or the Sun or the Earth elsewhere, and it connotes fixity. On the other hand, Soma is kṣatra (princely power) (ŚB 5.3.5.8), the vital airs, the breath, or the Moon. The dimensions spanned by Agni and Soma may be represented by Brahman and Prakṛti, or being and becoming.

Other orthogonal colures may be chosen. One such choice is that of Viṣṇu and Śiva. Viṣṇu is the moral self whereas Śiva represents the experiencing self, and this dichotomy helps create fragments of myth.

Each state of being that is named can only be frozen action. Not surprisingly, Śaunaka says that all names are derived from action (BD 1.27), and being and becoming need each other for definition. A sense must bridge a transformation, and if it is represented by a deva, the accruing change may be viewed through the agency of Śakti – consort of the deva.

A memory is a projection of a phenomenon that has several dimensions, guaranteeing that there is no end to insight and understanding. But the relationship between memories and personhood is a complicated one. This is a problem that I articulate in the poem called "Records of our lives" from my collection, *The Secrets of Ishbar*:

> What do we do with our memories, do we

trust them completely, or do we make recordings
of each moment we live, and keep a diary
for all thoughts? Then we can audit
each recall, and if we should forget

or get amnesia, we can go back to the books
and relive our days moment by moment,
refreshing any period of choosing.

But what if someone should steal my memories
and take my past for his own? Will the thief
become my twin? And can I sue him
for faking his past? But what if he believes
his new memories completely?

And how can I be certain that my recordings
are accurate and not transposed with some other's?
How shall I know this truth, or does it matter
whose memories these are anyway?

If we don't trust our memories fully, knowing
that we chose to forget many incidents,
how do we know what others say about us
is false?

Can memories return prompted by the dreams
of others o,r be raised by clever psychologists?

Are we responsible for our memories?
Should they be all nice and clean?
Can we borrow or buy good ones?
And if memories don't matter, then how do
we define
ourselves? How is our responsibility

measured? If memories are forced
by those around us, how much credit
is theirs? Where is freedom?

5

The Broken Circle of Words

Whatever be the inner world of reality, language is limited in its ability to communicate experience because it is linear and the associations of the individual words can never be universal. There may be further difficulty due to the inability to recall words or form suitable sentences, as happens to us from time to time. Nevertheless, language provides us the best means to communicate our experience, even though it may not prove adequate to express feelings.

Injury to brain damages the very architecture of the house of words. We call this aphasia – cognate with abhāṣā – where language loses its suppleness, and the world appears to have become brittle and strange.

It is to be expected that such impairment would be accompanied by a general reduction in the capacity to talk, understand, read, write, as well as do mathematics, and remember things. One would think 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 cognitive skills is very complex. In aphasia, many linguistic capacities, by themselves or in groups, can be destroyed or spared in isolation from the others. This is consistent with the view that abilities are localized, as appears to be true for savants. Aphasia helps us see the many dimensions of

the body of the mind.

Historically, several capacities related to language have been examined for aphasics. These include fluency in conversation, repetition, comprehension of spoken language, word-finding disability, and reading disturbances.[1]

Broca's Aphasia

In expressive or Broca's aphasia there is a deficit involving speech as a result of a deep subcortical pathology and 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, but the 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 severely impaired but comprehension is relatively intact. Such speech is often telegraphic or agrammatic.

Table 5.1 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 5.1: *Broca's aphasia*

Conversational speech: *Nonfluent*
Comprehension of 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 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 5.2).

Table 5.2: *Wernicke's aphasia*

Conversational speech: *Fluent, paraphasic*
Comprehension of language: *Abnormal*
Repetition of spoken language: *Abnormal*
Confrontation-naming: *Abnormal*
Reading aloud: *Abnormal*
Reading comprehension: *Abnormal*
Writing: *Abnormal*

The Wernicke patient may speak at an abnormally fast pace and augment additional syllables to the end of words or additional words 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.

Another characteristic of Wernicke's aphasia is paraphasia. Here words from the same general class may be inappropriately substituted, or syllables in the wrong order generated, or an utterance produced which is some-

what 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. In "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, we have "global" aphasia with considerable variation exists amongst the patients. In addition, there are other rare syndromes which indicate the involvement of further cognitive centres.

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 and Agraphia

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 are known: 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 is a loss or an impairment of the ability to produce written language. According to Benson,[2] "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.

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 centres, 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 centres. The actual centres are defined at some higher levels of abstraction.

Painting or ideogrammatic writing have their own characteristic aphasias.

Apraxia

The movements of the body may be considered a language. The daily movements are almost automatic, involving a whole sequence of intermediate steps which are performed in the right order with the correct timing. Graceful movement is like good speech, an expression of body language.

In parallel with aphasia, one would expect 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 encountered by physicians.

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 centre of verbal formulation and the motor areas of the frontal 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.

Beyond the language of body movement, one may also speak of language of social intercourse with its own aphasias.

Those without injury to the brain also exhibit deficits that are similar to aphasia. These deficits may be viewed as a consequence of an incomplete development. Thus, the body of consciousness has correlates in the physiological centres of the brain.

Blindsight

We have all heard anecdotal accounts of blind people who can see sometime and deaf people who can hear. This is the opposite of the inability to hear or see when not paying attention.

Normal people have similar experience when considering abstract narrative. Some people just cannot follow abstract mathematical reasoning yet sometimes they do, without understanding the process.

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."[3]

Unconscious Vision

Obviously, these patients possess blindsight or a visual ability that it is not part of conscious awareness. Blindsight has been explained as being a process similar to that of implicit memory which is recalled when some other seemingly unrelated information is presented. Al-

ternatively, if consciousness is taken to be the result of a dialogue between different regions of the brain, then when this dialogue is disrupted the person will not be aware of the stimulus, even if the sensory signals do reach the brain.

In visual processing, motion and form are processed separately – in parallel. Semir Zeki[4] 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 to carry on a dialogue. 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[5] 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 a threshold speed. Flohr[6] has suggested that consciousness depends not so much on the extent of neurons recruited but, rather, on the rate at which the recruitment occurs. This rate of recruitment may be slowed down by some inhibitory process.

These explanations of blindsight in terms of the dialogue 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. The simultaneous activity elsewhere need not be synchronized with the oscillations in the V1 and V5

regions.

Susan Greenfield summarizes:[7] "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 this holistic explanation, 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.

Agnosia

Agnosia, cognate with ajñāna, is a failure of recognition that is not due to impairment of the sensory input or a general intellectual impairment. A visual agnosic patient is 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, and 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 recognize their friends and relations by name or voice. Yet they do not recognize specific faces, not even their own in a mirror.

It may be appropriate to regard prosopagnosia as the opposite of blindsight. In blindsight, there is recogni-

tion 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. This may be due to several reasons one of which may be deep linkages between memories.

Generalizing from blindsight, one may speculate the existence of higher senses, beyond the ones that we are familiar with. The existence of "oceanic" states or others of uncommon lucidity appear to support this idea. If higher senses exist, they may be acute expression of ordinary capacity that lead to a qualitatively different experience, or they may represent other capacity that has not yet been conceived by the scientific community.

The postulation of higher senses would explain strange powers of savants. If higher senses exist, it should be possible for anyone to acquire them by training and education. Yoga is the discipline for such training, and it should be possible to put the claims of yoga under scientific test. Many of these claims regarding control over the autonomous nervous system have been verified.

6

The Two Sides of the Brain

Lessons of experience spring from the inner dialogue that deals with the dichotomies of being and becoming, reason and emotion, and things and transformation. Mythology, recognizing the power of these polarities, conceived of gods, titans and kings that embody the archetypes of experience related to the mirroring of the outer and the inner.

The asymmetric architecture of the brain, in which one of the two hemispheres is dominant for speech and the other for emotion, provides another polarity that is also relevant to the inner dialogue of the mind.

The connection between damage to the left hemisphere and impairment of speech was first made by Marc Dax in 1836. Paul Broca, in 1861, 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,[1] "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.[2] 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 only communicates through speech, neuropsychology is essentially a record of the workings of the left brain. Nevertheless, one may infer the workings of the rest of the brain through appropriate experimentation that does not require the subject to communicate through words.

The two sides of the brain mirror the split between subject and object and this facilitates the inner dialogue. There is further division at lower levels because of the recursive nature of reality. The finer division is expressed through the complex of specialized circuits with complementary function.

Looking at the process from bottom up, objects with opposite attributes combine together to form larger entities, and this goes on, defining ever greater aggregates. This recursion is true not only for physical structure but also for function. Since there is dialogue at the higher levels, languages of communication between the specialized circuits must exist.

Split Brains

Rich connections of the corpus callosum link the two hemispheres of the brain. The visual system is arranged so that each eye normally projects to both hemispheres. But 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, and when these fibers are also severed, the patient is left with a split brain.

A classic experiment on a cat with split brains was conducted by Ronald Myers and Roger Sperry in 1953.[3] 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 raise questions related to the nature and the seat of consciousness.[4] 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. Or, one may say 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 is 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 colours 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 behaviour is very similar to that of blindsight patients.

Modular Circuits and Unification

Of the many modular circuits of the brain that mediate different functions, some map conscious experience while others appear to be for unconscious processes. When the modules related to conscious sensations get "cross-wired," this leads to synesthesia. Perhaps similar joining of other cognitions also occurs, and it appears that this is deliberately sought in meditation. When the cross-wiring is cut off, the senses do not provide context to each other, leading to a loss of understanding.

From the point of view of damage, aphasias are connected with the left side of the brain, agnosias with the right side. They are examples of deficits that are complementary: one kind with articulation and the other kind with knowing.

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.

When seen as a non-material entity characterized by holistic quantum-like theory, consciousness may be understood much more naturally, where the various senses represent projections of the mind function along different directions. Injury to the brain destroys the hardware necessary to reduce the mind function in specific direction.

Aphasia and agnosia are just two windows that reveal the intricacies of mind function. The architecture of the mind continually adjusts to the environment, and this ability of adjustment makes it possible for it to compensate for the deficit with time, as if the inner decorations were rearranged and refurbished. Mind may also be compared to a society like of ants, where the individual members appear to work mechanically but the colony has the ability to respond to its environment in a very complex fashion.

The most significant argument against the reductionist and the neuronal connectionist views of the mind is that on commissurotomy, when the brain has been split into two separate, unconnected parts, the cognitive or the verbal intelligence of the patients is not disrupted. It appears 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[5] "conscious-

ness is a feeling about specialized capacities." But why should this feeling of unity persist 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, and the two hemispheres have very dissimilar conscious experience.

If there were two conscious beings within, the separated hemispheres will start a process of independent reorganization to all the sensory inputs. But in all tests the patient is found to have a single awareness, so the only conclusion is that the mind remains whole, although the brain has been sundered.

Brain-mind identity is called into question by this persistence of the feeling of unity in the awareness. When neuronal connections are severed, the unity must be maintained by some kind of a field within the brain.

But mere localization of cognitive function, even under the influence of a field, does not require anything different from a mechanistic computation. We need to invoke something higher because mechanical function could not lead to the emergence of cognition and awareness. No matter how many machines are connected together, all they would ever be able to do is to follow specified instructions.

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.

Although neuroscience began with a reductionist agenda, it has gathered evidence that seems reasonable only in a holistic framework. Let me summarize a few relevant

findings:

- 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 centres have autonomy.

- The senses do not operate in perfect unison, as seen in lucid dreaming, where some senses are shut off, and in non-alert waking states. In waking, attention determines the activity of the senses.

- Reality is constructed in the domain of our consciousness by fragments of past experience that are joined together. There are scripts of archetypal experience that are universal which make it possible for people to communicate with each other.

- Cognitive abilities have components that are inaccessible to the conscious mind, suggesting the existence of higher senses.

These findings represent facets that need to be joined together in a coherent fashion in a overarching theory. But it is not clear that a formal theory will be found because of the conundrum of the subject-object dichotomy.

7

The Vedas and Consciousness

The Vedas emphasize that any straight description of consciousness leads to paradox. Brahman, as Pure Consciousness, is the eternal subject, and it cannot be made an object.[1] One must presuppose Brahman in order to know objects, and this presupposition makes it impossible for us to apprehend it separately. "How can it be realized in any other way than by the affirmation of him who says: He is (KU 2.3.12)?" "He by whom Brahman is not known, knows it; he by whom it is known, knows it not. It is not known by those who know it; it is known by those who do not know it (KeU 2.3)."

Since Brahman, as the knower behind our knowledge can never become an object for us, it is *unknowable.* "That which cannot be expressed by speech, but by which speech is expressed – that alone know as Brahman, and not that which people here worship. That which cannot be apprehended by the mind, but by which, they say, the mind is apprehended – that alone know as Brahman, and not that which people here worship (KeU 1.5-6)."

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: "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, although some of these memories may be retrieved by hypnosis. Yoga is the discipline by which one may retrieve even deeper memories and gain mastery of mind.

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 (jāgarit), dream sleep (svapna), deep sleep, (suṣupta), 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.

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), shaping the waking and the dream behaviours. 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 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 samādhi.[2]

The mind is also 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 Ṛgveda tells us how prior to a separation between the subject and the object neither space nor time existed. In other words, ordinary reality is a result of the subject-object split.

The Vedic gods are shadowy, and they transform from one form to another with abandon. They are the potential associated with change, because at the deepest level nothing is fixed, and one can only speak of unceasing transformation.

Saguṇa Brahman

Pure Consciousness, as Nirguṇa Brahman, cannot be described by itself, hence the slogan: *neti, neti*, not this, not this. Nirguṇa Brahman, when modified by the attribute or upādhi of māyā, becomes Saguṇa Brahman.

Māyā is often translated into English as "illusion", but it is not that; it is the power of consciousness that brings the phenomenal universe into being. The phenomenal world is compared to the web of a spider: "The non-dual God spontaneously covers himself like a spider, with the web produced from his Prakṛti... Know Prakṛti

(nature) to be Māyā and the Great God its lord" (ŚU 6.10, 4.10).

Saguṇa Brahman, through the agency of māyā which operates at the universal and the individual levels, creates the illusion of the split between matter and mind. "He is the controller of all, the lord of all. He does not become better through good work or worse through bad work" (BU 4.4.22).

"Grasping without hands, hasting without feet, he sees without eyes, he hears without ears. He knows what can be known, but no one knows him" (ŚU 3.19).

Elements of the Mind

The transformation at the personal level – from the gross change related to the passages in physical existence to the changes in the mental world – is mirrored at the universal. This occurs because cosmic awareness is projected into primitives of ordinary awareness at various levels. At first arise tanmātras, subtle elements, which are the constituents of the five elements that mediate awareness. These five elements are not to be confused with the ordinary states of nature such as oxygen, hydrogen.

These elements are the ground that embodies awareness capacity. Thus ether (ākāśa) carries hearing, air carries touch, light or fire carries sight, water carries taste, and earth carries smell. This "ether" is not free space or gas, "air" is not the stuff we breathe, and, similarly, "fire", "water", and "earth" are not the ordinary substances.

Because cognition ranges from the subtle to the ordinary, the five elements have an extraordinary aspect as well.

Mirroring the dawning of individual awareness, the

creation of the universe may be seen in the following sequence 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 (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 texts 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 centred 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 steer 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, which are marked by a variety of absorption states. Beyond this variety lies the appre-

hension of Puruṣa, who is identical for everyone. This is the sequence of Sāṃkhya Yoga.

The Mahābhārata (12.286) says the five gross elements combine with sattva, rajas, tamas, time, consciousness of functions, mind, buddhi (understanding), and kṣetrajña (soul). The states – sattva, rajas, and tamas – depend upon the senses for their formation.

The senses simply gather the impressions of their respective objects: the mind is for doubt, the buddhi is for ascertainment, and the kṣetrajña is an inactive witness. When the buddhi is absent, the senses with the mind, and the other five attributes (sattva, rajas, tamas, time and acts), cease to be. That by which the buddhi sees is called the eye. When the buddhi hears, it is called the ear, and it likewise activates other senses.

When the buddhi desires anything, it becomes mind. The five senses, with the mind, which separately constitute the foundations, are the creations of the buddhi and they are called the indriyas.[3]

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 veterinary doctor but also a yogi, when I was a eight-year old boy. I used to see a frightening dream about falling in a chasm soon after going to bed every night, and this would wake me up. When I asked my father for help, he observed my sleep 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 was replayed, providing a "justification" for the physical event.

We cannot assume the mind operates on the sen-

sory input in a reflexive manner. Its agency creates the present and a suitable past, joining the two in a causal sequence.

The Three Bodies

At the time of creation, a movement of the guṇas, guṇakṣobha, and a vibrating spandana issues forth as the original Śabda Brahman. This causes forms to appear out of the formless and prakṛti, nature, moves to vikṛti, change. These vikṛtis are the original constituents of matter and mind.

The jīva, who is the particularized consciousness within the individual, comes to have three bodies, whose workings can be seen in the various states of consciousness.

The causal body This is the kāraṇa śarīra which embodies the most subtle aspects of the personality. This body encloses the jīva in dreamless sleep.

The subtle body This is the sūkṣma or liṅga śarīra consisting of the mind and the senses and their objects. This is the body of dreams, or the mental body.

The gross body This is the sthūla śarīra made up of the physical body which we consider to be all in our waking state.

There is a polarity in the three bodies: the causal body is free, whereas the gross body is subject to the laws of matter.

The Cakras

Another way to look at the structure of the mind is

through hierarchical levels of primary focus called cakras (wheels, circles). The Tantras mention seven, eight, or nine cakras. The beginnings of this system go right back to the Vedic times since Atharvaveda 10.2.31-2 describes the body as being eight-wheeled and nine-doored (aṣṭācakrā navadvārā devānāṃ pūryodhyā). Although the cakras are shown down the spine, their real location is in areas in the brain which map to different points along the spinal axis.

The cakra structure is described at length in medieval texts such as *Ṣaṭcakranirūpaṇa* and *Pādukāpañcaka*.[4] These cakras, visualized as lotuses, are to be pierced by the aroused Kuṇḍalini-śakti, which ordinarily lies dormant in the lowest cakra. The Kuṇḍalini-śakti is the energy whose passage through the cakras allows one to travel to the heart of consciousness.

The lowest cakra is located at the bottom of the vertebral column (mūlādhāra cakra). The next cakra is a few inches higher at the reproductive organs (svādhiṣṭhāna cakra). The third cakra (maṇipūra cakra) is at the solar plexus. The heart region is the anāhata cakra. The throat has the fifth cakra called the viśuddha cakra. Between the eyebrows is the ājñā cakra. Above this are two minor centres: manas cakra, the seat of the sensations of hearing, touch, sight, smell, taste, and centrally initiated sensations in dreams and hallucinations; and soma cakra, where are located sixteen tendencies of mercy, gentleness, composure, dispassion, constancy, prosperity, cheerfulness, thrill, humility, meditation, quietude, gravity, effort, non-agitation, magnanimity, and one-pointedness.

Above this is the region of the causal body, the kāraṇa śarīra. Here is the house without support (nirālamba purī) where yogis see the radiant Īśvara, and further above this is the praṇava (the symbol of om) shining like a flame.

Above praṇava is the white crescent, and above this last the point, the bindu, the void. There is then a White Lotus of twelve petals with its head upwards, over this lotus there is the ocean of nectar, the island of gems, the altar of gems, the forked lightning-like lines, *a, ka, tha.*

At the top of the head is the sahasrāra cakra, the lotus of the thousand white petals with red filaments, with its head downward turned. The fifty letters of the alphabet from *a* to *la*, which are also white, go round and round its thousand petals twenty times. Within the sahasrāra is the full moon, and further within there is the great void (bindu), which is the Brahma-pada (place of Brahman). This spot is called the abode of Śiva by the Śaivites, or the Parama Puruṣa by the Vaiṣṇavas. Others call it the place of Harihara, the abode of the Devi, or the place of Prakṛti-Puruṣa.

The elements associated with the first six cakras are earth, water, fire, air, ākāśa, and mind.

CAKRA	ELEMENT	SENSE	DEITY
Mulādhāra	earth	smell	Brahmā
Svādhiṣṭhāna	water	taste	Rudra
Maṇipūra	fire	sight	Viṣṇu
Anāhata	air	touch	Īśvara
Viśuddha	ether	hearing	Sadāśiva
Ājñā	mind	cognition	Śambhu

It may be assumed that the stimulation of these cakras in a proper way leads to the development of certain neural structures that allow the I-ness to experience the self. In other words, the cakras are points of basic focus inside the brain that lead to the explication of the cognitive process.

From each cakra radiate thousands of channels, nāḍīs, that carry consciousness. Not to be confused with nerves,

these nāḍīs are thousands in number, of which fourteen are important.[5] Within the fourteen are three that go down the spinal column, Iḍā, Suṣumnā, and Piṅgalā, meeting at the mūlādhāra and the ājñā cakras.

Iḍā and Piṅgalā entwine the Suṣumnā from left to right and right to left in an helical-like form. The three nāḍīs are also called Gaṅgā (Iḍā), Yamunā (Piṅgalā), and Sarasvatī (Suṣumnā). Their meeting place at the mūlādhāra is called Yukta Triveṇi, and at the ājñā it is called the Mukta Triveṇi. Iḍā is also described as the Moon and Piṅgalā as the Sun, and they carry the negative and the positive phases of consciousness.

8

Support of the Gods

The five elements, various senses, intelligence, ego, and citta (consciousness), undergoing continual change due to the evolution of the guṇas. are transformed into gods who literally hold up mind's sky, cidākāśa. The Vedas assertion of equivalence between the microcosm and the macrocosm means that the individual's consciousness mirrors the universal consciousness.

The Vedic gods and goddesses appear in dazzling variety: 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 many others. Some of them are primarily of astronomical inspiration, others that represent cognitive categories, and still others that have both astronomical and cognitive function. As a general rule, their character is mixed. We must remember the advice of Yāska, who reminds us in Nirukta (7.4-11) that the functions of the devas are not clearly delineated. Their shadowyness springs from mutual interconnections, which is also seen in cognitive function.

The gods are not defined in any linear relationship. Sometimes they are represented in pairs, and the couple related in turn to another one in a new opposition, in a sequence of oppositions and syntheses.

Each Vedic god has only a few essential traits that are combined together with many other traits that are com-

mon to all gods. The common traits include brilliance, power, beneficence, wisdom, and cosmic function. They are classified in three groups: celestial, atmospheric, and terrestrial, corresponding, no doubt, to the mind, the senses and the vital airs, and the body. But the body itself may be defined differently; it could represent the physical ground or the ground in mind.

The main celestial gods are Dyaus, Varuṇa, Mitra, Sūrya, Savitar, Pūṣan, Viṣṇu, Vivasvat, Ādityas, Uṣas, Aṣvins. The atmospheric gods include Indra, Trita Āptya, Apāṃ Napāt, Mātariśvan, Ahi Budhnya, Aja Ekapād, Rudra, Maruts, Vāyu, Parjanya, and Āpaḥ. The terrestrial gods include Agni, Bṛhaspati, and Soma.

The mind's own changes transform the location of the gods, and what is cognitive becomes precognitive as a result of habituation.

The celestial gods represent the highest levels of the mind. Since the atmospheric gods are the medium to transport the individual from the earthly to the immortal realm, they are given the most importance in the hymns. The terrestrial gods are related to speech, the "earthly" vessel of wisdom.

The astronomical deities have a corresponding cognitive function. This understanding must have emerged out of a knowledge of biological cycles matched to astronomical periods.

The devas are more clearly defined in later literature, and they almost become anthropomorphic. Their exploits are narrated at great length in the Purāṇas, where their interaction with human actors is described. But such stories are a highly symbolic narrative.

The ten wisdom goddesses (Mahāvidyā) Kālī, Tārā, Tripurā Sundarī, Bhuvaneśvarī, Bhairavī, Chinnamastā, Dhūmāvatī, Bagalā-mukhī, Mātaṅgī, Kamalātmikā represent the personification and control of several aspects

of learning and wisdom.[1] The 108 or 1,008 names of the great god (Viṣṇu or Śiva) or goddess (Devī) list the attributes of consciousness, and these are to be seen as more than just an enumeration of qualities.

Here is a list of the major Vedic gods and their psychological and outer functions:

Agni: Speech, Ātman

Indra: The Controller of the Senses

Viṣnu: God as Embodiment of Moral Law

Śiva: Pure Consciousness

Pārvati: Prakṛti, Intuition, Nature

The Play of Gods

The names mark the loci of awareness, discovered through a meditative process that illuminates the inner space of mind. The Purāṇic, Yogic and Tantric literature contains extensive descriptions in parable and myth of awareness states.

Since cognitive abilities are localized, the idea that a contemplative discipline can help further these abilities becomes plausible. The Yogic and Tantric texts speak of powers obtained through the mind and it should be possible to test this by further research since meditation modifies the organization of the cognitive centres.

According to modern physics, the subject and the object are not two worlds that are forever apart since they interact with each other at the moment of measurement. The Vedic view goes further, claiming that consciousness provides a means for subject and object to become one –

a process in which the cognitive centres are transformed into doorways of holistic perception.

For this phenomenal world to exist, the gods must not only interact with each other but also with the asuras, the lower centres identified with the body. But a consequence of the gods and the asuras resting on different ground is that their interaction looks disembodied. Nevertheless, this provides us a means to understanding human action. According to Karel Werner,[2] the Vedic system is "a very coherent theory of human personality which, expressed in our contemporary idiom, sounds very modern. Man, in the Vedic understanding, is a complex being. His personality is a structural unity of dynamic forces or elements which are themselves impersonal and universal by nature. But they are no blind mechanical or physical forces, rather they possess an inherent intelligence of different grades which leads them to the formation of functional units with inner hierarchical structures, on both cosmic and individual levels. Thus cosmos emerges out of chaos and individual beings out of the interplay of cosmic forces."

Sri Aurobindo, in his book *Isha Upanishad*, summarizes nine fundamental dichotomies that form the web of existence.[3] Here I rephrase them in the two groups of the material and the subjective universes:

1. Consciousness and phenomenal nature
2. The indifferent witness and the evolving universe
3. Freedom of the subject and determinancy in nature
4. The One Reality and the multiple movement
5. Renunciation and enjoyment
6. Being and becoming

7. Vidyā and Avidyā

8. Birth and non-birth

9. Knowledge and works

The first four of these relate to the universe and consciousness at large. The remaining ones concern the human's specific situation, where the oppositions of existence are the projections of the unitary reality.

The gods represent consciousness, whereas the phenomenal nature is Prakṛti. The indifferent witness is the subject who perceives continuing change about him. The witness is free, whereas changes unfold according to natural law. The multiple movements are the shadows of the One reality.

The subject is torn between the impulse to disengage and to enjoy, and to remain the same or become something new. Seeing himself as his mind (vidyā) or his body (avidyā), the subject sees a break in time or movement. Finally, there is a feeling of distinction between the logic behind the unfolding and the movement itself. These opposites are bridged by sacrifice,[4] which is a theatrical performance providing insights into the meaning and function of the devas.

The Goddess

The Śiva Purāṇa 49.1-43 describes the origin of the Goddess Umā, from whom Sarasvatī representing knowledge and everything else is born as follows.

Once there was a battle between the gods and the demons. The gods became victorious through the grace of the goddess Mahāmāyā, but being ignorant of this they became vainglorious.

At this, a blazing tower of splendour appeared before them. Their king, Indra, asked for it to be investigated. First, Vāyu approached the towering splendour and, when asked to introduce himself, he said, "I am the breath of the world. This entire creation with its moving and unmoving creatures is woven lengthwise and crosswise upon me. I am the support of the universe and I set the whole world in motion." He was challenged to move a straw, but was unable to do so in spite of blowing his mightiest.

Silenced, Vāyu returned to Indra's assembly and narrated the circumstances of his defeat. He felt the gods were not omnipotent as they had thought. Other gods challenged the tower of light, but were similarly defeated. Finally, Indra went to investigate himself, but at his approach the blazing presence disappered. Indra was so astonished that he vowed to take refuge in this person.

Meanwhile, there appeared the body of the female Śiva in the person of Umā as the embodiment of existence, consciousness, and bliss. Shining at the center of the light, she exclaimed, "I am truly Brahman! Neither Brahmā, nor Viṣṇu, who is the gods' delight, nor lord Śiva, enemy of Pura, are entitled to pride before me in any way. Why speak of other gods? The supreme Brahman, the Sun on high, the syllable *om* encompassing the opposites – all this am I. There is no higher than I. Formless, yet possessing form, consisting of all the reals, with undefinable attributes, eternal, consisting of both causes and effects, sometimes taking the form of a lovely woman, sometimes of a man, sometimes both, I am the goddess who assumes all forms... Ignorant of my true nature, all you gods glory in your omnipotence to no avail. It is by my power alone that you have defeated the demons. As a magician makes a wooden puppet dance, so do I, the goddess, make all creatures act. Wind blows,

fire burns and the world-protectors continually do their duty, wholly out of awe of me... Recognize who I am, O gods, and renounce your pride! Worship me, the eternal Prakṛti, with love!"

The Kūrma Purāṇa speaks of the birth of the goddess thus: First emerged from Prajāpati the three-eyed Rudra, embodying time. His body was half woman, half man, fearsome and dreadful to behold. Prajāpati said to Rudra: "Divide yourself in two!"

Thus ordered, Rudra split himself into two parts, one female and another male. Then he divided the male half into eleven parts, the Rudras called Kapālin, Īśa and so on. Then he divided the female half in various ways: gentle and fierce, beautiful and ugly, with complexions light and dark. These became the the śaktis, the energies, like Lakṣmī and other goddesses.

A Ṛgvedic Hymn

The Ṛgvedic hymn 10.124 is very instructive in informing us about the character of the gods. Here Indra, the lord of the senses and the king of the gods, beckons the devas to join him at his sacrifice. The devas emerge from amongst the asuras and the sacrifice transforms them.

1. O Agni! Come towards this yajña of the five extensions, three cycles, and seven threads. Be our invocation bearer and leader. For long you have lain in vast darkness.

2. From the *adeva* I depart a deva; secretly, through dark caves, I go to immortality. I desert those who were kind to me, and I go from my friends to strangers.

3. Seeing the guest of the other branch, I balance the abundant rules of the law. I say a kind farewell to the asura father. From outside the yajña to a share in the yajña I go.

4. I passed many years within this one. Choosing Indra, I desert the father. Agni, Soma, Varuṇa - they fall away. The kingdom is revolving – this I promote by going.

5. The asuras are now without magical power since you love me, Varuṇa. From the right, O king, sift out the false, and rule my kingdom.

6. Here is the Sun, here is nobility, here the brilliance, the wide atmosphere! O Soma, let us two slay Vṛtra. You are the offering, with offering we worship.

7. The poet by his vision has marked the sky and, without straining, Varuṇa has let the waters flow. Peace thus created, the primordial waters carry his colours.

8. They accompany his supreme faculty. He dwells in those who rejoice in their nature. They choose him as chieftain, deserting the dreadful Vṛtra.

9. The companion of the dreadful is the wild goose, who glides in the comfort of the celestial waters. The poets in their minds have seen Indra dancing to the anuṣṭubh.

Agni as speech springs from the churning of the mind of five sheaths, three bodies, and seven cakras. The gods arise from amongst the asuras, just as the mind emerges out of the body. The asura father is the mortal body. From mortality, the individual goes to the immortality of consciousness.

The Deities Elsewhere

The Vedic devas appear also in other cultures of the Indo-European world, sometimes directly, and more commonly in clearly recognizable cognates. Most of these forms are attested from times much after the Vedic period. Remarkably, the names of the deities vary within Europe, but the same set is found together in the Vedas.

Thus Agni is seen in Slavic *Ogun* and Lithuanian *Ugnus*; Aryaman is seen in Greek *Arēs*, Irish *Eremon* and Scandinavian *Irmin*; Bhaga in Slavic *Bogu*; Dyaus in Greek *Zeus* and Roman *Jupiter*; Indra in Mitanni *Indara*, Celtic *Andrasta* and Avestan *Indra*; Marutas in the Roman *Mars* and Irish *Morrighan*; Apāṃ Napāt in Roman *Neptunus*; Parjanya in Slavic *Perenu*; Ṛbhu in Greek *Orpheus*; Sūrya in Greek *Helios* and Roman *Sol*; Uṣas in Greek *Eos* and Roman *Aurora*; Varuṇa in Greek *Ouranos* and Latin *Urina*; and Yama in Scandinavian *Ymir*.

This is just a random list. The correspondences are deep when one considers the structure of the myths.[5] The Greek gods, for example, hold up the sky as is clear from the case of Hercules. But they don't only hold up the outer sky, they also hold up the inner sky.

Other civilizations had similar gods, understood commonly through the astronomical connections, but having a secret, mystical meaning in terms of the constituents of

the inner space. Georgio de Santillana and Hertha von Dechend in their *Hamlet's Mill: An Essay on Myth and the Frame of Time* (1969) describe the commonality in the myths of India, Persia, Europe, Mexico, China, Polynesia, arguing that they code knowledge of the changing frame of time due to the precession of the earth and the consequent shifting of seasons.[6] But myth also presents the human counterpart to these celestial motions and this is a drama whose actors are our faculties.

9

The Tattvas and Atoms

The Vedic sages recognize that although nature follows laws, a certain freedom characterizes human behaviour. The fundamental unity of reality is seen split into two distinct categories related to innate nature and cognition. The universe not only exists outside of ourselves, but a copy of it, howsoever imperfect, exists within each one of us.

The cognitive capacities in their purest form, the devas, are analyzed in the disciplines of Yoga and Tantra, where their mutual relationships, the structure of the inner space of the mind, and the dualistic nature of the phenomenal being are also examined. These details being outside the scope of the present work, we confine ourselves to broad principles alone.

Sāṃkhya deals with the enumeration of categories as they arise in the space of the mind. The stated objective is to obtain discriminative knowledge of the manifest (vyakta), the unmanifest (avyakta) and the knower (Puruṣa).[1] On the other hand, Vaiśeṣika's goal, in the words of Kaṇāda, the mythical founder of the system, is: *yad iha bhāvarūpam, tat sarvaṃ mayāupasaṃkhyātavyam*, "I shall enumerate everything [in this world] that has the character of being."

The two systems have differing focus. Sāṃkhya addresses evolution at the cosmic and the psychological levels; Vaiśeṣika delves deeper into the nature of substances and its scope includes both physics as well as

metaphysics. In considering behaviour and structure in terms of primitives, they both complement the view of cognition as the activity of gods.

The emphasis in Indian thought on knowing the outside through an analysis of cognitive categories was far in advance of the concepts used by historians of science until the rise of modern physics. As a result, the six darśanas were misrepresented in the commentaries written on them in the nineteenth century. These mistakes have been repeated in more recent works because the academic tradition continues to favour the reductionist paradigm.

Meanwhile, with the rise of relativity and quantum mechanics, the subject became central in the understanding of the physical universe, with some even asserting that the outer world exists because there is someone to perceive it. The mind is viewed not as a machine but rather the cumulation of the associations between objects and processes of the outer and inner worlds.[2] An examination of the physical world in terms of categories of the mind or of "being" constitutes a perfectly legitimate way, albeit it is different from the manner in which early Western science developed.

Sāṃkhya and Vaiśeṣika are generally paired with Yoga and Nyāya, respectively. The reason behind such pairing is that the elements within each paired system provides complementary insights. The focus in Sāṃkhya is the inner world and, therefore, an experiential or meditative attitude complements it. The insights of Yoga validate the categories of Sāṃkhya, indeed the two proceed in a fashion, which appears to almost overlap, somewhat like the two ends of a arc that close on itself.

In Vaiśeṣika, the focus is on an enumeration of the categories of being, perceived apart from oneself. Since the categories are very many, the use of formal logic is

essential to draw inferences, and in this respect Nyāya is its sister system.

Actually, Nyāya (logic) provides the analytical basis for all philosophy. Naiyāyikas say *astitva jñeyatva abhidheyatva*, "whatever exists, is knowable and nameable." But wince speech has four forms, of which one kind, the parā, is unmanifest,[3] therefore all description and analysis is limited by paradox.

The categories of Sāṃkhya and Vaiśeṣika describe the physical and the psychological worlds. Presenting a comprehensive theory, they integrate the insentient and the sentient worlds in a manner that leaves room for free will.

Overview and Early Development

Consider first the chronology of the texts. New results in archaeology have traced the Indian tradition back in a series of unbroken phases to at least 8000 BC. Archaeologists and geologists also believe that the Sarasvatī, the preeminent river of the Ṛgvedic age, dried up around 1900 BC, leading to the collapse of the towns of the Harappan era which were primarily distributed in the Sarasvatī region. The Ṛgveda should thus be prior to 1900 BC; astronomical references indicate it must even older. The early Brāhmaṇas and the Upaniṣads cannot be later than the second millennium BC.[4]

The Vedic hymns speak of ideas that are described at greater length in the darśanas. Nature has an order that is expressed as ṛta.[5] This order is behind the regularity in the movements of the planets, the seasons, and cycles on earth. Ṛta defines an inflexible law of harmony which offers a basis for its comprehension through the mind. This principle of order is sometimes represented by the pillar (skambha) as in the Atharvaveda[6] and anthropomorphized as Brahmaṇaspati.[7]

The Ṛgvedic hymn 10.129 describes how prior to a separation between the subject and the object neither space or nor 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.[8]

After the connections (bandhu) between the outer and the inner are affirmed, there is mention of the dichotomy between Puruṣa and Prakṛti, 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 are created. Such an enumeration is described at greater length in the Upaniṣadic dialogue between Yājñavalkya and Maitreyī, where seventeen of the twenty-three categories of classical Sāṃkhya are noted:

> 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.[9]

These include the five material elements, the five organs of sense, the five organs of action, the buddhi, in the form of vijñāna, ahaṃkāra,[10] 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 where the specific abstract correspondences for certain outer functions, such as speech, breath, and order, are listed in terms of bhūtamātrā,[11] the word mātrā here referring to the essence in the same manner as in tanmātra. Ahaṃkāra is described in the Chandogya Upaniṣad as the one who sees the universe.[12]

In other words, all the elements of Sāṃkhya seem to be in place in the Vedic literature. It is part of 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.

The Vedic system, as a tripartite and recursive world view, views the universe as the three regions of earth, space, and sky with the corresponding entities of Agni, Indra, and Viśve Devaḥ (all gods). These three regions are represented in the ritual as three different altars, and there is a mapping of these regions within the human body as well. The Chāndogya Upaniṣad speaks of a tripartite manifestation of reality, expressed as fire (red), water (white), and food (black), correlated with speech, breath, and mind.[13] The Śvetāśvatara Upaniṣad also describes the red, white, and black aspects of the One.[14] In Āyurveda, the three doṣas (humours), vāta, pitta, and kapha, likewise define a tripartite model.

Counting separately the joining regions leads to a total of five categories where, as we see in Figure 1, water separates earth and fire, and air separates fire and ether.[15] This counting in groups of five is seen in a variety of contexts as in the five directions, five senses, five seasons, five metres, five chants, five peoples, and five breaths.

Since the processes in the sky, on earth, and within the mind are connected, it becomes impossible to truly separate entities, and language, relating objects and motions that are considered apart and separate, is found inadequate. The one category transcending all oppositions remains Brahman, and Vedic ritual is performance that celebrates this view.

The complementarity between the mind and the outer world is mirrored by the two forms of knowledge – the

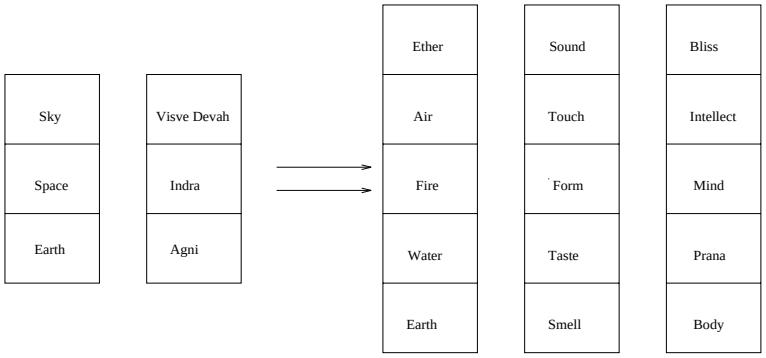

Figure 1: From the tripartite model to five categories of analysis

lower (aparā) or dual and the higher (parā) or unified, that describe two sides of the one reality. Knowledge is only superficially dual and paradoxical, the material and the conscious being aspects of the same presence.

In the Chāndogya Upaniṣad, Uddālaka Āruṇi describes the unity behind the apparent duality as sadvidyā. Being (sat) is the locus of both origin and unity from which the world springs and into which it merges:

> In the beginning, my dear, this world was just Being, one only, without a second. Others say: "In the beginning this world was just Nonbeing (asat), one only, without a second; from that Nonbeing Being was produced." But, my dear, how could this be? How from Nonbeing could Being be produced? No, my dear, in the beginning this world was just Being, one only, without a second.[16]

In the Taittirīya Upaniṣad, the individual is represented in terms of five different sheaths or levels that

enclose the individual's self.[17] This represents another instance of expanded tripartite model. These levels, shown in an ascending order, are:

- The physical body (annamaya kośa)
- The energy sheath (prāṇamaya kośa)
- The mental sheath (manomaya kośa)
- The intellect sheath (vijñānamaya kośa)
- The bliss sheath (ānandamaya kośa)

These sheaths are defined at increasingly fine levels. At the highest level, above the bliss sheath, is the Self. Intellect is placed below bliss, which is a recognition of the fact that eventually meaning is communicated not by associations, but rather by a synthesizing vision expressed by bliss.

Prāṇa is the energy coursing through the physical and mental processes. Looking at the individual in the three fundamental levels, the physical body is at the lowest, at the next higher level are the energy systems at work, and at the highest level are the thoughts. Since the three levels are interrelated, the energy situation may be changed by inputs either at the physical level or at the mental level.

The key notion is that each higher level represents characteristics that are emergent on the ground of the previous level. In this theory, mind is an emergent entity, but this emergence requires the presence of the Self.

The mind may be viewed in a five-fold way: manas, ahaṃkāra, citta, buddhi, and ātman. Again these categories parallel those of Figure 1.

The notions of enumeration and indivisibility are so pervasive in Vedic thought that it is impossible to put

a date on the rise of Sāṃkhya and Vaiśeṣika. But there developed specific schools where a particular manner of defining the attributes was taken; these schools trace their lineage to masters, often starting with a mythical ṛṣi.

Classical Sāṃkhya

We saw the notions of Sāṃkhya form a part of the earliest Vedic texts. As a system called by its formal name, it is described in the Mokṣadharma and the Bhagavad Gītā as well as in the Upaniṣads. Its legendary founder was the sage Kapila who used to be dated to around 7th century BC, but in light of the new findings related to Indian antiquity, is likely to have lived much earlier than that. The texts speak of at least twenty-six teachers including Āsuri, Pañcaśikha, Vindhyavāsa, Vārṣagaṇya, Jaigīṣavya, and Īśvarakṛṣṇa. By "classical Sāṃkhya" we mean the Sāṃkhya-Kārikā (SK) of Īśvarakṛṣṇa. The Sāṃkhya-Kārikā claims to be the summary of an earlier, more comprehensive treatise, the Ṣaṣṭitantra.

According to Sāṃkhya, reality is composed of a number of basic principles (tattva), which are twenty-five in the classical system. Since the heart of the system is its hierarchical framework, the exact number of the principles varies, especially in the earliest writings. But such a variation is of no fundamental importance.

In the classical system, the first principle is (1) Prakṛti, which is the cause of evolution. From Prakṛti develops (2) intelligence (buddhi, also called mahat), and thereafter (3) self-consciousness (ahaṃkāra). From self-consciousness emerge the five subtle elements (tanmātra): (4) ether (ākāśa), (5) air, (6) light, (7) water, and (8) earth. From the subtle elements emerge the five (9-13) material el-

ements (mahābhūta). Next emerge the five organs of sense (jñānendriya): (14) hearing, (15) touch, (16) sight, (17) taste, and (18) smell, and five organs of action (karmendriya): (19) speech, (20) grasping, (21) walking, (22) evacuation, and (23) procreation.

Finally, self-consciousness produces the twenty-fourth of the basic elements: (24) mind (manas), which, as a sixth sense, mediates between the ten organs and the outside world. The last, twenty-fifth, tattva is (25) Puruṣa. Figure 2 represents this classification in a simplified form of the above structure.

The emergence from Prakṛti of intelligence and, later, of subtle and gross elements, mind and consciousness, appears to mirror the stages through which a newly-conceived individual will pass. Here intelligence, as the second tattva, is what endows the newly fertilized cell the ability to organize and grow; self-consciousness represents the stage which allows the organism to sense the environment, and so on. Fundamental interconnections make possible the resonance between the cosmic and the psychological levels.

The doctrine of the three qualities – sattva, rajas, and tamas – is the ground on which Sāṃkhyan physics and metaphysics rest. The guṇas are in equilibrium in the undeveloped state of the cosmic matter. As the world evolves, one or the other of these become preponderant in different objects or beings, giving specific character to each. The quality of sattva, which stands for virtue or transparence, inheres in all things tending to truth, wisdom, beauty or goodness; the quality of rajas, or activity, energy or passion, is present in all that is fierce, forceful

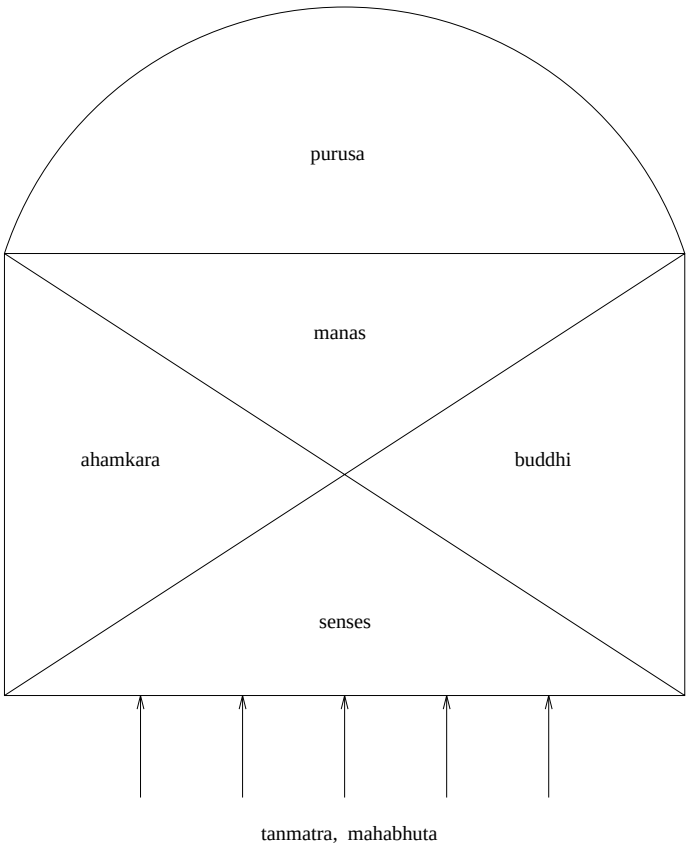

Figure 2: The basic Sāṃkhya model

or active; the quality of tamas, which stands for inertia, is to be found in all that is stupid or dull. The guṇas can be viewed as the three constituent strands of materiality.

Sāṃkhya can also be seen as having three basic dimensions:

1. The constitutive (tattva) dimension, deals with form (rūpa), the principle or the essential core (liṅga);

2. The projective (bhāva) dimension, is concerned with the projective or the intentional (pravṛtti), the predispositional, or cause-effect (naimittanaimittika); and

3. The consequent (phala) dimension, deals with what has come to pass (bhūta), or the phenomenal creation (pratyayasarga).

They guṇas may also be viewed as the threads that tie together the three realms of the tattvas, the bhāvas, and the bhūtas.

Vaiśeṣika

This school of "individual characteristics" is said to have been founded by Kaṇāda, the son of Ulūka, and other sages associated with this tradition include Candramati, Praśastapāda, Vyomaśiva and Udayana. Kaṇāda's Vaiśeṣika Sūtras (VS) describe a system of physics and metaphysics. Its physics is an atomic theory of nature, where the atoms are distinct from the soul, of which they are the instruments. Each element has individual characteristics (viśeṣas), which distinguish it from the other non-atomic substances (dravyas): time, space, soul, and mind. The atoms are considered to be eternal.

There are six fundamental categories (padārtha) associated with reality: substance (dravya), quality (guṇa), motion (karman), universal (sāmānya), particularity (viśeṣa), and inherence (samavāya). The first three of these have a real objective existence and the last three are products of intellectual discrimination. Each of these categories is further subdivided.

There are nine classes of substances (dravya), some of which are nonatomic, some atomic, and others allpervasive. The nonatomic ground is provided by the three substances ether (ākāśa), space (diś), and time (kāla), which are unitary and indestructible; a further four, earth (pṛthivī), water (āpas), fire (tejas), and air (vāyu) are atomic composed of indivisible, and indestructible atoms (aṇu, paramāṇu); self (ātman), which is the eighth, is omnipresent and eternal; and, lastly, the ninth, is the mind (manas), which is also eternal but of atomic dimensions, that is, infinitely small.

There are seventeen qualities (guṇa), listed in no particular order as colour or form (rūpa), taste (rasa), smell (gandha), and touch (sparśa); number (saṅkhyā), size or dimension (parimāṇa), separateness (pṛthaktva), conjunction (saṃyoga), and disjunction (vibhāga); remoteness (paratva) and nearness (aparatva); judgment (buddhi), pleasure (sukha), pain (duḥkha), desire (icchā), aversion (dveṣa), and effort (prayatna). These qualities are either physical or psychological, and remoteness and nearness are interpreted either temporally or spatially. The reality of these capacities is to be gauged from the fact that a person may lose any one of these qualities. Oliver Sacks in his *The Man Who Mistook His Wife for a Hat*

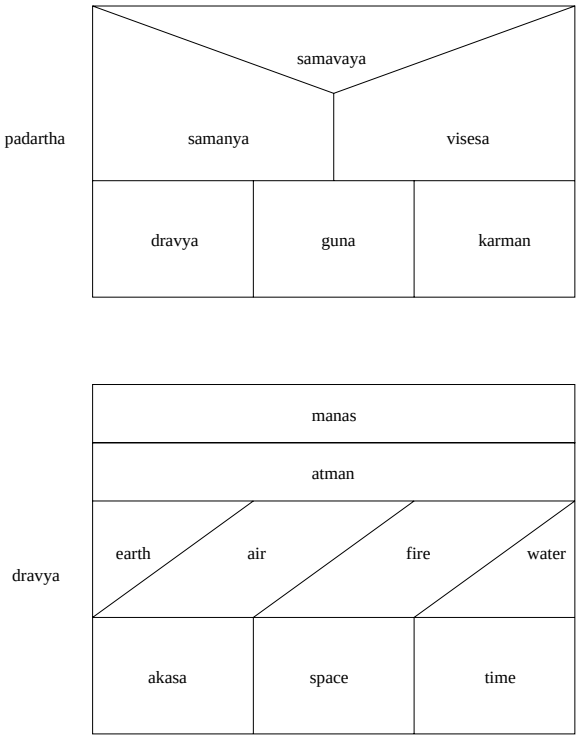

Figure 3: The Vaiśeṣika categories

describes a woman with perfect elementary sensations in her hands whose hands are "useless" in the sense that she has no capacity for touch.

This list is not taken to be comprehensive because later sound is also described as a quality. But there is a fundamental difference between sound and light. Sound is carried by the non-atomic ākāśa, whereas light, implied by rūpa, is carried by tejas atoms. But even sound is sometimes seen as a specific characteristic of atoms.

There are five different types of motion (karman) that are associated with material particles or the organs of the mind: ejection, falling (attraction), contraction, expansion, and composite motion.

Universals (sāmānya) are recurrent generic properties in substances, qualities, and motions. Particularities (viśeṣa) reside exclusively in the eternal, non-composite substances, that is, in the individual atoms, souls, and minds, and in the unitary substances ether, space, and time.

Inherence (samavāya) is the relationship between entities that occur at the same time. This provides the binding that we see in the various categories so that we are able to synthesize our experience.

The Vaiśeṣika atomic structure characterizes four of the five Sāṃkhyan mahābhūtas; the fifth, ether, is non-atomic and all-pervasive. Some of the Vaiśeṣika guṇas correspond to the Sāṃkhyan tanmātras. In Sāṃkhya the tanmātras come first, in Vaiśeṣika atoms are primary.

These schools has a long history[18] of developing variations to the classical formulation given above, and there is considerable difference in interpretation.

Physical Concepts

The Vaiśeṣika categories appear to provide a conve-

nient starting point to examine the physical concepts inherent in these two systems.

The ground layer consists of indivisible, invisible and indestructible atoms (aṇu, paramāṇu). It is the aggregation of these atoms that give rise to different destructible compound substances. These atoms are ideals, representing unities of fundamental attributes. In this sense, they are quite similar to the concept of elementary particles of modern physics proposed on theoretical grounds.

Considering the modern atomic doctrine for the sake of reference, the elementary particles are characterized by various attributes, each of which has a numerical value. These attributes include mass, charge, angular momentum, and energy. The properties of bulk matter are, in principle, obtainable from those of its constituents, but at each higher level of aggregation of atoms, new properties emerge.

Philosophically, there are two main approaches, *positivism* and *realism*, for the understanding of physics. According to the positivist, the only scientific knowledge is that which can be expressed in logical statements. Since our logic and our language is a result of the observations of the world, this presupposes that the observer is central to this knowledge. This is essentially the same as the Nyāya position. The realist believes that there exists an independent reality which is probed through observation and experiment. Put differently, the positivists believe that knowledge is subjective, whereas realists believe that it is objective.

A positivist accepts that there are elements of an empirical reality which science uncovers, but points out that the realist view involves a logical contradiction, since there is no way of observing an observer-independent reality and hence we cannot verify that such a reality exists.

A weaker form of objectivity is sometimes identified

with the positivist position. Here we speak of an empirical reality which is not independent of the observer, but is the same for all observers. Such weak objectivity characterizes relativity theory.

Atoms and Their Combinations

According to the Vaiśeṣika Sūtras, "Earth possesses colour, taste, smell, and touch. Waters possess colour, taste, and touch, and are fluid and viscid. Fire possesses colour and touch. Air possesses touch. These (preceding characteristics) are not in ether."[19] This indicates how the qualities are seen as being built out of elementary entities. Such a unitary picture is even more clearly spelt out for the atoms and the tanmātras. As mentioned before, Sāṃkhya provides a slightly different focus, where the abstract tanmātras are considered to be the building blocks for the gross atoms.

The Vaiśeṣika atomic substances are defined in a matrix of four non-atomic substances (dravyas) – time, space, soul and mind. In other words, the physical universe has an objective existence and mind and soul do not simply emerge from the material ground and disappear when the material structure disintegrates.

The objective elements of the physical world are characterized by dravya, guṇa, and karman, or substance, quality, and action. There is a further characterization in terms of non-reactive and reactive properties.

Two atoms may combine to form a binary molecule (dvyaṇuka). Two, three, four or more dvyaṇukas combine into grosser molecules of tryaṇuka, caturaṇuka, and so on. The other view is that atoms form dyads and triads directly to form molecules fo different substances. Atoms possess an incessant vibratory motion. The activity of the atoms and their combinations are not arbitrary

but according to laws that are expressed as the adṛṣṭa.

Molecules can break up under the influence of heat (pākajotpatti). In this doctrine of pīlupāka (heating of atoms), the impact of heat particles decomposes a molecule.

Heat and light rays are taken to consist of very small particles of high velocity. Being particles, their velocity is finite. This is also apparent from the fact that motion is contingent upon time as one of the dravyas. The particles of heat and light can be endowed with different characteristics and so heat and light can be of different kinds.

Elsewhere it is said that there is no difference between the atom of a barley seed and paddy seed, since these are but atoms of earth. Under the impact of heat particles, atoms can exhibit new characteristics.

A bhūta-atom evolves out of integration from the corresponding tanmātra. This indicates a primacy of the abstract over the material. On the other hand, the atoms may be taken to be unitary objects and their combinations seen as generating various tanmātras. One may further assume that rudiment matter (bhūtādi) leads to its more specific forms. Seal summarizes some views on the relationship between atoms and tanmātras as follows:[20]

> The rudiment-matter (bhūtādi) acted on by rajas (energy) produces the sound-potential (vibration-potential).
>
> The vibration-potential, as a radicle, with accretion of atoms, condensing and collocating, generates the touch-potential which is impingent as well as vibratory.
>
> The impact-potential, as a radicle, with a similar accretion of atoms generates the heat-

> and-light-potential which radiates light and heat in addition to being impingent as well as vibratory.
>
> The light-and-heat-potential, as a radicle, with further accretion of atoms generates the taste-potential.
>
> The taste-potential, as a radicle, with further accretion of atoms, generates the smell-potential.

The order of the formation of the bhūta-paramāṇu is seen according to the following hierarchical scheme:[21]

1. The sound-potential, subtile matter, with accretion of rudiment-matter generates the ākāśa atom.
2. The touch-potential combines with vibratory particles (sound-potential) to generate the vāyu atom.
3. The light-and-hear-potentials combine with touch and sound-potentials to produce the tejas atom.
4. The taste-potential combines with the foregoing three to produce the āpas atom.
5. The smell-potential combines with the foregoing four to generate the earth atom.

Summarizing, matter is seen as being of a unitary nature which, when excited to different states, produces potential of different kinds that are the tanmātras, leading ultimately to the formation of different elements.

The *Padārthadharmasaṃgraha* of Praśastapāda deals with the question of ultimate substances. Earth, fire, water, and earth are here taken to be the basic material

substances. But their existence is contingent on the presence of someone who knows of them, namely Brahman. Praśastapāda's commentary and exposition of the relevant sūtras of VS, with sūtra numbers shown in parentheses, is as follows:[22]

> Ākāśa (ether), time and space do not have any lower constituents. (VS 2.1.27, 29-31)

> Of ākāśa the qualities are – sound, number, dimension, separateness, conjunction and disjunction. (VS 7.1.22)

> Thus, then, being endowed with qualities, and not being located in anything else, it is regarded as a substance. And in as much as it has no cause, either homogeneous or heterogeneous, it is eternal. (VS 2.1.18)

> Time is the cause of the [relative] notions of "priority," "posteriority," or "simultaneity" and "succession," and of "late" and "soon." In as much as there is no other cause or basis for these notions, as appearing with regard to these objects, – notions which differ in character from all notions described before, – we conclude "time" to be the basis of these. (VS 2.2.6)

> Time is the cause or basis of the production, persistence and destruction (or cessation) of all produced things; as all these are spoken of in terms of time... (VS 2.2.9)

> Though from the uniformity of the distinguishing character of time, time is directly by itself, one only, yet, it is indirectly, or figuratively, spoken of as manifold, on account of the diversity among the conditions afforded by the production, persistence and cessation of all produced things...
>
> Space is the cause of the notions of east, west, below and above, and so on, with regard to one material object considered with reference to another material object as the starting point or limit. Specially so, as there is no other cause for these notions. (VS .2.12; 2.1.31; 7.1.24; 7.2.22)

The Nature of Sound

The underlying physical ideas of our systems are presented well in the discussion of sound. According to Praśastapāda:[23]

> Sound is the quality of ākāśa, perceptible by the auditory organ. It is momentary. It can be produced by contact, by disjunction, or by another sound. There are two kinds of sound: varṇa (syllables) and dhvani. The production of the syllables is a result of the contact of the internal organ and self when influenced by memory. First, one desires to produce the sound and then makes an effort. The moving air strikes the throat, producing a contact with the ākāśa, and resulting in the sound. Sounds are always produced in a series, like

> a series of ripples in water and when these waves reach the ear we hear them.

Sound energy is viewed as a wave. The waves impinge on the hearing organ and are recognized through associations. Although Praśastapāda's dhvani is like noise, its role is similar to the dhvani of Ānandavardhana and Abhinavagupta which is the power of suggestion in its purest form, that plays a significant part in the recall of the conscious and unconscious associations.

Evolution

With the background of the bandhu between the outer and the inner in mind, it is clear that the evolution of the tattvas can also be viewed as an evolution of the universe. Buddhi or mahat arises before space and matter. This presumes that with buddhi also emerges the cognition of time. And further, that space and matter, which constitute the physical universe, are contingent on the existence of intelligence. The working of the nature's intelligence is seen as soon as the notions of prior and posterior, related to the change associated with a physical process, become real.

The Sāṃkhya system presupposes a universe which comes into being and then is absorbed back in the ground-stuff of reality. This is what we see in the Purāṇic cyclic universe also. Within each cycle, a gradual development of intelligent life is assumed. It is postulated that the plants arose first, followed by animals of various kinds, and lastly by man. Such a creation and destruction may be viewed to be taking place at various levels, including the psychological level related to the creation and

destruction of thoughts.

Analysis, Causality

The choice of the basic categories in both Sāṃkhya and Vaiśeṣika is dictated by considerations of economy. This parallels a similar emphasis on economy in the Indian grammatical tradition. The fundamental bandhu between language, thought and empirical reality make it possible to analyze the processes of nature.

The Sāṃkhya Kārikā presents the question of pramāṇa, the method of validation, thus:[24]

> Perception, inference, and reliable authority are considered the three means for this purpose. Perception is the selective ascertainment of particular sense-objects. Inference, which is of three kinds, depends upon a characteristic mark and that which bears that mark (association). Reliable authority is trustworthy verbal testimony. The understanding of things beyond the senses is inferred by analogy.

The Vaiśeṣika Sūtra also clearly presents the principle of cause (kāraṇa) and effect (kārya).[25] Praśastapāda describes time and space as nimittakāraṇa, efficient cause, for all phenomena. This indicates position in space and change in time are fundamental to all reality.

Causality is expressed in Sāṃkhya as satkārya, "the doctrine of the existence of the effect (in the cause)."[26]

> The effect exists due to: (a) the non-productivity of non-being; (b) the need for an appropriate material cause; (c) impossibility of all things coming from all things; (d) things producing

only according to their nature; (e) the nature of the cause.

There is no *ex nihilo* creation in Sāṃkhya but only a progressive manifestation.

The guṇas provide the necessary ingredient for the universe (be it physical or psychological) to evolve, making it possible to distinguish the prior and the posterior. The action of guṇas is essential to the definition of time and to the workings of causality.

But guṇas are really not objective constituents of nature. Rather, they represent a relative property. This is explained most clearly in Gauḍapādabhāṣya in the relativity inherent in "the beautiful and virtuous woman who is a source of delight but cause of pain to her co-wives and of delusion in the passionate."[27] In physical terms, one may speak of a separation between two extremes by activity in the middle, or the guṇas may be viewed as the potential whose gradients set up the process of ceaseless change. The activity in the middle, characterized by rajas, separates the two poles of Puruṣa and undifferentiated Prakṛti, or those of sattva and tamas.

How Does the Mind Make Sense?

The observer has always been a central figure in Indian philosophical thought. The question of observation in Sāṃkhya and Vaiśeṣika is considered at two levels: at the level of the mind, which is seen as an instrument; and at the level of the awareness ground-stuff, Puruṣa.

The Sāṃkhya model of the mind, as shown schematically in Figure 2, has intellect (buddhi), self-consciousness (ahaṁkāra) and mind (manas) as the three inner instruments that process the sense impressions.

> Since the buddhi together with the other internal organs (ahaṁkāra and manas) comprehends every object; therefore, the three-fold instrument is the doorkeeper and the remaining (ten) are the doors.[28]

Memory arises due to associations and the traces let by past cognitions; this involves a contact between the self and the internal organ. The traces are stored by repetitions and by selective interest in the objects of the past cognitions. A recalled memory may become the cause of recollection of a part of the previous cognition, desire or aversion, and of further association of ideas.[29]

Ordinary language is limited in its capacity to describe all nature, likewise memories are inadequate in their remembrance of the past. But ātman, by virtue of its linkages with Brahman, does have access to the hidden memories. This means that a part of the mind is unconscious, inaccessible to the empirical self.

Praśastapāda calls memory as a form of true knowledge (vidyā) but does not count it as a pramāṇa. The objection to memory being considered as true knowledge is that it is just a trace. A memory does not represent an object completely; it leaves out some of the properties previously present and adds others that were not initially there. In other words, memories are reconstructions of reality.

Cognition cannot be taken to arise out of the sense-organs.

> These (organs, namely, ahaṁkāra, manas and the ten senses) which are different from one another and which are distinct specifications of the guṇas, present the whole to the buddhi, illuminating it for the Puruṣa like a lamp.[30]

The question of the seat of intelligence is analyzed:[31]

> In the cognitions of sound, etc, we infer a "cognizer." This character cannot belong to the body, or to the sense-organs, or to the mind; because all these are unintelligent or unconscious. Consciousness cannot belong to the body, as it is a material product, like the jar; and also as no consciousness is found in dead bodies.
>
> Nor can consciousness belong to the sense-organs; because these are mere instruments, and also because we have remembrances of objects even after the sense-organ has been destroyed, and even when the object is not in contact with the organ.
>
> Nor can it belong to the mind; because if the mind be regarded as functioning independently of the sense organs, then we would have perception and remembrance simultaneously presenting themselves; and because the mind itself is a mere instrument.
>
> And thus the only thing to which consciousness could belong is the self, which thus is cognized by this consciousness.
>
> As from the motion of the chariot we infer the existence of an intelligent guiding agent in the shape of the charioteer, so also we infer an intelligent guiding agent for the body,

> from the activity cessation from activity appearing in the body, which have the capacity of acquiring the desirable and avoiding the undesirable.

When we consider Puruṣa, it is said *na prakṛtir na vikṛtiḥ puruṣaḥ,* that it is neither prakṛti (creative) not vikṛti (created).[32] Puruṣa transcends vyakta and avyakta, it is discriminating, subjective, specific, conscious and non-productive.[33] Puruṣa is a witness, free, indifferent, watchful, and inactive.[34]

Puruṣa, in this characterization, does not interfere with Prakṛti and its manifestations. It is transcendent and completely free (kaivalya).

What are the reasons that Puruṣa must exist?

> *saṃghātaparārthatvāt*
> *triguṇādiviparyayād adhiṣṭhānāt,*
> *puruṣo'sti bhoktṛbhāvāt*
> *kaivalyārthaṃ pravṛtteś ca.*

> Puruṣa exists because aggregations exist for another; because there must be the opposite to the three guṇas; because there must be superintending power; because there must be an enjoyer; because there is activity for the sake of freedom.[35]

This conception of the "enjoyer" or "observer" parallels the observer of modern physics.[36] The physical laws are immutable; nevertheless, the universe appears to require that observers be present.

There is the paradox that although corresponding to Prakṛti there exists a single Puruṣa – single root consciousness –, in reality there are many observers.

jananamaraṇakaraṇānāṃ
pratiniyamād ayugapatpravṛtteś ca,
puruṣabahutvaṃ siddhaṃ
traiguṇyaviparyayāc cai'va.

> The plurality of Puruṣas arises from: the diversity of births, deaths, and faculties; actions or functions at different times; difference in the proportion of guṇas in different individuals.[37]

The proximity between Prakṛti and Puruṣa makes it appear that the unconscious is endowed with awareness.[38]

The language of the kārikās acknowledges with clarity, and in a manner perfectly consistent with modern insights, that consciousness represents a paradox. Ordinarily, the mind operates in a causal fashion, just as the physical world. The sensory input is transformed by the associations stored in the memory and by the predispositions (as determined by the guṇas) to reach judgments.

Qualities, Motions, Universals

Kaṇāda lists seventeen qualities and says there are more. Candramati, in Daśapadārthaśāstra, adds the following seven to this list: mass (gurutva), fluidity (dravatva), viscidity (sneha), disposition (saṃskāra), merit (dharma), demerit (adharma), and sound (śabda).

Mass inheres in earth and water and causes a substances to fall down. Fluidity inheres in earth, water and fire and causes the flowing of a substance. Viscidity inheres in water and causes coherence with a substance such as earth. Disposition can either be physical, in relation to a motion, or mental. Merit and demerit are psy-

chological qualities related to pleasure and pain. Merit is of two kinds, viz., activity (pravṛtti) and inactivity (nivṛtti).

In physical terms, four states of matter are described: ākāśa or ether, which is non-atomic and, therefore, by itself represents vacuum; gas, as in tejas; liquid, as in water; and solid, as in earth. Since the aggregate substances have size, the question of the manner in which their qualities inhere arises.

A distinction is made between qualities which pervade their loci and those which do not. Candramati lists the following as locus-pervading:

colour	taste	smell
touch	number	dimension
separateness	farness	nearness
contact	disjunction	fluidity
viscosity	weight	velocity

These are the ones of significance for physical objects. Sometimes, a few additional qualities are said to be locus-pervading.

Praśastapāda describes qualities related to objects somewhat differently than Candramati. He offers weight, fluidity, viscidity and saṃskāra (disposition); this last quality is further subdivided into inertia (vega), elasticity (sthitisthāpaka), and trace (bhāvanā).[39]

Fluidity is of two varieties: natural and instrumental. It is a natural quality of water and an instrumental quality of earth and fire. When water freezes into ice, the natural fluidity of water is seen to be counteracted by the fire of the sky, so that the atoms combine to form a solid. Water, earth, and fire all have fluidity. However, water's fluidity is held to be primary, while that of the other two substances is secondary. Viscidity is responsible for cohesion and smoothness.

Kaṇāda says that motion can be seen to be of five

types: ejection (utkṣepaṇa), attraction (avakṣepaṇa), contraction (ākuñcana), expansion (prasaraṇa), and composite movement (gamana).[40] In the case of gamana there is contact with points of space in various directions, or there are many loci.[41] Motion by gravity is discussed. "Weight causes falling; it is imperceptible and known by inference."[42] Motion is produced by mass, which is the same as a motion due to gravitational attraction.[43]

Inertia is the quality of a moving object which is responsible for its continuing in its motion. The Vaiśeṣika position is that inertia is countered by other forces, leading to energy loss, which is why the moving object slowly loses its speed.

That motion cannot take place instantaneously, was well understood. Vyomaśiva in his Vyomavatī speaks of how a motion has several parts that will take increments of time. Likewise, motions produced in cooking will take time to produce the new quality associated with the process, where time, in this context, is equivalent to energy. This is a statement of the empirical fact that a minimum energy needs to be expended before a state change occurs. With water the temperature must reach the boiling point before steam will be obtained. This observation expresses an understanding of the quantum effect in daily processes.

It is stated that there are two kinds of universals: higher and lower.[44] The higher universal here is Being, which encompasses everything. Lower universals exclude as well as may be inclusive, leading to a their hierarchical definition. The higher universal encompasses all possibilities and in this sense it anticipates the essence of

the quantum theory.

Cosmology

The ideas of Sāṃkhya and Vaiśeṣika are intertwined with the development of other Indian sciences. In particular the influence of Sāṃkhya has been enormous. This is most easily seen for astronomy for which layers of texts exists, allowing us to see a gradual development of ideas. This evolution of astronomy must have paralleled the development of other sciences.

Ideal forms play a role in Vaiśeṣika. For example, sphericity (pārimaṇḍalya) is considered a basic shape. Candramati speaks of two kinds of sphericity: when it is minute, it resides in an atom, and when it is absolutely large (infinite), it resides in ākāśa, time, place, and self. In between the very large (cosmos) and the very small (atom) are the objects of the observable universe which will not conform to the ideal shape. In astronomy, which represents this middle ground, one must consider deviations from spherical or circular shapes and orbits.

Since only the cosmos as a whole may be considered to be perfect, space as a dravya will not have any absolute properties. This reasoning sets Indian physical science apart from the tradition of Greek science which took space to be absolute and the observer on the earth to have a privileged position. In Indian physics, space and time are taken to be relative.

The physical concepts underlying the systems of Sāṃkhya and Vaiśeṣika represent a sophisticated framework for the laws of nature. Their physics is based on a tradition of observation. Since an element of the two philosophical systems is metaphysical, the reasoning is often validated based on psychological arguments. Both systems emphasize causality and so are capable of elucidat-

ing nature's laws. The basic categories are ideals and the modifications of these notions provide endless structure.

The complementarity of Sāṃkhya and Vaiśeṣika works in different ways. By considering the evolution of the tattvas, Sāṃkhya emphasizes genesis both at the cosmic as well as the psychological levels, while greater details related to the constitution of the physical world are provided by Vaiśeṣika. These structures are like the Indian grammatical philosophy with its emphasis on production based on a small set of axioms.

There is also a recognition that new enumerative categories are needed in the characterization of empirical world. Thus in Sāṃkhya, we have for the mind 8 fundamental predispositions (bhāva); 8 resultant life trajectories; a set of 5 breaths that support the embodied condition; and 5 sources of action (karmayoni).

In addition, there are two sets of 50 enumerations related to the states of the mind and states of life. Sentient life is defined in terms of 14 levels, with plants at the bottom, humans at the middle, and gods (creative humans) at the top.

The description of the physical world requires categories that go beyond the basic 25 of the Sāṃkhya system. Some of them are described in Vaiṣeṣika, but there the emphasis is on atoms and their mutual relationships. The new categories necessary to characterize the motion of planets arose in astronomy and we can see how this enlargement was perfectly in the spirit of the two systems. Driven by the requirement of reconciling the cyclic ideal motions of the planets to the actual ones, more complex orbits were introduced. This complexity was seen as being engendered by the workings of gravity-like forces.

Speaking of one of these philosophies, the historian of philosophy Karl Potter says:[45]

> Nyāya-Vaiśeṣika offers one of the most vig-

> orous efforts at the construction of a substantialist, realist ontology that the world has ever seen. It provides an extended critique of event-ontologies and idealist metaphysics. It starts from a unique basis for ontology that incorporates several of the most recent Western insights into the question of how to defend realism most successfully. This ontology is "Platonistic" (it admits repeatable properties as Plato's did), realistic (it builds the world from "timeless" individuals as well as spatio-temporal points or events), but neither exclusively physicalistic nor phenomenalistic (it admits as basic individuals entities both directly known and inferred from scientific investigations). Though the system has many quaint and archaic features from a modern point of view, as a philosophical base for accommodating scientific insights it has advantages: its authors developed an atomic theory, came to treat numbers very much in the spirit of modern mathematics, argued for a wave theory of sound transmission, and adapted an empiricist view of causality to their own uses.

In reality, the scope of Sāṃkhya and Vaiśeṣika is even greater than this, because they reconcile the observer to the frame of a materialist physics, leading to subtle insights that have been validated by modern physics. Consider, for example, the notion that one may take the tanmātras to be composed of bhūtādi as well as its reverse. The tanmātras as abstract potential and bhūtādi as elementary atoms stand like quantum wavefunction and material particles. Sāṃkhya, where the observer is

central, considers tanmātras to emerge first. Vaiśeṣika, with its focus on atoms and their combinations, does not speak of tanmātras although some of the guṇas are like the tanmātras. Sāṃkhya extolls the potential whereas Vaiśeṣika addresses the atomic reality. In other words, we have something akin to the concept of wave-particle duality of quantum physics.

The assumption that all observed world emerged out of Prakṛti implies that the material substratum of all substances is the same. The qualities of Vaiśeṣika emerge as material atoms combine in different ways. These emergent properties are not limited to inanimate matter but also to the instruments of cognition, excepting that the actual cognition requires the Self to be the activating agent. The atoms and the tattvas help us conceptualize the embodiments of the gods within.

10

The Devas and Music

Having considered the linguistic correlates of the devas, we investigate music, which is perhaps the most abstract linguistic expression. Nonhumans have means of social communication and birds can sing, but these repertoires are limited. Only humans possess language and music beyond any need for survival seen in an evolutionary sense.

Music's influence on the mind is well known. Stammerers with acute disability sing perfectly as soon as they abandon themselves to the tune of the song. Some Parkinson's patients, who are frozen on one side with tics and chorea on the other, become perfectly coordinated when they play music. Even the EEG from their two hemispheres becomes synchronized as if by an inner music, something that medication is unable to achieve.

We are told that the gods especially like music because, unlike ordinary language, it is not constrained by linear rules and the burden of commonplace associations. The word gāndharva was used in the Vedic times to describe musical language and the gandharva were the mythical beings who had mastery over it.

In the Ṛgveda, the outward appearance of the gandharva is left vague, but in later writing he is shown with a horse's head and a man's torso who lives in a supernatural world of his own. The gandharva (used also in plural) are drinkers who steal the soma and carry off women and nymphs, apsarās. The gandharva have chariots and

horses because they are the swift carriers of musical experience to the inner sun. The are half-men because they live in a world between that of men and the gods. The gandharva are remembered in the horse-headed Greek centaur – wild drinkers, sensual, ravishers of women.

The superiority of music over the spoken word is stressed in many ways. The Sāmaveda, meant to be sung, is equated to heaven while the Ṛgveda is equated to the earth. It is through music that the earthly human is advised to seek divinity. The hymns of the Ṛgveda are for grounding, but song and sacred theatre (provided by the ritual of the Yajurveda) are essential to soar.

Vedic hymns have several layers of structure which appear to be matched to different levels of reality. The metres of the hymns are like bricks that go to form larger structures, and one may speak of a chandaspuruṣa, the body of the metres, and also of saṅgītapuruṣa, the body of music.

In one view, cosmic sound (nāda) is the cause of the material universe and it is identified with the Brahman of the Upaniṣads. Nāda is synonymous with parāvāk, and it comes in two forms: āhata (perceptible sound), and anāhata (unstuck or absolute sound). Music is the elevated form of āhata nāda whereas anāhata nāda can be cognized only through Yoga. The two kinds have a close relationship, and a śruti, a small interval of sound, represents their joining.

The texts tell us that 22 śrutis span the seven notes of the *saptaka*. The problem as to why this subdivision has 22 elements has concerned musicologists for a long time.[1] It is also not clear why the śrutis are divided non-uniformly into groups of four, three, and two into musical notes in Bharata's Nāṭya Śāstra.

The saptaka, the "series of seven" – the same as the *octave* or the "series of eight" of Western music – spans

a doubling of frequency. The seven notes of the saptaka are named *sa* (for ṣaḍja), *ri* (ṛṣabha), *ga* (gāndhāra), *ma* (madhyama), *pa* (pañcama), *dha* (dhaivata), and *ni* (niṣāda).

It must be said that we are speaking of a very old tradition. Manomohan Ghosh, who prepared the critical edition of NatS and translated it, assigns it to about 5th century BC. He based his estimate on a variety of considerations[2] that include archaic features of the language and the fact that Bharata speaks of the Arthaśāstra of Bṛhaspati and not of Kauṭilya, making him prior to the Mauryas.

Pāṇini in his Aṣṭādhyāyī (4.3.110-1) (c. 450 BC) speaks about Śilālin and Kṛśāśva as the authors of the Naṭa-sūtras, which appears to have preceded the Nāṭya Śāstra. It seems that Bharata's text was in the same tradition as Śilālin's, and the evidence indicating that Bharata preceded the Mauryas makes him a near contemporary of Pāṇini. Their two works have similarity in that they analyze language, speech in the case of Pāṇini and drama, dance, and music in the case of Bharata, in terms of their primitives. One can see that these works would have appeared in the same intellectual atmosphere.

The śrutis of music are like the words of poetry or gestures of dance. The śrutis are given different sentiment and feeling in groups of five: moderate (madhyā), keen (dīptā), large (āyatā), compassionate (karuṇā) and tender (mṛdu). Śārṅgadeva (13th century) in his Saṅgīta-Ratnākara (SR 1.3.24-25) says that sound is first heard as śruti and through resonance it expands into a note (svara) to create an expression in the mind of the hearer.

The notes are viewed to have an organic unity. Thus *sa* is said to be the ātman, *ri* the head, *ga* the arms, *ma* the chest, *pa* the throat, *dha* the lips, and *ni* the feet. These seven limbs evoke a presence, and give birth to

the devas.

Music, as a constituent of Indian art, is best understood from the point of view of rasa. The sounds, presented through the body of sentiments and moods, evoke a state (rasāvasthā) in which transcendental bliss is experienced. Eight or nine states of being can be experienced through the sequence of states (bhāvas) that are transitory (vyabhicārī) or involuntary (sāttvika), expressed through dominant moods (sthāyī), explaining the functioning of the rāgas. There are eight rasas: heroism, fury, wonder, love, mirth, compassion, disgust and terror. Bharata lists another 33 less permanent sentiments. The artist, through movement, voice, music or any other creative act, attempts to evoke them in the listener and the spectator. This evocation helps to plumb the depths of the soul, thereby facilitating self-knowledge.

The texts speak of three registers across three octaves. Within each register, there are three scales (grāma): the ṣaḍjagrāma, the madhyamagrāma, and the gāndhāragrāma. The third of these, the gāndhāragrāma, is rarely referred to by Bharata, suggesting that it had long ago gone out of use and that it represents an early scale used in sacred ritual. The presiding deities of the three grāmas are Brahmā, Viṣṇu, and Śiva, respectively.

The notes are consonant (saṃvādin), assonant (anuvādin) and dissonant (vivādin) depending on the distance in śrutis with respect to the sonant (vādin). According to NatS 28.22-23:

> Notes that are at distance of 9 or 13 śrutis from each other are mutually saṃvādin. Examples are *sa* and *ma*, *sa* and *pa*, *ri* and *dha*, and *ga* and *ni* in the ṣaḍjagrāma. Similar is the case in the madhyamagrāma, except that *sa* and *pa* are not consonant while *pa* and *ri* are.

> The notes that are at the distance of two or twenty śrutis are vivādin, for example *ri* and *ga*, *dha* and *ni*.
>
> The vādin, saṃvādin and vivādin notes having been determined, the remaining notes are to be called anuvādin.

The mention of the distance between the saṃvādin and vivādin notes is helpful in the understanding of the measure of śruti, and we will return to this later. Another definition is provided in NatS 22.24 where it is said that in the madhyamagrāma pañcama should be made deficient in one śruti, and this is the standard (pramāṇa) śruti.

Śārṅgadeva (SR 1.3.10-22) tells us of how the seven notes can be produced on two twenty-two stringed vīṇās. One of the vīṇās is kept invariable and the other one is used in a variable mode. He shows how the notes one śruti apart merge. By this he establishes that there is a natural division into 22 audible pitch differences. But his method works because the number of stings in the vīṇās is 22, and it does not answer the more basic question of the number of microtones in a saptaka.

One theory is that the division of the śrutis provides a convenient division in terms of simple ratios. A combination of the cycle of fourths and fifths is invoked to generate 23 values from the twelve notes and the extra value of the fifth is dropped, leaving us with 22 values.

Considering the cycle of fifths, and ignoring the varying number of śrutis amongst the notes, *ri* is fifth from *pa* (in the next octave). Since *pa* is midway through the octave (*pa* is 3/2), *ri* should be: $1/2 \times 3/2 \times 3/2 = 9/8$. This, in turn, implies that *ma* should be $3/2 \times 8/9 = 4/3$. The fourth from *ma* is *ni*, so it becomes $4/3 \times 4/3 = 16/9$. The fifth from *ri* is *dha*, so its value should be $9/8 \times 3/2 = 27/16$. Now *ga* can be calculated either as the fifth from

dha or the fourth from *ni* and this gives us the values of 81/64 or 32/27.

This gives us the ratios upto the *sa* of the next octave:

$(1, 9/8, 81/64, 4/3, 3/2, 27/16, 16/9, 2)$

or

$(1, 9/8, 32/27, 4/3, 3/2, 27/16, 16/9, 2)$

But there is no certainty that this reasoning was followed by the ancient musicologists. These ratios do not contain the small proportions 5/3 and 5/4, which are pleasing to the ear. It is plausible that *ga* was pegged at 5/4 and *dha* was fixed at 5/3. If that was the case then the difference in the ratios for *dha* would be $27/16 \times 3/5 = 81/80$. We get the same difference at *ga* for one of the two values. This ratio is the comma.

Using the modified ratios for *ga* and *dha* we can generate new values for the other notes, and it has been argued that this leads to a total of 22 notes. But it is not clear what ratios of the seven notes were used in the ancient period, especially because a shift in the ratios appears to have occurred as the arched harp type of vīṇā was replaced by the stickzither vīṇā. But it is clear that the śrutis did not represent a uniform division of the saptaka into 22 parts.

Scholars have reconstructed the ratios variously:[3]

$(1, 9/8, 32/27, 4/3, 3/2, 5/3, 16/9, 2)$

$(1, 9/8, 5/4, 4/3, 3/2, 5/3, 15/8, 2)$

$(1, 9/8, 6/5, 4/3, 3/2, 5/3, 9/5, 2)$

$(1, 16/15, 9/8, 4/3, 3/2, 8/5, 5/3, 2)$

$(1, 9/8, 5/4, 11/8, 3/2, 27/16, 31/16, 2)$

$(1, 11/10, 7/6, 4/3, 3/2, 33/20, 7/4, 2)$

Clearly, other choices can be made, especially since the śruti interval between the notes in not the same.

It has been suggested that the 22 śrutis may be connected to the 7 notes via the value of π in a diameter to circle mapping. But no plausible theory for such a

connection has been sketched. In particular, we cannot justify the specific non-uniform assignment of the śrutis to the different notes in a diameter to circle mapping.

Another theory is that the number 22 is rather connected to the number of Rudras (11), where a multiplier of 2 is used to include the corresponding śakti. The plausibility of this theory becomes stronger when it is noted that the expanded list of śrutis[4] totals 66, which will then equal twice the number of devatās mentioned in the Vedas. It is noteworthy that according to whe NatS 29.23-74 there are 33 alaṅkāras (ornamentations) in instrumental music.

The number associated with the earth and also with the sun in the Vedic literature is 21. The number 22 then represents a point that goes beyond the earth or the sun.

Still another possibility may be the connection with the number of rāgas in each scale, which is $484 = 22^2$. Might this knowledge have prompted the theorists to pick 22 as the number of subdivisions based on some numerical considerations? One or more than one of these reasons may have been behind the choice of the number 22.

Here we investigate connections between Vedic chanting and the saptaka in the early texts prior to the Nāṭya Śāstra of Bharata Muni. In particular, we examine evidence from the Śikṣā texts and the Chāndogya Upaniṣad, and we examine if the antecedents of the number 22 go before the time of Bharata.

More on the Saptaka

The seven notes commencing with ṣaḍja are said to be produced respectively by the peacock, ox or cātaka, goat, crane, blackbird, frog, and the elephant (SR 1.3.46). Each note can be low (mandra), medium (madhya), or

high (tāra).

Śārṅgadeva (SR 1.4.5) speaks of the rare use of the gāndhāragrāma by the phrase that it is used in the heavens, and not in this world. This is why there is no unanimity regarding the assignment of the śrutis in the gāndhāragrāma.

From each grāma are derived a number of secondary scales (mūrchanā). The names of the ṣaḍjagrāma mūrchanās are: uttaramandrā, rajanī, uttarāyatā, śuddhaṣaḍjā, matsarīkṛtā, aśvakrāntā, abhirudgatā (SR 1.4.10-11). The first is the original scale, the remaining are the permutations. Thus rajanī is *ni sa ri ga ma pa dha.*

The names of the madhyamagrāma mūrchanās are: sauvīrī, hariṇāśvā, kalopanatā, śuddhamadhyā, mārgī, pauravī, hṛṣyakā. The gāndhāragrāma mūrchanās are: nāndī, ālāpā, sukhā, citravatī, citrā, sumukhī, viśālā (SR 1.4.22-26).

Each grāma is the foundation for pentatonic and hexatonic series of notes (tāna), melodic line (varṇa), figuration and ornamentation (alaṅkāra) and mode (jāti).

Each note (like *sa, ri*) not only represents that particular frequency but also the interval from the preceding note upto that note. Thus *sa* represents the entire interval from *ni* to *sa*. The notes that form the basic scale are called śuddha, notes lowered a śruti are called cyuta or komala (soft), and those raised by a śruti or two are called tīvra (sharp), sādhāraṇa or kaiśika (for one śruti) or antara or kākalī (for two śrutis). The altered notes are called vikṛta. SR 1.3.39-45 gives the following 19 notes that consist of 7 śuddha and 12 vikṛta notes:[5]

> sādhāraṇa sa (1), cyuta ri (2), śuddha ri (3), śuddha ga (5), sādhāraṇa ga (6), antara ga (7), cyuta ma (8), śuddha ma (9), sadhāraṇa ma (10), triśruti pa (12), śuddha pa (13), kaiśika pa (14), śuddha dha (16), kaiśika dha

(17), śuddha ni (18), kaiśika ni (19), kākalī ni (20), cyuta sa (21) śuddha sa (22).

With this as the background, here is the traditional division of the śrutis in the three grāmas, where the distribution for the gāndhāragrāma is the most likely reconstruction:[6]

Table 10.1: *Śrutis in the three different grāmas*

ṣaḍjagrāma		*madhyamagrāma*		*gāndhāragrāma*	
interval	śrutis	interval	śrutis	interval	śrutis
ni-sa	4	ga-ma	4	ri-ga	4
sa-ri	3	ma-pa	3	ga-ma	3
ri-ga	2	pa-dha	4	ma-pa	3
ga-ma	4	dha-ni	2	pa-dha	3
ma-pa	4	ni-sa	4	dha-ni	4
pa-dha	3	sa-ri	3	ni-sa	3
dha-ni	2	ri-ga	2	sa-ri	2

It is noteworthy that in the ṣaḍjagrāma the distribution of the śrutis displays a symmetry about *ma*: 4, 3, 2/4/4, 3, 2. This indicates that *pa* must have been at the precise ratio of 3/2 with respect to *sa*. This also means that the notes could not have been powers of a simple ratio and that vikṛta notes must have been a part of the entire set from early on.

Śārṅgadeva says only the ṣadja- and the madhyamagrāmas are used in the world (*dvau dharātale*, SR 1.4.1). The gāndhāragrāma must have fallen into disuse very early on. The names of the śrutis given by Śārṅgadeva are as follows:

Table 10.2: *Names of the śrutis*

svara	śrutis
Ṣadja	*Tīvrā, Kumudvatī, Mandā, Chandovatī*
Ṛṣabha	*Dayāvatī, Ranjanī, Raktikā*
Gāndhāra	*Raudrī, Krodhā*
Madhyama	*Vajrikā, Prasāriṇī, Prīti, Mārjanī*
Pañcama	*Kṣiti, Raktā, Sandīpanī, Alāpinī*
Dhaivata	*Madantī, Rohiṇī, Ramyā*
Niṣāda	*Ugrā, Kṣobhiṇī*

The division of śrutis into five classes is as follows:

1. dīptā (dazzling): tīvrā, raudrī, vajrikā, and ugra

2. āyatā (vast, extended): kumudvatī, krodhā, prasāriṇī, sandīpanī, rohiṇī

3. karuṇā (compassion): dayāvatī, alāpinī, madantī

4. mṛdu (tender): mandā, raktikā, prīti, kṣiti

5. madhyā (moderate): chandovatī, ranjanī, mārjanī, raktikī, ramyā, kṣobhinī

The names used in this classification evoke different emotional states.

Early Music

Singing is mentioned at several places in the Ṛgveda.[7] The ṛcas were chanted in three notes: anudātta, svarita, and udātta, or "grave", "medium", and "acute". Furthermore, there were the five sāman notes prathama, dvitīya, tṛtīya, caturtha, and mandra. The saptaka was completed with the addition of the the upper seventh

kruṣṭa before prathama and the lower sixth atisvārya after mandra. The sāmans were sung in a descending order. Vedic chanting and the singing of the Sāman were two separate musical styles.

The notes were associated with the Vedic metres: anuṣṭup, gāyatrī, tṛṣṭup, bṛhatī, paṅkti, uṣṇik and jagatī (SR 1.3.58-59).

The metres are central to the Vedic hymns. Although, the above sequence seems to be jumbled up in terms of the lengths of the metres, with its ratios of 8, 6, 11, 9, 10, 8, 12, I think that the ratios of the notes may have had something to do with the syllables in the metres. One sequence that is plausible is:

24, 27, 30, 32, 36, 40, 45, 48

corresponding to gāyatrī (24), uṣṇik (28), atiśakkarī (30 for half), anuṣṭup (32), bṛhatī (36), paṅkti (40), tṛṣṭup (44), and jagatī (48). A sequence of the metre names is given in NatS 15.43-49.

The lengths of the hymns varies with the metre. The gāyatrī is used in a 9-versed hymn called rathantara, the tṛṣṭup in a 15-versed hymn called bṛhat, the jagatī in a 17-versed hymn called vairūpa, the anuṣṭup in a 21-versed hymn called vairāja, the paṅkti in a 27-versed hymn called śakvara, and the atichandas (56) in a 33-versed hymn called raivata. The significance of the number of verses is not clear.

The Pāṇinīya Śikṣā (PS 12) maps the Vedic notes to the seven svaras:

> *uddāte niṣādagāndhārāvānuddātte ṛṣbhadhaivatau*
> *svaritaḥ prabhavā hyete ṣaḍja madhyama pañcamāḥ*
>
> Of the seven musical notes niṣāda and gāndhāra
> can arise in the high pitch (udātta), ṛṣabha
> and dhaivata in the low pitch (anudātta), while

> śaḍja, madhyama, and pañcama have their source in the medium pitch (svarita).

The same thing is said by the Nāradīya Śikṣā (NarS 1..8.8) and the Yājñavalkya Śikṣā (YS 8).

In NarS 1.5.1-2, Nārada equates the tones of the veṇu flute to the seven notes of the sung sāman:

> *yaḥ sāmagānāṃ prathamaḥ sa veṇormadhyamaḥ*
> *svaraḥ yo dvitīyaḥ sa gāndhārastṛtīyastvṛṣbhaḥ*
> *smṛtaḥ*
>
> *caturthaḥ ṣaḍja ityāhuḥ pañcamo dhaivato bhavet*
> *ṣaṣṭe niṣādo vijñeyaḥ saptamaḥ pañcamaḥ smṛtaḥ*

In other words, the order is *ma, ga, ri, sa, dha, ni, pa*, which is the standard saptaka in descending order excepting for a transposition of *dha* and *ni*.

The grāmegeyagāna and the āraṇyegeyagāna of the Sāmaveda provide a musical notation for the melodies. The Brāhmaṇa and the sūtra literature have references to singing and playing of musical instruments. Nārada of the Nāradīya Śikṣā associates musical notes with deities, social classes, animals, colours, and with fingers.

The notes with 4 śrutis are called brāhmaṇa, with 3 śrutis are termed kṣatriya, with 2 śrutis are termed vaiśya, and the half-notes are called śūdra (NarS 1.4.3-4). SR 1.3.53-55 says: "Ṣaḍja, madhyama, and pañcama are brahmins, ṛṣabha and dhaivata are kṣatriya, niṣāda and gāndhāra are vaiśya, while the notes antara-gāndhāra and kākali-niṣāda are śūdra.

The classification of the notes as the sounds of the deities is as (NarS 1.4.13-14): *sa* is Agni's, *ri* is Brahman's, *ga* is Soma's, *ma* is Viṣṇu's, *pa* is Nārada's, *dha* and *ni* are Tumburu's notes.

Their respective colours are: red, pale yellow, golden yellow, sparkling white, black, plain yellow, and variegated (SR 1.3.54-55).

The Chāndogya Upaniṣad has considerable discussion of the structure of sāmans. While examining this material, it should be noted that the Vedic system of knowledge is recursive and what is described at the gross level is also applicable at finer levels.

CU 2.10 informs us that the seven-fold sāman has twenty two parts. The counting is done in terms of the syllables of the names of the seven parts of the sāman which are hiṅkāra, prastāva, ādi, udgītha, pratihāra, upadrava, and nidhana. Their individual syllable counts are 3, 3, 2, 3, 4, 4, 3, respectively.

Although this division of the sāman is for the different parts of the song, the recursive system at the basis of Vedic narrative could suggest that it was also applied to notes. If that were the case, we find an exact match with the division of the śrutis for the gāndhāragrāma.

As to the special significance of the number 22, CU 2.10.5 says:

> *ekaviṃśatyā"dityamāpnotyekaviṃśo vā ito'sāvādityo dvāviṃśena paramādityājjayati tannākaṃ tadviśokam*

> With twenty-one intervals (syllables) a man reaches the sun, for the sun is the twenty-first from here. With the twenty-second he conquers what is beyond the sun, that is glory, that is freedom from sorrow.

Other very early texts describing music include the Mārkaṇḍeya Purāṇa (chapter 23), Devīmāhātmya Purāṇa (chapters 81-93), and the Vāyu Purāṇa (chapters 86-87).

The division of the saptaka To return to the question of the division of the saptaka, consider the fixed ratio of 1.104 which takes us through the range in seven steps, as a straightforward calculation will show. In a similar manner, one śruti in the series of 22 represents a ratio of 1.032. Table 10.3 presents a match between the two series:

Table 10.3: *The svara and the śruti series*

number	svara ratio	śruti ratio	error
1	1.104	1.099 (3)	0.005
2	1.2188	1.208 (6)	0.010
3	1.346	1.3278 (9)	0.018
4	1.486	1.5060 (13)	0.02
5	1.64	1.6553 (16)	0.0153
6	1.81	1.8193 (19)	0.0093
7	1.998	2.0 (22)	0.002

The match is excellent. The error between the two series is extremely small. The mapping maps the śrutis in groups of 3, 3, 3, 4, 3, 3, 3.

If one takens 21 śrutis instead of 22, the match turns out to be even closer, as expected. For this the ratio for each śruti is 1.0336. This theoretical exercise shows that the saptaka couldn't have been divided in this fixed manner. Neither could this reasoning have been at the basis of the choice of 22 śrutis. The view that the śrutis are non-uniformly distributed is supported by this calculation.

The number of rāgas The Nāṭya Śāstra describes eighteen melodic tunes called jātis: of these seven were considered pure and eleven as hybrid. The pure jātis made 146 modified forms and the hybrid ones had many variations. The total number of these melodic tunes was

nearly two hundred. The modern rāga is an evolution of the idea of jāti.

A rāga must have a combination of rising (āroha) and falling (avaroha) notes that are at least five in number. The combinations of pentatonic are called auḍava, of hexatonic ṣāḍava, and of heptatonic saṃpūrṇa. In addition, there are the sādhāraṇa tānas (NatS 28.32-36). Without going into further constraints – and there are many of those –, the combinations of rāgas that are obtained are as follows (Table 10.4):[8]

Table 10.4: *Number of rāgas in a scale*

Category of rāga	Number of rāgas
auḍava-auḍava	$15 \times 15 = 225$
auḍava-ṣāḍava	$15 \times 6 = 90$
auḍava-saṃpūrṇa	$15 \times 1 = 15$
ṣāḍava-auḍava	$6 \times 15 = 90$
ṣāḍava-ṣāḍava	$6 \times 6 = 36$
ṣāḍava-saṃpūrṇa	$6 \times 1 = 6$
saṃpūrṇa-auḍava	$1 \times 15 = 15$
saṃpūrṇa-ṣāḍava	$1 \times 6 = 6$
saṃpūrṇa-saṃpūrṇa	$1 \times 1 = 1$
Total	484

This number, as mentioned before, equals 22^2. If the rāga is a late concept, we can only speculate if its definition was influenced by the choice of such a number.

Alain Daniélou suggests that the śruti interval is the comma diesis 81/80, defined as the difference between *pa* considered as the upper fourth from *ri*, and *pa* as the lower fourth from *sa*. Daniélou also presents a detailed reconstruction of the intervals of the 66 śrutis.

Although we cannot be certain as to what precise ratios were used by Bharata, scholars have argued tthat 22 śrutis provide a natural division of the saptaka.

From the evidence we reviewed, it appears that the question of the origin of the 22 śrutis cannot be answered unambiguously. The choice could have been based on the significance of the number 22 that goes back to Vedic ritual, as a number that transcends the earth or the sun. The number 22 may have even been arrived at from $3 \times 7 + 1$ where the basic number is the 7 of the number of notes and the tripling is from the "three worlds" and the 1 represents the usual transcendence. Or it may be related to the capacity to distinguish the śrutis and a division that provides cycles of fourths and fifths.

If the choice of the 22 śrutis was based on the mapping of Table 10.3, then the original distribution of the śrutis for the various svaras must have been uniform with a single exception. From there the mapping of Bharata in his Nāṭya Śāstra represented further development. But the śrutis were not uniformly distributed, clear from the fact that the transition from a five-tone octave to a seven-tone octave is not uniform.

On the other hand, we do have evidence pointing to a logical basis to the division. But, irrespective of that basis, Bharata may have received the system from his predecessors, because the number 22 appears earlier in the Upaniṣads.

Drama and Music

In the Viṣṇudharmottara Purāṇa, Mārkaṇḍeya tells King Vajra that in order to learn the art of icon-making one needs to learn the art of dance, and the art of music before learning dance. Indian arts are interrelated not only at the level of aesthetic experience but also at the level of technique. It is not surprising then to see the number 22 (and the related numbers of 11 and 33) appear

in so many different contexts.

The nāṭya is created by taking significant details from each of the Vedas: pāṭhya or recitative text from the Ṛgveda, song or melody from the Sāmaveda, abhinaya or acting from the Yajurveda, and sentiments from the Atharvaveda. Since the four Vedas come together in the dramatic performance, nāṭya is called the Fifth Veda.

Bharata Muni locates the various deities in different places in the theatre. Jarjara, Indra's flagpole to ward off demons and to protect the actors, is installed on the stage. The performance is offered to Brahmā.

The pūrvaraṅga, performed prior to the performance, included the nāndī, a prayer for divine blessings. The performance concluded with the benedictory bharata-vākya.

Kālidāsa describes nāṭya as a visual sacrifice to the gods, where the stage symbolizes the cosmos and the gods are invited to inspire the actors to be creative. The visual sacrifice transforms the actors as well as the audience.

On Three Languages

Although most ancient narrative is as myth, a code language intermixing history, psychology, astronomy and metaphysics, three ancient sages wrote about language with great directness. Euclid (c 300 BC) in his *Elements* describes the language of mathematical ideas, Pāṇini in his *Aṣṭādhyāyī* describes the language of universal grammar, and Bharata Muni writes about the languages of gesture, dance and music in his Nāṭya Śāstra.

Euclid, educated in Plato's academy, did his work in Alexandria. He presented Greek mathematics and geometry in terms of axioms and theorems. His approach was so elegant that his book remained the textbook of elementary geometry and logic up to the early twentieth

century. Its formal method became the standard to be emulated for every new discipline. The idea of a short constitution to which which all pay allegiance may ultimately be traced to Euclid's framework.

Pāṇini described the grammar of Sanskrit algebraically in complete detail, an achievement that has not been matched for any other language until today.[9] Pāṇini's grammar is as intricate in its structure as the most powerful computing machine. The scope of his achievement qualifies Pāṇini as one of the greatest geniuses who ever lived. Not only did he influence attitudes in the East for centuries, his ideas led to the development of the subject of philology in the West.

Bharata Muni's Nāṭya Śāstra not only presents the language of creative expression, it is the world's first book on stagecraft. It is so comprehensive that it lists different postures that can be combined to give the various movements of dance. Bharata's ideas are the key to an understanding of Indian arts, music and sculpture. They provide the insight of how different Indian arts are expressions of a celebratory attitude to the universe. He describes the dhruvapada songs that were part of musical performance.

Euclid and Pāṇini are well known to scholars and the general public. Euclid's formal system became the exemplar for European science. Pāṇini's algorithmic approach to knowledge was the model for scientific theories in the Indic world, extending from India to the east and southeast Asia. The ideas of the Nāṭya Śāstra make intelligible the sculpture, temple architecture, performance, dance and story-telling of the culture of east and southeast Asia.

Bharata's great text lay forgotten in India for almost a thousand years, his ideas remembered mainly through secondary sources. This is surprising considering this

work has a sweep broader than that of Euclid or Pāṇini. It is easy to understand success in devising a method of geometrical reasoning or finding the algebra of grammar as they are inherently structured. But imagine the audacity of creating a language for gesture, dance and music! Also, Euclid and Pāṇini wrote for the scholar, whereas Bharata's work influenced millions directly or indirectly. For these reasons alone, the Nāṭya Śāstra is one of the most important books ever written.

The comprehensiveness of the Nāṭya Śāstra forged a tradition of tremendous pride and resilience that survived the westward movement of Indian musical imagination through the agency of itinerant musicians. Several thousand Indian musicians were invited by the fifth century Persian king Behram Gaur. Turkish armies used Indians as professional musicians.

The large Roma exodus from north India as a consequence of the Ghaznavid invasions gives us a clearer link between Indian music and the West. The Roma in Europe, living as tinkers, craftsmen, horsetraders and entertainers – a despised minority in the fringes of society – were able to maintain cultural continuity, especially in music.

Their devotion to their ways earned them grudging respect for exemplifying "freedom" which by the late 18th century had caught the imagination of Europe fighting the suffocation of the Church. Slowly, the Roma (Gypsy) singers began to enjoy the patronage of the middle-class and the aristocracy.

According to Linda Burman-Hall: "Gypsy bands ... travelled from village to village accompanying the 'strong' dancing of soldiers who recruited continuously for Nicolas the Magnificent's military operations. The style of this *verbunkos* (the so-called 'recruiting' music), – a deliberate fusion of earlier Gypsy music (such as the 16th cen-

tury works preserved in organ tablature) and elements of the western European tradition, – influenced Haydn and other classical composers because it was favored by public taste. As a national fashion this style remained popular through the 19th century with composers such as Beethoven, Hummel, Schubert, Brahms, von Weber, Doppler and especially Liszt writing in a "style Hongrois" influenced by the jagged rhythms and fantastic cadences of the *verbunkos* style."

Bharata stresses the transformative power of creative art. He says, it teaches duty to those who have no sense of duty, love to those who are eager for its fulfillment, and it chastises those who are ill-bred or unruly, promotes self-restraint in those who are disciplined, gives courage to cowards, energy to heroic persons, enlightens men of of poor intellect and gives wisdom to the learned.

11

The Great God

rūpaṃrūpaṃ pratirūpo babhūva
tadasya rūpaṃ praticakṣaṇāya

He became the original form of every form
It is his form that is everywhere to be seen.
-Ṛgveda 6.47.18

Śiva and Viṣṇu are both hailed as the Great God. In the Ṛgveda, Viṣṇu, the pervader, is praised for his three strides with which he measures the universe. These three strides may mean the three division of the skies, three bodies of the human, or the three divisions of time.

Viṣṇu is also called Nārāyaṇa, "he whose abode is in the waters." These are waters of time, between each cycle of creation and dissolution, in which Viṣṇu preserves the universe.

Viṣṇu's consort is Lakṣmī, the goddess of good fortune and prosperity. She is said to have emerged during the churning of the ocean by the gods and demons.

Śiva, the Great God, inheres within him all opposites.[1] In the Ṛgveda, he is called Rudra. His fierce side is called Bhairava, "terrible", and his beneficent side is called Śiva, Śankara, and Śaṃbhu, "auspicious." He is an ascetic, but he is also a devoted husband to Pārvatī. He is the lord of dancers, and the lord of yogins.

When viewed as one with Viṣṇu, he is Harihara, half Viṣṇu, half Śiva. When viewed as one with the goddess,

he is Ardhanārīśvara, half Pārvatī, half Śiva. He unites ascetic and erotic, creative and destructive, male and female aspects of existence into himself.

There are numerous Purāṇic stories that provide details to the personalities of the two gods, showing how each represents Pure Consciousness, Paramātman, in different embodied forms. Here we consider a text that articulates this basic meaning directly.

The Śiva Sūtra

The Aphorisms of Śiva, the Śiva Sūtra (SS), reiterates the Vedic view of consciousness. According to one legend, Vasugupta (c. eighth century) saw the aphorisms (sūtras) in a lucid dream. But the aphorisms did not represent new knowledge, only a a fresh statement of old ideas. The Śiva Sūtra led to the flowering of the Kashmiri schools of consciousness (Kashmir Śaivism). It is due to its highly lucid exposition that Śaivism has come to be quite influential in contemporary scholarship.

This chapter presents a translation of the 78 aphorisms of the SS.[2] The number 78 has a very important significance in the Vedic altar ritual: the earth-altar is assigned the number 21, the atmosphere-altars the number 78, and the sky-altar the number 261.[3] The heart of the ritual is building the sky-altar but this comes at the end of a sequence which includes building other altars signifying the earth and atmosphere.

Indra, the atmospheric god and the lord of the senses in the Vedas, is lauded the most because he is the intermediary in the strivings to reach the sky or the heavens. In the SS, Śiva replaces Indra as the intermediary. We believe this happened when the nakṣatra Maghā, representing the ādhidaivika aspect of Indra, stopped rising at

vernal equinox due to the precession of the earth. But Śiva not only represents the Indra, the intermediary, but also elements of Sūrya and Soma. The number 78 is appropriate for a god of the intermediate space.

In order not to burden the reader with an unfamiliar vocabulary, and to provide a fresh view of the text, my comments are not based on the commentatorial tradition and my translation is direct.

The Individual and the Universal

The aparā and parā kinds of knowledge of the Vedic texts may be described by the dichotomies individual and universal, ordinary and extraordinary, or lower and higher. According to SS, ordinary knowledge comes from phenomenal associations, and this knowledge relates to the outer world. But the associations in themselves need something to bind them together,[4] which means that outer knowledge is not completely unconnected to the inner one. The inner energy that binds the associations is mātṛkā, and it makes it possible for us to understand words or symbols strung together as language. Since they lack mātṛkā, computers or machines cannot understand language or images.

To explain how we reach universal knowledge starting from ordinary knowledge, SS begins with a description of universal consciousness, which, as a unity, is Śiva or Bhairava. Śiva makes it possible for the phenomenal associations of the physical world to communicate meaning. Nevertheless, the domain of the union of Śiva and the phenomenal world is puzzling and astonishing (1.12). This astonishment becomes most acute as one switches from the consciousness of the "enjoyer" to that of the "observer." How much of one's phenomenal self is the "enjoyer" and how much is the "observer", and can

these proportions be changed? And what is process of such change?

Behind the dichotomy of enjoyer and observer is the idea of two sides of the self, seen first in the Ṛgveda 1.164.20, where the mind is likened to two birds sitting on a tree, one of them eating the sweet fruit while the other looking on without eating. One of the birds represents the universal consciousness while the other signifies the individual consciousness. In reality, there is only one bird; the second bird is just the image of the first energized by the fruit! This wordplay hides a puzzle which is left unresolved. The key to this mystery resides in consciousness (Śiva, prakāśa, cit) itself, because it can reflect on itself. In later texts this capacity is called vimarśa.

Another Vedic metaphor is that of the sun of consciousness illuminating the associations in the mind. This illumination is facilitated by icchāśakti, the "power of the will," and Umā[5] represents this śakti. When Umā illuminates specific associations, the subject becomes the enjoyer with respect to these associations, and the subject (Śiva) becomes one with the ground stuff of the associations (Umā). This is the union of Śiva and Śakti that takes place continually, representing an unceasing process.

Innate knowledge emerges from the mind as *mantra*, which is not to be viewed as a formula but with the inherent capacity to reflect. Mantra merges into a "apprehension" (sākṣātkāra) of the reality that lies beyond material associations.

Sound is meaningful in sequence of words of specific association. "Elementary" sounds (śruti) are the ones informed by the śakti underlying the senses. This śakti comes into play as one opens the "crack" between the universal and the individual. The individual then enters a state of understanding, where knowledge is the goal.

A detachment from associations, where the subject has separated himself from his ordinary self, is the key to the knowledge of the universal Self. The separation of the senses from their associations make it possible to arrive at the heart of the Self.

A twist is given to the three-fold classification of consciousness into the states of waking, dreaming, and deep sleep. It is claimed that the transcending fourth state, where one is *creatively* aware, may be experienced in any of the three states, leading to a creative awareness accompanied by insight and new connections. The experienced world's structure become knowable with the help of the fourth state.

SS uses a striking image where the mind, embodied by various "energies," seeks an existence in which knowledge is its goal (food). The mind is the Self, but it must transcend its conditioned manifestation to be *itself*.

The perception of the outer reality is a creation of the mind, and the universe is the dance which comes into form only when there are observers. The dance has a grammar, a unity, but its expression is of many dimensions.

Mind, as mantra, is energized by the breath of the eternal.

Individual knowledge, in itself, cannot lead to higher knowledge, although it might be informed by it. The deepening of individual knowledge does, however, set up a process of self-transformation, which is described in Part 3 of SS. This process requires a calm mind and a reaching for the source of the cognitions. It is in this manner that the search for individual knowledge facilitates the acquisition of universal knowledge.

The problem of the transformation of the subject from being the "enjoyer" to the "observer" is addressed. The self that emerges as a result is an "actor" (3.9). But

this does not mean that the individual's humanity is diminished. On the other hand, this leads to freedom and creativity (3.10). The process of creativity is a manifestation of the universal. "When separateness is gone, action can lead to creation" (3.37). It is asserted that the fourth (transcendental) state of consciousness should inform the lower states (such as waking, sleep, and deep sleep). Various wondrous attributes of the *free* person are described.

The mind and the body are coupled in many ways. It is should be possible, therefore, to heighten the awareness of the mind through an awareness of the body. One must breathe properly (3.23) to harmonize the physiological and psychological processes. One must meditate on sounds and words to learn to separate and join perceptions (3.25).

The Text Translated

1. Universal consciousness

1.1 Consciousness is the Self.

1.2 (Ordinary) knowledge consists of associations.

1.3 Sets of axioms generate structures.

1.4 The ground of knowledge is mātṛkā (the energy that weaves reality together).

1.5 The upsurge (of consciousness) is Bhairava.

1.6 By union with the energy centres one withdraws from the universe.

1.7 Even during waking, sleep, and deep sleep one can experience the fourth state (transcending consciousness).

1.8 (Sensory) knowledge is obtained in the waking state.

1.9 Dreaming is free ranging of thoughts.

1.10 Deep sleep is māyā, the irrational.

1.11 The experiencer of the three states is the Self.

1.12 The domain of the union is wonder.

1.13 The power of the will is the playful Umā (the consort of Śiva as the energy that moves, creates and binds).

1.14 The observed has a structure.

1.15 By fixing the mind on its core one can comprehend the perceivable and emptiness.

1.16 Or by contemplating the pure principle one is free of the power that binds (to associations).

1.17 Right awareness is the knowledge of the Self.

1.18 Blissful sight is the goal of samādhi.

1.19 The body emerges when the energies unite.

1.20 Elements unite, elements separate, and the universe is gathered.

1.21 Pure knowledge leads to a mastery of the wheel (of energies).

1.22 The great lake (of space-time, of Self) is experienced through the power of *mantra.*

2. The emergence of innate knowledge

2.1 Mantra is the mind.

2.2 Effort leads to attainment.

2.3 The secret of *mantra* is the being in the body of knowledge.

2.4 The expansion of the mind in the womb is the forgetting of common knowledge.

2.5 When the knowledge of one's Self arises one moves in the sky of consciousness – the Śiva's state.

2.6 Guidance is essential (i.e., the guru is the means).

2.7 The awakening of the wheel of mātṛkā (the binding energies).

2.8 The body is the oblation.

2.9 The food is knowledge.

2.10 With the extinction of knowledge emerges the vision of emptiness.

3. The transformations of the individual

3.1 The mind is the Self.

3.2 (Material) knowledge is bondage (limiting association).

3.3 Māyā is the lack of discernment of the principles of transformation.

3.4 The transformation is retracted in the body.

3.5 By the quieting of the vital channels, the mastery of the elements, the withdrawal from the elements, and the separation of the elements (is achieved).

3.6 Perfection is through the veil of delusion.

3.7 Overcoming delusion and by boundless extension innate knowledge is achieved.

3.8 Waking is the second ray (of consciousness).

3.9 The Self is the actor.

3.10 The inner Self is the stage.

3.11 The senses are the spectators.

3.12 The pure state is achieved by the power of the intellect.

3.13 Freedom (creativity) is achieved.

3.14 As here so elsewhere.

3.15 Emission (of consciousness) is the way of nature and so what is not external is seen as external.

3.16 Attention to the seed.

3.17 Seated (in the highest power) one sinks effortlessly into the lake (of consciousness).

3.18 The measure of consciousness fashions the world.

3.19 As (limited) knowledge is transcended, birth is transcended.

3.20 Māheśvari and other mothers (sources) of beings reside in the sound elements.

3.21 The fourth (state of consciousness) should be used to oil the (other) three (states of consciousness).

3.22 Absorbed (in one's own nature), one must penetrate (the language) with one's mind.

3.23 Balanced breathing leads to balanced vision.

3.24 The lower plane arises in the centre (of the language).

3.25 What was destroyed rises again by the joining of perceptions with the objects of experience.

3.26 He becomes like Śiva.

3.27 The activity of the body is the vow.

3.28 The recitation (of sounds) is the discourse.

3.29 Self-knowledge is the boon.

3.30 He who is established is the means and knowledge.

3.31 For him the universe is the aggregate of his powers.

3.32 Persistence and absorption.

3.33 Even when (there is) this (maintenance and dissolution) there is no break (in awareness) due to the perceiving subjectivity.

3.34 The feeling of pleasure and pain is external.

3.35 The one who is free of that is alone (conscious).

3.36 (Owing to) a mass of delusion, the mind is subject to activity.

3.37 When separateness is gone, action can lead to creation.

3.38 The power to create is based on one's own experience (of the Self).

3.39 That which precedes the three (states of consciousness) vitalizes them.

3.40 The same stability of mind (should permeate) the body, the senses and the external world.

3.41 Craving leads to the extroversion of the inner process.

3.42 When established in pure awareness, (the craving) is destroyed and the (empirical) individual ceases to exist.

3.43 Although cloaked in the elements one is not free, but, like the lord, one is supreme.

3.44 The link with the vital breath is natural.

3.45 (The breath is stilled by) concentrating on the centre at the top (within the nose); of what use (then) are the left and the right channels or suṣumnā?

3.46 May (the individual) merge (in the lord) once again!

Although the contents of SS are cryptic, they complement the insights of the Upaniṣads. Later Tantric and Āgamic texts describe important details of this conceptual system for consciousness.

The Śaiva Approach to Reality

There are several Śaiva schools based on different Tantra and Āgama texts. In Śaivasiddhānta, three basic realities are conceived, namely, Śiva (pati), the fettered soul (paśu) and the forces that bind it (pāśa). There are correspondingly three kinds of knowledge: paśu-jñāna and pāśa-jñāna lead to the understanding of individuals, words and things; only pati-jñāna leads to mastery. Śaivasiddhānta is dualistic where the difference between the individual and the universal is maintained. It emphasizes the reality of experience. Consciousness is the direct experience of things as they are in themselves (anubhava), free of thought-constructs.

Two other schools which are non-dualistic are that of the Pratyabhijña (Philosophy of Recognition) and the Spanda (Doctrine of Vibration). According to the Pratyabhijña, knowledge appears as a flash as a recognition of the force of one's own consciousness. This occurs not by any direct process but by suggestion and indirect means, permitting the seeker to see the universal consciousness within him.

Consciousness in this tradition is tranquil, but it is not like an insentient void. The Absolute is believed to be self-conscious and this self-awareness itself is a subtle form of activity. This activity is compared to a vibration, spanda, which is the double-edged movement of consciousness proceeding outwardly and inwardly at the same time. The inward movement is the identity with I-ness, while the outward movement is the identity with the outer universe (and non-identity with the Self). Consciousness is like light (prakāśa) in its outer form and blissful self-awareness (vimarśa) in its inner form.

Other philosophical formulations of Vedic thought were done by Śankara, Rāmānuja and Madhva, who system-

ized Advaita (nondual), Viśiṣṭādvaita (qualified nondual), and Dvaita (dual) schools of Vedānta.

Advaita maintains an ultimate identity of the individual consciousness (Jīvātman) and Brahman. According to Śankara all subject-object knowledge is distorted by adhyāsa, superimposition, which falsifies knowledge in such a way that the subject is unable to find objective truth.

Viśiṣṭādvaita considers reality to be consisting of three components: the world of material things, the multiplicity of individuals (Jīvātman), and Brahman. It insists that multiplicity of things is real and that Brahman (universal consciousness) must be viewed in terms of qualities. The universe is a projection of Brahman as the primary entity. According to Dvaita, there is fundamental difference between the Jīvātman and Brahman and this difference is not completely bridgeable. Whereas Śankara takes Śiva to be Brahman, Rāmānuja and Madhva believe it is Viṣṇu.

Vaiṣṇava Parallels

The difference between the Śaiva and the Vaiṣṇava schools is just a matter of nuance. The Śaivites emphasize consciousness whereas the Vaiṣṇavites consider moral law to be primary, but scratching below the surface one finds that the two overlap each other. One can see this in the Bhagavad-Gītā 15.16-17 which, echoing the Upaniṣads, speaks of a dual manifestation of the nondual: There are two spirits in the world, the perishable and the imperishable. Perishable are all beings, and the unchanging is the imperishable. But the highest spirit is another; it is called the supreme Self, who, entering the three worlds as the eternal lord, supports them.

In a similar manner, the Yoga-Vāsiṣṭha insists that

the world exists because consciousness is, and the world is the body of consciousness. There is no division, no difference, no distinction between the observed and the observer. The universe may be said to be both real and unreal: real because of the reality of consciousness which is its own reality, and unreal because the universe does not exist as universe, independent of consciousness.

A Vaiṣṇava enlargement of the Vedic theory of the mind is provided by the Pāñcarātra tradition, in which Vāsudeva (Kṛṣṇa) represents the ground-stuff of reality. Vāsudeva is also called *kṣetrajña*, the knower of the field.

This is elaborated in the Mahābhārata, Śānti Parva, 340, "Sattva, rajas, and tamas are the three original attributes. These act and dwell in the bodies of all creatures. The jīvātman, kṣetrajña, enjoys and endorses the actions of these three attributes, yet he transcends them. Having created them himself, he is above them all. At dissolution, earth, which is the refuge of the universe, merges into water, water disappears into light, light into wind, wind into space, and space into mind. Mind is a great being, and it disappears into unmanifest Prakṛti. Unmanifest Prakṛti disappears into inactive Puruṣa. There is nothing higher than Puruṣa which is eternal. There is nothing among mobile and immobile things in the universe that is immutable, except Vāsudeva, the eternal Puruṣa. Endued with great power, Vāsudeva is the soul of all creatures."

kṣetrajñaṃ cāpi māṃ viddhi
sarvakṣetreṣu bhārata
kṣetrakṣetrajñayor jñānaṃ
yat taj jñānaṃ mataṃ mama

Know also that I am the knower in all fields,

> O Bhārata;
> and only the knowledge of the field and its knower do I regard as true knowledge.
> *–BG 13.2*

From Vāsudeva develops Saṅkarṣana at the beginning of time; this is identified with Śeṣa and with Prakṛti. Next arises Pradyumna, who is identified with manas, or mind. Lastly, we have Aniruddha, who is ahaṃkāra. Thence evolve the three guṇas.

This model makes an interesting departure from the kośa model. Each intermediate levels is identified with a god. Saṅkarṣana is the same as Balarāma, Kṛṣṇa's brother while Pradyumna is his son and Aniruddha is his grandson. The idea is to suggest an individuality to each of the stages of the expansion of the mind.

Actually, the idea of multiplicity, as emerging from a fundamental unity, permeates the entire Vedic literature. This is how the Vedic gods emerge in the Ṛgveda, and the Bhagavad Gītā (15.16-17) speaks of the three-fold Puruṣa. In the words of Sri Aurobindo:[6]

> Kshara Purusha is the Self reflecting the changes and movements of Nature, participating in them, immersed in the consciousness of the movement and seeming in it to be born and die, increase and diminish, progress and change. Atman, as the Kshara, enjoys change and division and duality; controls secretly its own changes but seems to be controlled by them; enjoys the oppositions of pleasure and pain, good and bad, but appears to be their victim; possesses and upholds the action of Nature, by which it seems to be created. For, always and inalienably, the Self is Ishwara, the Lord.

> Akshara Purusha is the Self, standing back from the changes and movements of Nature, calm, pure, impartial, indifferent, watching them and not participating, above them as on a summit, not immersed in these Waters. This calm Self is the sky that never moves and changes looking down upon the waters that are never at rest. The Akshara is the hidden freedom of the Kshara.
>
> Para Purusha or Purushottama is the Self containing and enjoying both the stillness and the movement, but conditioned and limited by neither of them. It is the Lord, Brahman, the All, the Indefinable and Unknowable.

The paradox of separation and identity of the observer and the observed were later expressed as the bhedābheda doctrine of Bhāskara of the tenth century, who held that Brahman and the world, or the principles of unity and multiplicity, were both eternal and metaphysical truths.

Caitanya's metaphysics goes somewhat beyond it and has been called acintya bhedābheda by Jīva Goswāmī. According to it, Kṛṣṇa is inconceivably (acintya) and simultaneously one with *and* different from his manifestations. The inconceivability of this metaphysics is in the concept of simultaneous union and separation, but it is so only if classical logic is used. A beautiful representation of this subtle logic is the rāsa-līlā.

In the rāsa dance, the jewel-like gopīs link their arms together, forming a necklace of pearls around the sapphire of Kṛṣṇa, who is dancing in the middle of the group with Rādhā. In order to share himself with all the gopīs, Kṛṣṇa produces expansions of his own form, such that a Kṛṣṇa-sapphire becomes faceted between each gopī-pearl of this necklace of love, the rāsa-maṇḍala. In the words

of B.V. Tripurāri:[7] "Kṛṣṇa is *rasa*. aesthetic experience, and he is *rasika*, the greatest connoisseur of aesthetic experience. Rādhā is the outpouring of this internal unity of *rasa* and *rasika*... In the eternal function of *līlā*, or divine play, Kṛṣṇa fully tastes himself through his primal energy, Rādhā. Rādhā gives life to Kṛṣṇa as energy brings the energetic source to life. As sugarcane cannot taste itself, similarly the tasting of the Absolute (*rasa*) necessitates such a dynamic, non-dual Absolute. The effect of the Absolute tasting itself through its essential *śaktis* is the creation of the phenomenal world and all souls' apparent relationship with it. When the Absolute (Kṛṣṇa) relates with the phenomenal world, this act of grace attracts all souls to unite with him, enter his divine play, and experience *rasa* beyond the confines of the phenomenal world."

Vaiṣṇava metaphysics confronts the question of objective and subjective reality directly. It presents its resolution in terms of a paradoxical unity between consciousness and the material world. The details of the cognitive structure are a part of Vaiṣṇava Tantra that belongs to an esoteric tradition that is well known only to the adept.

Śaiva metaphysics is largely similar to Vaiṣṇava metaphysics, and Śaiva Tantra has parallels in Vaiṣṇava Tantra. The image of Harihara symbolizes their underlying identity.

12

The Temple

The mind, held together by the gods, looks out on the material world. When it turns inwards to reflect, it experiences the gods and it envisions a place for them outside the body to describe their mystery. This brings us to the conception of the temple.

The classical Indian temple has evolved from the massive fire altars of the Vedic times. In the heart of these altars was placed a golden icon representing divinity.

Very few original Hindu temples, reflecting harmony between the cosmological, the social, and the spiritual aspects of reality, have been constructed in India in the past few centuries. This is no doubt due to a break with the tradition that took place due to unsettled conditions for about half a millennium. The break of tradition was more severe in north India.

Thanks to the efforts of scholars, we are again getting to understand the logic of the Hindu temple.[1] In particular, the harmony of the temple architecture with other creative expression that forms part of temple activities (such as dance, sculpture, painting, music) is described by Kapila Vatsyayan thus:[2] "In the context of Indian architecture and sculpture, the basic geometrical motifs, the fundamental concept of Man-Nature relationship, along with the common vocabulary of myth and legend, find a place in every constituent part of the Indian temple."

The temple represents the cosmos, both at the level of the physical universe and the subject. The architecture reflects the connections between the two. The most impressive aspect of the design is its representation of the universe in a recursive fashion, mirroring the Vedic idea that the microcosm symbolizes the macrocosm at various levels of expression. This is done not only in the domain of numbers and directions, but also by the use of appropriate mythological themes, and historical incidents. The mythological scenes skillfully use the oppositions and complementarities between the gods, goddesses, asuras, and humans defined over the matrix of ordinary and sacred time and space. This is seen most clearly in the architectural plan of the Angkor Wat temple.[3]

The temple is the image of the Cosmic Puruṣa, on whose body is all creation in its materiality and movement. Paradoxically, the space of the Puruṣa is (Ṛgveda 10.90) in the sanctuary only ten fingers wide, although he pervades the earth.

Here I present the ground plan for a temple reflecting traditional ideas of such abode for the gods. This design is inspired in part by the Padmanābha temple in Thiruvananthapuram. It also has features that emerge from the study of the Vedic altars, and it reflects many numbers from Vedic astronomy.

The broad structure of the temple is given in arbitrary units: the rectangular structure (A) 45×90 represents the earth (Figure 4). In a variant the rectangular is replaced by circular within the square (Figure 5). The square structure on the right (B) represents the atmosphere and the sun (garbhagṛha). The rectangular structure A is a Devi temple, whereas B is a temple to Harihara. This structure has basic dimensions of 90×90 which are augmented by extensions to 100×100. The width of each extension is 20. The area of the central extensions is

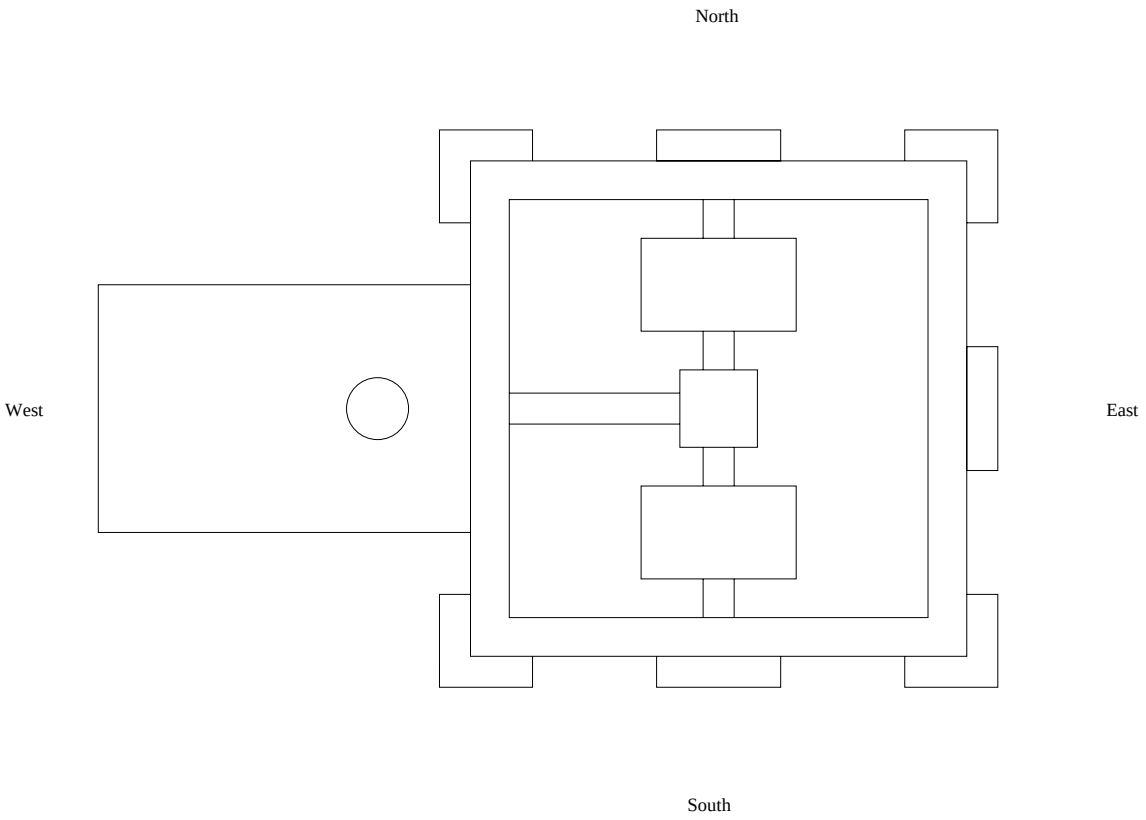

Figure 4: The basic temple plan

thus 100, and that of the corner extensions is 175. The entry to the temple is through the doorway to the west. The plan could be inverted by switching the east-west coordinates.

The distance from the inner passageway to the garbhagṛha is 27. If this passage is flanked by two rows of pillars on either side, the total count of the pillars will be 108. This number, 108, is the distance between the Earth and the Sun in sun-diameter units, and the distance between the Earth and the Moon in moon-diameter units. The

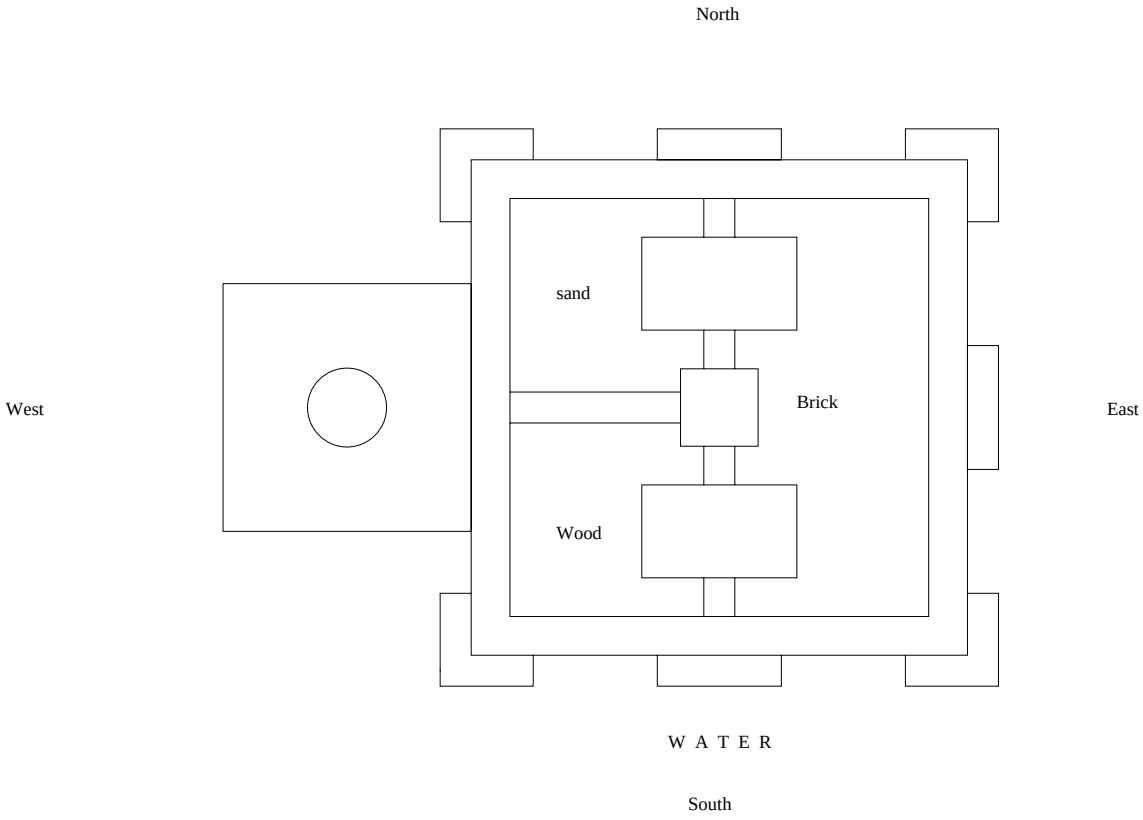

Figure 5: A variant of the basic temple plan

significance of this number related to the distance of the Sun and the Moon was known to the Vedic Indians. But it is unlikely they knew that the ratio between the Sun and the Earth diameters is also 108.

The garbhagṛha is 16×16 units. Flanking it are two rectangular spaces for meditation and instruction that have areas of 338 each. There is a walkway around the perimeter of width 10 units, but extensions augment this to larger spaces where an individual might sit down and meditate. The three courtyards have floors of sand, brick, and wood – or of some other three different material –, respectively.

More on the Hindu Temple

The temple construction begins with the Vāstupuruṣa maṇḍala, which is a yantra, mostly divided into 64 (8×8) or 81 (9×9) squares, which are the seats of 45 divinities. Brahmā is at the centre, around him 12 squares represent the Ādityas, and in the outer circle are 28 squares that represent the nakṣatras.[4] The Vāstumaṇḍala with its border is the place where the motions of the sun and the moon and the planets are reconciled. It is the Vāstu in which the decrepit, old Cyavana of Ṛgveda 1.116.10 asks his sons to put him down so that he would become young again, where Cyavana is the moon and Sukanyā, whom he desires, is the sun.

In the basic Vedic scheme, the circle represents the earth and the square represents the heavens or the deity. But the altar or the temple, as a representation of the dynamism of the universe, requires a breaking of the symmetry of the square. As seen clearly in the agnicayana and other altar constructions, this is done in many ways. If the main altar is square or its derivative, the overall sacred area is made to depart from this shape. In particular, the temples to the goddess are drawn on a

rectangular plan. In Śiva or Viṣṇu temples, which are square, change is represented by a play of diagonal lines. These diagonals are essentially kinetic and are, therefore, representative of movement and stress, embodying the dynamic of time.

In the Śilpa Prakāśa (1.90-106), a 9th-12th century Orissan temple architecture text, Rāmacandra Kaulācāra describes the Yoginī Yantra for the layout of the goddess temple. Alice Boner writes,[5] "[the Devī temples] represent the creative expanding forces, and therefore could not be logically be represented by a square, which is an eminently static form. While the immanent supreme principle is represented by the number ONE, the first stir of creation initiates duality, which is the number TWO, and is the producer of THREE and FOUR and all subsequent numbers upto the infinite." The dynamism is expressed by a doubling of the square to a rectangle or the ratio 1:2, where the garbhagṛha is now built in the geometrical centre. For a three-dimensional structure, the basic symmetry-breaking ratio is 1:2:4, which can be continued further to another doubling.

The constructions of the Sarasvati-Sindhu culture all the way down to the Harappan phase of the 3rd millennium BC appear to be according to the same principles. The dynamic ratio of 1:2:4 is the most commonly encountered size of rooms of houses, in the overall plan of houses and the construction of large public buildings. This ratio is also reflected in the overall plan of the large walled sector at Mohenjo-Daro called the citadel mound. It is the ratio used in the most commonly encountered brick size.

There is evidence of temples in the Harappan period which is in addition to iconography that recalls the goddess. Structures dating to 2000 BC, built in the design of yantras, have been unearthed in northern Afghanistan.

Thus there is ample evidence for a continuity in the religious and artistic tradition of India from the Harappan times, if not earlier. These ideas, together with the underlying astronomy, continued to be used in the architecture of the temples of the classical age. Stella Kramrisch argued that the number 25,920, the number of years in the precessional period of the earth, is also reflected in the plan of the temple.

As a representation of the macrocosm, change in the temple is described in terms of the motions of the heavenly bodies. According to Alice Boner[6]:

> [T]he temple must, in its space-directions, be established in relation to the motion of the heavenly bodies. But in asmuch as it incorporates in a single synthesis the unequal courses of the sun, the moon and the planets, it also symbolizes all recurrent time sequences: the day, the month, the year and the wider cycles marked by the recurrence of a complete cycle of eclipses, when the sun and the moon are readjusted in their original positions, a new cycle of creation begins.

The Hindu temple as a conception of the astronomical frame of the universe serves the same purpose as the Vedic altar, which reconciled the motions of the sun and the moon. The progressive complexity of the classical temple was inevitable given an attempt to bring in the cycles of the planets and other ideas of the yugas into the scheme.

The Hindu temple further represents the inner cosmology of the subject. The devas reside within one's consciousness, and the temple represents a schematic map of the architecture of the mind.

The number 108 is also taken to represent the "dis-

tance" from the body of the devotee to the *ātman* within. The chain of 108 "links" is held together by 107 joints, which is the number of *marmas*, or weak spots, of the body in Āyurveda. The 108 beads of the rosary (japamālā) map the steps between the body and the inner sun. The Nātya Śāstra (NatS 4.62-169) speaks of the 108 *karaṇas* – combined movements of hand and feet – of dance.

The number of days in a civil year, 360, is another important cosmological number. It is used, either directly or indirectly as its fourth part, 90, in altar and temple design, and it is a part of our design, too. According to Āyurveda, the developing foetus has 360 bones which later fuse into the 206 bones of the adult.

We present two different versions of the basic plan. The difference is the plan for the left portion, which is rectangular in one and circular in the other (Figures 4 and 5). Other variations can be proposed.

The main dimensions of the temple are given in Figure 6. The two rectangular buildings within the courtyards are for meditation and other instructional purposes. It is fitting that the areas of each of these buildings turns out to be 338, just one less than one-third the number of the Ṛgvedic hymns. Remarkably, the dimensions of the rectangular halls add up as $2 \times (26 + 13) = 78$, which, as we know, is the Vedic altar number for atmosphere.

The elevation of the temple will be a function of the geographical coordinates, location, and scale. When it is built, the temple will be in harmony with the elements through space, form and sculpture.

Temples of other traditions also represent the cosmos, as is clear from the conception of the cathedral. But the Indian temple not only embodies the idea of cosmic power and grandeur, it maps numbers of astronomical and physiological origin, Vedic ritual and Āyurveda.

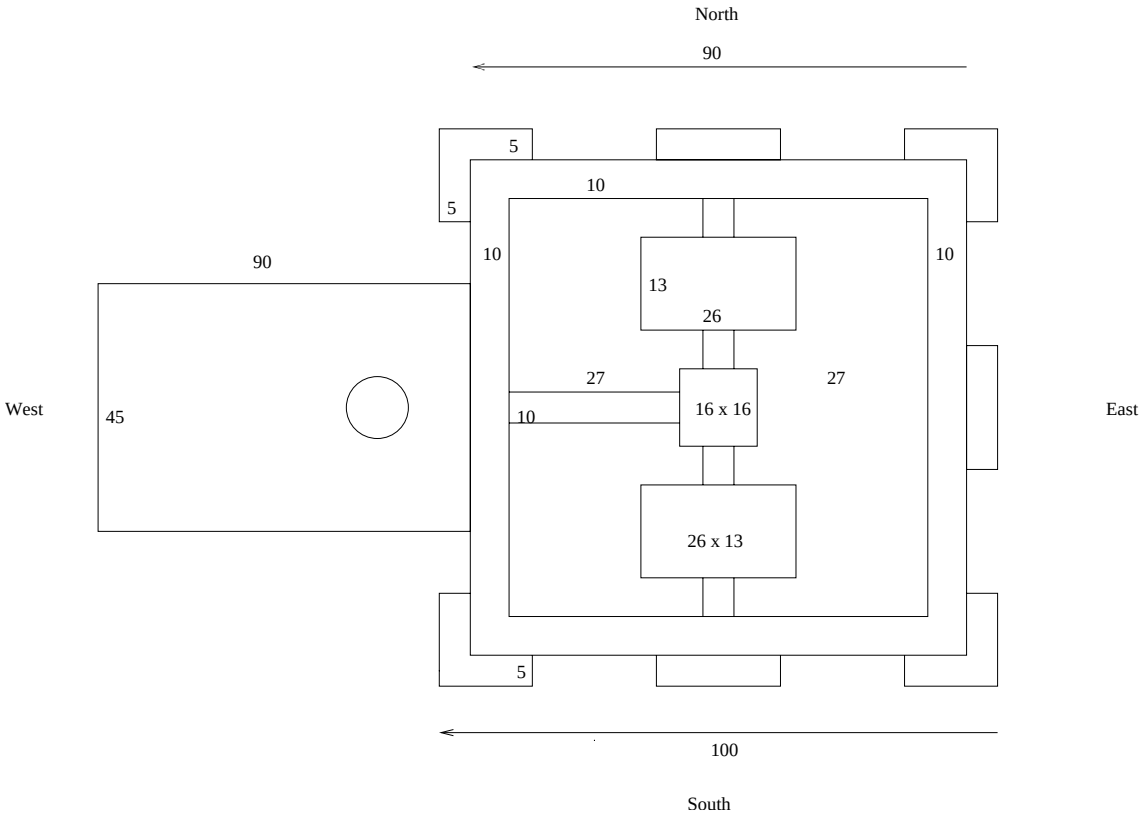

Figure 6: The main dimensions of the temple

Magical Numbers

The brain is a physical system like others in nature, so we would expect some of its characteristics to be found elsewhere also. One number that shows up in brain structure is the Golden Ratio, 1.618033989, which is also at the basis of petal patterns of flowers, and even the planet periods. It is the ratio obtained by dividing consecutive elements, the larger by the smaller, of the Fibonacci series: 1, 1, 2, 3, 5, 8, 13, 21,... where the next term is the sum of the preceding two terms. The Golden Ratio is also the solution to the equation $x = 1 + 1/x$. The Golden Ratio raised to the powers -3, -1, 0, 1, 5, 7 gives the periods of Mercury, Venus, Earth, Mars, Jupiter, and Saturn in years, suggesting that the solar system must be viewed as a single whole.

It was as a boy that I first heard of the number 108 in the title of swamis in India, as in Śrī-108 so-and-so, which irked me not only because of its pretentiousness but also because no one seemed to know why it was "holy". I also had heard of 1,008, another equally mysterious number used by swamis.

Much, much later, I asked professors about these numbers. One gentleman told me that its secret lies in the "holiness" of the number 18, as evidenced by the eighteen Purāṇas, and the eighteen chapters of the Bhagavad Gītā, and the number 108 is obtained from 18 by slipping a zero in between, and doing this again leads to 1,008. But this explanation is not satisfactory. Why is 18 holy, to begin with? And if it is, why doesn't slipping a zero in between 1 and 8 destroy that holiness? If it doesn't for whatever reason, leading to 108 and 1,008 in two stages, why doesn't it lead to 10,008 and other larger numbers?

Another gentleman said that 108 was 27 times 4, that is 27 nakṣatras (constellations in the moon's monthly cir-

cuit) multiplied by four of the four cardinal directions. But why should this be important? Also, in reality, the moon takes 27 and one-third days to complete its circuit, not exactly 27.

I ultimately found the answer to the mystery of these numbers while doing research on early Indian astronomy. Three facts from any book on astronomy are:

- Distance between Earth and Sun = 108 times sun-diameter,
- Distance between Earth and Moon = 108 times moon-diameter, and *most remarkably*,
- Diameter of the Sun = 108 times the earth-diameter

The knowledge of the first two above by the Indians shouldn't surprise because it can be found by anyone without the need of any instruments. Take a pole, mark its height, and then remove it 108 times its height. The pole will look exactly of the same angular size as the Moon or the Sun.

I don't believe the Indians knew the third fact, that is the Sun is 108 times as large as the Earth, because there is no evidence of this knowledge in the old astronomy manuals. If they did know this, it would be as amazing a coincidence as the knowledge of the correct speed of light before modern measurements.[7]

The 108 joined to the name is merely a boast that one is a spiritual adept, a master of the journey of 108 steps through the intermediate regions of danger.

The other number 1,008 has a slightly different basis. Early Indian astronomy divides[8] the *kalpa* – the total period within a creation, the day of Brahma, which is part of an infinite cycle – into 1,008 yugas. The use of this number as a title is to boast that one knows the mystery of time from creation to annihilation.

A few months ago in Chennai, Padma Subrahmanyam, the great dancer and dance theorist, told me a story of discovery that relates to the number 108.

In the 1960s, Padmaji had come to the realization that the four-hands of the Śiva figures in Tanjavur represented animation. Then, in 1980, Sri Chandrasekharendra Saraswati Swamigal, the Shankaracharya of the Kanchi Peetham – who was to pass away at the age of 100 fourteen years later –, asked her to design a fresh set of *karaṇa* figures for the panels of the new Uttara Chidambaram Nataraja Mandir in Satara, Maharashtra, based on the Nāṭya Śāstra descriptions. Each panel had to show Śiva and Pārvatī.

She first had to decide whether to use Śiva with four arms as at Tanjavur or Śiva with two arms as at Kombakonam, together with Pārvatī with two arms as at Chidambaram. She took pictures of these panels and went for advice to Swamiji, but he said he did not want copies of existing images. Ultimately, she chose four arms for Śiva and two for Pārvatī, to denote movement, and created new designs.

Later in the 1990s, Padmaji was approached by Alessandra Iyer, an Italian scholar, who wished to study the influence of the Nāṭya Śāstra on the Far East. They discovered that the Satara temple panels of Padmaji were similar in form to the 53 surviving dance panels of the 9th century Prambanam temple of Java, Indonesia, that was largely destroyed by earthquake in the 15 century.

This established that Padmaji's choices were right and her understanding of the four-armed poses as frozen movements was correct. Since her reconstruction were based on brief description, it also suggests that the karaṇas are archetypes of motion.[9]

The idea of archetypes brings me to Wofgang Pauli and Carl Jung who, in a book they wrote in 1952 called

The Interpretation of Nature and the Psyche, argued that our discoveries are a consequence of the preexisting patterns in our mind. Pauli wrote, "I prefer to say that mind and matter are governed by common, neutral ordering principles 'that are not in themselves determinable.'" The idea of archetype, borrowed by Jung from Yoga, makes it possible for us to see how different people can come to the same discovery independently.

In his contribution to the book, Pauli indicated how the great Kepler had come by his three laws of planetary motion upon the use of Fibonacci sequences. From there the next step was the Newtonian synthesis that viewed the universe as a machine. But now we have come full circle in our realization that if the universe is a machine, it is one where the components are all connected together – it is a holistic, conscious machine.

13

Epilogue

It took a long time for consciousness to emerge out of the shadows of philosophy. Where before we only had its description by the mystic, we can now harness neuroscience to describe it, if only indirectly. Cognitive deficits show that mental capabilities are localized and decentralized, and that the mind constructs its reality. This reality is based not just on abstract and mechanical rules but also on personal, emotional factors that incorporate judgment and feeling. Without this element of feeling we would behave like robots.

Mind is not identical to the brain, and its behaviour is very complex. This is seen most dramatically in phantoms. A person accidently cuts off his right index finger but he cannot shake off the phantom of the finger, rigidly extended as it was when it was cut off. The person doesn't want to bring his hand to his face, afraid that he may poke his eye with his phantom finger.[1] Amputees with artificial lower limb need to incorporate the phantom into their body image, lacking which walking is not possible. Phantom feel real pain. Another example of the construction of reality by the mind is anosognosia where patients have a difficulty in recognizing their ailments. Thus a patient whose left arm and leg is paralyzed may insist that his paralyzed limbs are functioning normally, even immediately after failing to perform a simple task.[2]

Experiments have uncovered other tricks played by

the mind. In an study done by Kornhuber and his associates over twenty five years ago,[3] subjects were asked to flex the index finger of their right hand suddenly at various times of their own choosing while the electrical signals in their brain were being recorded on an EEG. It was found that there was a gradual build-up of recorded electric potential for a second or a second and a half before the finger was actually flexed. This indicates that the conscious mind takes over a second in order to act. In contrast, the automatic or reflex response – as in the blinking of eye to a light flash – is over five times faster.

In another experiment by Libet and associates[4] on patients undergoing open brain surgery, it took about half a second to register a stimulus applied to the skin, despite the fact that the brain would have received the signal of the stimulus in about a hundredth of a second and the pre-programmed reflex response takes only about the tenth of a second.

In other experiments, regions of the somatosensory cortex were stimulated after the touching of the skin. If the electrical stimulation occurs about a quarter of a second after the touching of the skin, then due to "backwards masking", the touching of the skin is not felt at all. The conscious perception is masked by a later event so long as that event occurs within about half a second, that is the conscious awareness of such a sensation occurs about half a second after the event producing the sensation.

In a variation of the experiment, the cortex was stimulated first, for over half a second, and then the skin was touched, but less than half a second after the cortex stimulation. The subject perceived both the stimuli separately. But he felt that the skin-touching occurred first, despite the fact that the cortex stimulation was done earlier. Thus the subject appears to refer the perception

of the skin-touching backward in time by about half a second. This is further evidence that the experiencing of time in our consciousness is delayed by about half a second by the conscious self.

If the mind sequences events irrespective of their objective order, it is to be expected that it also creates other aspects of reality. The cognitive centres do not only reveal to the mind, they also conceal by agnosia, caused not by injury to the pathways in the brain but by deliberate forgetting.

The phantom limb phenomenon shows that the mind keeps a map of the complete body even when a limb is missing. Perhaps it is this creation that codes objective truths which, consequently, can be inferred by looking within, as was claimed by the Vedic sages. This is why the astonishing parallels between ancient wisdom and modern science are not blind chance.

But if meditation on consciousness can yield secrets, can it lead to other insights that lie beyond the current "scientific" understanding of reality?

As matter coalesces into different substances according to natural law (*ṛta*), there must be laws of the manifestation of the Self into the various senses. The Vedic texts and the Tantras speak of this manifestation, but they do it cryptically. To understand these texts scientifically, we need a convergence in the languages of mystical experience and science.

Consciousness – and its embodiment in senses – involves self-referral and paradox. Only by approaching the subject indirectly can we hope to reach the centre, but like the perfectly calm eye of a cyclone, the centre does not yield secrets easily.[5]

In this book, we began with neuroscientific correlates of the mind that showed localization of function. Sketching parallels with Indian psychology and mythology, we

related cognitive capacities to the activities of the gods of the Vedas. But we are yet to discover the interpretative key that will unlock the details of the Vedic system and make possible its use in further development of the science of consciousness.

We examined two philosophical systems that are used in the study of gods and cognition in the Indian tradition. The systems of Sāṃkhya and Vaiśeṣika make it possible to conceive of reality not as a "thing" but as continual change in a dance of being and becoming. The gods have no precise form, suggesting interdependence of cognitive systems. Conceived as a unity, they may be viewed through the grand conception of the Great God – Śiva or Viṣṇu, or the Goddess.

Since ordinary language is limited in its capacity to describe change, and experience is greater than any linguistic expression, inner vision may be presented best through the creative act, that is, in music, art and architecture. For example, the temple as a representation of the universe as well as the subject communicates to us at many different levels.

Modern science has facilitated the appreciation of the mystical idea that the gods hold up the individual's consciousness. Further advances should make it possible for each person to recognize and harness the awesome power of the gods within. This will transform the world in many ways; for example, the links between mind and body will revolutionize medicine.

When the study of consciousness embraces animals it will broaden our understanding. Animals of many nonhuman species pass all operational tests of consciousness, such as vocal and symbolic communication, foraging, predatory behaviour and tool use; but there is a difference of capacity. Further study of animal minds should tell us more about consciousness states and men-

tal capacities.[6] We will most likely find that the gods reside in the consciousness of animals as well.

But do the gods exist only within, or do they also have an outer existence? If consciousness is not merely subjective, but also external, then the gods exist outwardly as well, although they may speak to us only through embodied forms.[7] As science develops richer expression and more subtle methods of measurement, we may be able to answer the question of the outward reality of the gods.

Abbreviations

AB	Aitareya Brāhmaṇa
AV	Atharvaveda
BD	Bṛhad-Devatā
BG	Bhagavadgītā
BU	Bṛhadāraṇyaka Upaniṣad
CU	Chāndogya Upaniṣad
KU	Kaṭha Upaniṣad
KeU	Kena Upaniṣad
KBU	Kauṣītaki Brāhmaṇa Upaniṣad
NarS	Nāradīya Śikṣā
NatS	Nāṭya Śāstra
PP	Padārthadharmasaṃgraha of Praśastapāda
RV	Ṛgveda
ŚB	Śatapatha Brāhmaṇa
SK	Sāṃkhya Kārikā
SR	Saṅgīta Ratnākara
SS	Śiva Sūtra
ŚU	Śvetāśvatara Upaniṣad
TU	Taittirīya Upaniṣad
VS	Vaiśeṣika Sūtra

Notes

Chapter 1: Introduction

1. See, for example, John Woodroffe, 1922, for consciousness in Tantric texts.

2. Quoted in Springer and Deutsch, 1985.

3. Woodroffe, 1922.

4. Sacks, 1990.

5. See Schrödinger, 1958; Bohm, 1980; Pribram, 1987; d'Espagnat, 1995; Penrose, 1994; Kak, 1996a for a philosophical basis of physics and observers. For reality in the Vedic tradition see Aurobindo, 1971a,b,c; Frawley, 2000; Pande, 2001; and Feuerstein *et al*, 2001.

6. Kak, 1997, 1997-98,a,b; see Feuerstein, 1998, and Frawley, 1997, for a background to the Vedic and Yogic material; de Nicolas, 1976, for an elucidation of the four languages of the Ṛgveda; Colavito, 1992, for four languages of mythology; and Klostermaier, 1994, for a general introduction to the Indic tradition.

7. We are led to the conclusion that the present influences the past if we insist on using classical logic in quantum theory, as in Wheeler's delayed-choice experiment (Wheeler, 1982); see also Kak, 1996c.

8. Schrödinger, 1944, page 87; Kak, 2001b.

Chapter 2: States of Consciousness

1. Palmer, 1976.

2. Aserinsky and Kleitman, 1953.
3. Antrobus and Fisher, 1965.
4. Humunculus is the imagined self inside the head who is observing the electrical activity in the brain. For a review of a philosophical study of consciousness, see Sommerhoff, 2000.
5. Luria, 1987b.
6. Nikhilananda, 1977.

Chapter 3: Strange Powers

1. Sacks, 1985, pages 199-200.
2. Sacks, 1985, page 203; see also Sacks, 1995 for further examples.
3. Treffert, 1989.
4. Quoted in Sacks, 1985.
5. Hadamard, 1945, page 31.
6. Kak, 2000b.
7. Penrose, 1989, page 420.
8. Van de Castle, 1994.
9. Gandhi, 1957.
10. Hartmann, 1998.
11. Quoted in Hartmann, 1998.
12. Ramsay and Rocke, 1984.
13. Woodroffe, 1922; Aurobindo, 1971,a,b,c; Feuerstein, 1998.

Chapter 4: Fragments of Reality

1. Penfield and Perot, 1963.
2. Penfield and Perot, 1963, page 635.
3. Penfield and Perot, 1963, page 640.
4. Penrose, 1994.
5. Sacks, 1985, page 27.
6. Kak, 1996a.
7. Luria, 1987a.
8. Kak, 2000a.
9. Goswami, 1998.
10. James, 1897.

Chapter 5: The Broken Circle of Words

1. Chamberlain, 1928.
2. Benson, 1979.
3. Weiskrantz *et al*, 1974.
4. Zeki, 1993.
5. Greenfield, 1995.
6. Flohr, 1991.
7. Greenfield, 1995.

Chapter 6: The Two Sides of the Brain

1. Quoted in Sacks, 1990.
2. Springer and Deutsch, 1985.
3. Myers and Sperry, 1953.
4. Gazzaniga, Bogen, Sperry, 1962.
5. Gazzaniga, 1995.

Chapter 7: The Vedas and Consciousness

1. Aurobindo, 1971a,b,c.; Frawley, 2000; Feuerstein, Kak, Frawley, 2001.
2. See Frawley, 1997, and Feuerstein, 1998, for elucidation of a variety of yogic states. Neuroscience illuminates Vedic and Purāṇic passages that speak about consciousness directly.
3. Feuerstein, 1998.
4. See Woodroffe, 1922, for details.
5. Woodroffe, 1922.

Chapter 8: Support of the Gods

1. Kinsley, 1997.
2. Werner, 1978.
3. See Aurobindo, 1986; pages 73-79 for a detailed discussion of these oppositions in the Īśa Upaniṣad; see also Aurobindo, 1971c, for an interpretation of the Vedic mythology in terms of the interplay between the devas and the asuras.

4. See Kak, 2001a for a study of Vedic sacrifice which describes the movement between being and becoming; see also Kak, 2001b.
5. Dumézil, 1988.
6. Santillana and Dechend, 1969.

Chapter 9: The Tattvas and Atoms

1. SK 2; see also Gurudatta, 1976.
2. Heisenberg, 1989; Kak, 1996a, 1997.
3. RV 1.164.45.
4. See, for example, Kak, 1995; Feuerstein et al., 2001.
5. RV 4.23; 10.85; 10.190.
6. AV 10.
7. RV 2.25; 10.121.
8. RV 10.129.4-5.
9. BU 4.5.12-13.
10. BU 1.4.1.
11. KBU 3.5.
12. CU 7.25.1.
13. CU 6.2-5.
14. ŚU 4.5.
15. TU 2.1.
16. CU 6.2.1-2.
17. TU 3.2-6.

18. See, for example, Dasgupta, 1932; Matilal, 1977; Potter, 1977; Hulin, 1978; Gurudatta, 1976; Larson, 1979; Larson and Bhattacharya, 1987; Mohanty, 2000.
19. VS 2.1
20. Seal, 1915, pages 37-38.
21. Seal, 1915, pages 38-39.
22. PP 5.41-3.
23. PP 137.
24. SK 4-7.
25. SK 7.
26. SK 9.
27. Gauḍapādabhāṣya 9.
28. SK 35.
29. PP 121.
30. SK 36.
31. PP 5.44s; see also VS 3.1.19.
32. SK 3.
33. SK 11.
34. SK 19.
35. SK 17.
36. Kak, 1996a, Kak, 2000a.
37. SK 18.
38. SK 20.
39. PP 129-133.

40. VS 10.
41. PP 143.
42. PP 129.
43. PP 149.
44. PP 154.
45. Potter 1977, page 1.

Chapter 10: The Devas and Music

1. See e.g. Daniélou, 1980; Nijenhuis, 1974; McClain, 1978; Shringy and Sharma, 1978, 1989.
2. Ghosh, 1967.
3. Bṛhaddeśī; see also Shringy and Sharma, 1989, vol. 1, page 404.
4. Shringy and Sharma, 1989, vol. 1, pages 141-2.
5. SR 1.4.1-5. See also Shringy and Sharma, 1989, vol. 1, page 164.
6. Prajñānanda, 1960; see also Gupt, 1996.
7. Shringy and Sharma, 1989.
8. Shringy and Sharma, 1989.
9. Kak, 2001b.

Chapter 11: The Great God

1. Kramrisch, 1981.
2. Jaideva Singh, 1979; Dyczkowski, 1987, 1992; Pandit, 1997; see also Abhinavagupta, 1987, 1989.

3. Kak, 2000b.
4. Kak, 1996a.
5. Umā the consort of Śiva; the name is also a a play on *aum*.
6. Aurobindo, 1971, 1986.
7. Tripurari, 1997.

Chapter 12: The Temple

1. See Kramrisch, 1946; Boner, 1962; Kaulācāra, 1966; Vatsyayan, 1997.
2. Vatsyayan, 1997, page 94.
3. Mannikka, 1996; Nafilyan, 1969; Kak, 1999; Millar and Kak, 1999.
4. See Vatsyayan, 1968, 1997.
5. Boner, 1962, page 27.
6. Boner, A., "Introduction" In Kaulācāra, 1966, pp. xxxiii.
7. Kak, 2000b.
8. Kak, 2000b.
9. Subrahmanyam, 1997.

Chapter 13: Epilogue

1. See, for example, Sacks, 1985.
2. Ramachandran and Blakeslee, 1998.
3. Deeke *et al*, 1976.
4. Libet *et al*, 1979; Libet, 1989.

5. This is the fundamental conundrum related to making the cognizing subject into object. John Woodroffe expresses this mystically as: "Rest implies Activity, and Activity implies Rest. Behind all activity there is static background. Śiva represents the static aspect of Reality and Śakti the moving aspect. The two, as they are in themselves, are one. All is Real, both Changeless and Changeful. Māyā is not in this system 'illusion', but is in the concise words of the Śākta Sādhaka Kamalākānta 'the Form of the Formless' (śunyasya ākāra iti māyā). The world is *its* form and these forms are therefore Real." (Woodroffe, 1922)

6. Kak, 1996b; Griffin, 1992; Masson and McCarthy, 1996.

7. The Tantras explicitly address this question.

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