AYATANAS, SENSORS AND SENSING

David Tin Wm*

Abstract

Thefive sensing processes: stimuli, sensors,feeling, perception, and response are examined from Buddhist and Science aspects. Parallels and differences are identified.

1. INTRODUCTION

One important major function of life is sensing - oneself and the environment. The sensing processes generally include stimuli from the environment that impact with the internal sensors producing consciousness and perception, leading to mental, verbal or physical responses. Buddha had explained this in the Ahbidhamma (Buddhist Canon) over 2,500 years ago. Science had generally neglected the mind and had developed along physical or material paths, until relatively recent times.

Mind and matter may belong to either of three major function types:

1. **Space - Time function (Rupakhanda - particles)** detected by the five senses (thought excluded).

2. **Time** only function **|Namakhanda (Citta, Cetasika) + Rupakhanda - waves (light, sound)|**, detected by the five senses and the mind.

3. **Timeless - Spaceless** function *(Nibbana)* detected by **mind**.

Note: Buddhism identifies Rupa, Nama (Citta and Cetasika) and Nibbana as the four Paramatta truths (ultimate realities). These four items are the only ones that really exist. All others are relative or Panatti realities.

In observing and acquiring knowledge science uses five senses only and is thus limited to sense-data. Consequently perception is bounded; impression is DISTORTED and understanding is INCORRECT. Science knows only time-space functions and some time only functions such as waves like light and sound. It does not know timeless - spaceless functions. It does not know nibbana. Science truth is changeable and relative (Panatti Truth). It is true at the respective lower consciousness levels. Buddhism calls this **avijja** or ignorance of the ultimate realities.

In addition to the five senses Buddhism uses the mind: mental experiences viadhammayatana, manodvara, manodhatu, and manovinanna. It transcends sense-data. Hence perception is unbounded, true impressions are obtained; understanding is CORRECT. Insight is achieved. Thus Buddhism knows time-space functions, time only functions (Citta, Cetasika - waves) and timeless - spaceless function (nibbana). Buddhist truth is unchangeable and absolute (Paramatta Truth). It is true at the unique ultimate consciousness level. Buddhism calls this vijja.

The methodology of Buddhism and science are closely similar if not identical. The major difference being that Buddhism does a detached

*Professor David Tin Win holds a Ph.D. in Physical Chemistry from Strathclyde University, Glasgow, U.K. He is a Lecturer in the Faculty of Science and Technology, Assumption University of Thailand. He is the author of several articles on Buddhism and Meditation.

study of the inner world, whereas science focuses on the external world. Buddhism involves a critical investigation that is personally verified. It includes procedures like: getting information by reading, listening, and attending talks or courses; digesting; practicing (analogous to science experimenting); observing (experiencing); checking the truth; and concluding by accepting or rejecting (Kalama Sutta). If accepted Buddhists live accordingly.

Science does an objective study via distanced analysis on the environment that involves data collection (observation); digestion of data; setting up a hypothesis (reasons for occurrence of phenomena). This is followed by testing the hypothesis (experimenting) and includes observing, interpreting and concluding. The hypothesis may be accepted or rejected. If rejected, a modified hypothesis is proposed and tested again. This is repeated until an acceptable hypothesis is obtained. It becomes a theory. Repeated tests and modifications are made until an acceptable theory emerges. Buddhism is not dogmatic. It is not based on faith, belief, divine revelation, here-say or logic. It is based on personal experience. Acceptance or rejection is purely personal. There is no conflict with science, social, cultural, political development. Notice there never has been Buddhist wars! Science also is supposedly not dogmatic; but some persons dominate - work of established scientists is rarely questioned.

Buddhism outdates science by over 2,500 years. Science is slowly confirming what Buddha had discovered ages ago - without instruments - using only his mind. Albert Einstein said "*If there is any religion that would cope with modern scientific needs, it would be Buddhism*".

There are many who regard Buddhism as being endorsed by science -"*Buddhism is right as checked against science*". But it shall be the other way around. In fact science is catching up only now. Science endorsing Buddhism would be like a young student trying to grade a Ph.D graduate. If at all, science needs to check its progress by using Buddhism as a benchmark. It shall be "*Science is right as checked against Buddhism*". A striking example of Buddhism preceding science is demonstrated by research on fundamental particles. In the Standard Model of Fundamental Particles, physicists realize that "things" more fundamental than quarks, leptons and force carrier particles exist[1] at the boundary between particle and energy. They do not know what these are. But Buddhism knows these as the real rupakhandas, manifested as the four mahabutas and four properties (wunna, ghana, rasa, awja) making up eight-fold cells (atha kalapa), with the characteristics of impermanence (Anicca), stress (Dukkha) and soullessness (Anatta).

Demonstration of the above factors using the ayatanas, sensors and sensing is attempted. The science of the external and internal ayatanas is presented. Sensing in the Buddhist and science views is compared. Parallels and differences are identified; and factors unique to Buddhism are revealed. The general sensing factors are shown in figure 1. The corresponding Buddhist and science concepts are shown in figures 2 and 3. The signal conversion and transmission process according to Buddhist and science concepts are shown in figures 4 and 5.

2. THE SCIENCE OF EXTERNAL AYATANAS (STIMULI)

The two basic factors of relative or panatti truths are particles and waves[2]. Thus physical signals or stimuli (external ayatanas = bahidayatana) may be particles or waves. Light pattern (image), sound vibration pattern, and thought pattern are wave stimuli; and smell pattern, taste pattern, and touch pattern are particle stimuli.

[1]particles smaller than the sub-atomic particles: electron, proton and neutron

[2]Buddhist truth identifies ultimates as Citta, Cetasika, Rupa, and Nibbana

Alternatively, the external ayatanas or signals may be classified as physical (waves - light pattern, sound pattern, thought pattern), chemical (smell pattern, taste pattern) or mechanical (touch pattern).

Note that bahidayatana does not include the source. Consider objects like a flag, a perfume bottle, and a gong. According to Buddhism, the flag is not ayatana, the image (light pattern) is the ayatana, and the ayatana carrier is light. Similarly the perfume bottle is not ayatana, the chemical vapor is ayatana; dispersion is the carrier. The gong is not ayatana, the sound vibration pattern is the ayatana. Sound wave is the carrier.

2.1 **Wave Stimuli**

2.1.1 *Light Pattern - Image*

The image carrier is light - transverse electromagnetic waves. Visible light is a minute part of the electromagnetic spectrum. Objects reflect light forming an "image", which is carried by light to the eyes that contain light sensitive photoreceptors of two kinds: rods and cones.

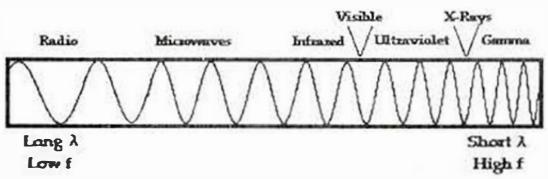

Figure 1: The Electromagnetic Spectrum

2.1.2 *Vibration Patterns*

The carriers are sound waves, which are longitudinal waves.

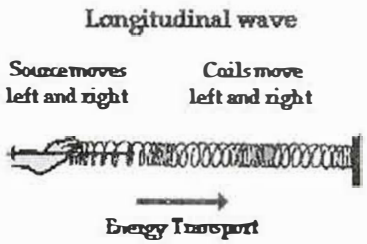

Figure 2: Longitudinal Wave (Sound Wave)

2.1.3 *Thought Pattern*

The carriers are thought waves. Not much real progress is apparent in this area. Mainly spiritual speculations are made. It is interesting to note that Buddhism says thought receptor is a "cave" in the heart (hadaya); whereas science says specific brain areas are the thought receptors. Neuroscientists are finding out that this is not true; brain areas are not that specific.

2.2 **Particle Stimuli**

2.2.1 *Smell Pattern*

The carrier is dispersion. Chemical molecules of scent are transported to the nose, where they interact with the olfactory receptor, located in the olfactory epithelium membrane placed some 7 cm into the nose. The chemicals dissolve in the mucous.

2.2.2 *Taste Pattern*

The carrier is transportation. Chemical molecules of food are transported to the tongue, where they react with taste receptors. The chemicals dissolve in the saliva.

2.2.3 *Touch Pattern*

The carrier is pressure, mechanical pressure against the skin. Meissner corpuscular cells are pressure receptors; and free nerve endings are pain receptors.

3. THE SCIENCE OF INTERNAL AYATANAS (SENSORS)

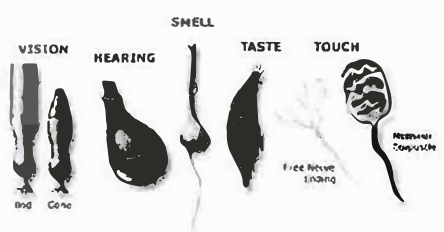

Figure 3: The Five Kinds of Receptors

There are five kinds of receptors associated with the five senses. The external ayatana or signal impacts with the appropriate receptor in the sense organs (eye, ear, nose, tongue, skin). Nerve impulses are produced and are transmitted to the brain, which interprets and send an output for subsequent response.

3.1 **Skin Receptors**: There are four different types of skin receptors:

(1) Glabrous: skin without hair with 1.5 mm epidermal layer and a 3 mm dermis.

(2) Hairy: skin with hair, contains 0.07 mm epidermal layer and a 1-2 mm dermis.

(4) Mucous membrane: lining the inside of body orifices.

(5) Mucocutaneous: at the junction of the mucous membrane, hairy skin, lips, and tongue.

The following are some examples of various skins:

Hair follicle ending - responds to hair displacement - wraps around hair follicle in hairy skin

Ruffini endings - responds to pressure on skin - on dermis of both hairy and glabrous skin

Krause corpuscle - responds to pressure - on lips, tongue, and genitals

Pacinian corpuscle - responds to vibration (150-300 Hz) - deep dermis layers - hairy and glabrous

Meissner corpuscle - responds to vibration (20-40 Hz) - dermis of glabrous skin

Free nerve endings - responds to mechanical, thermal or noxious stimulation - all skin

Merkel cells - responds to pressure on the skin - epidermis of glabrous skin

Nerve fibers can be of two kinds: (1) The "slowly-adapting" nerve fibers, which discharge during the stimulus. They transmit information about ongoing stimulation - eg. Ruffini nerve endings; (2) The "rapidly-adapting" nerve fibers, which discharge at the start or end of a stimulus. They send information related to changing stimuli - eg. Pacinian corpuscle receptor.

It is interesting to note that about 50 million skin cells are lost daily; and the eyelid has the thinnest skin. (Sims, M., *Adam's Navel*, NY, Viking, 2003)

3.2 **The Eye**

The eye is roughly 2.5 cm and weighs 7 g. Light passes through the cornea, pupil, lens, vitreous humor, and finally hit the retina that the photo-sensitive receptors (rods and cones). The receptors generate electrical signals that are transmitted to the brain via the optic nerve. The iris muscle controls the light amount by adjusting the pupil size. The vitreous humor is a clear gel at a constant pressure that maintains eye shape. The cranial nerves control eye movement.

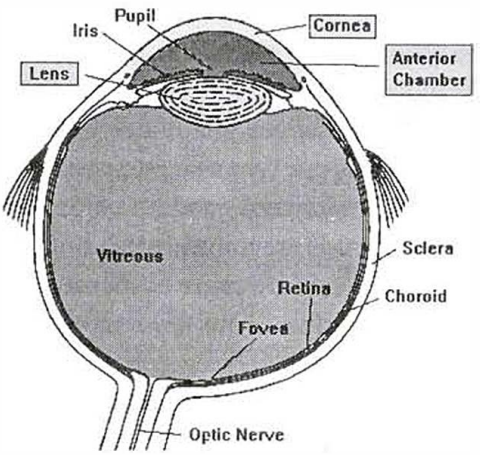

Figure 4: Parts of the Eye

Table 1: Parts of the Eye

Part	Structure / Function
Aqueous Humor	- Clear, watery fluid found in the anterior chamber of the eye.
Choroid	- Layer of blood vessels that nourish the eye; also acts as a light-absorbing layer, because of the high melanocytes content.
Cornea	- Transparent tissue covering the front of the eye. Have nerves but no blood vessels
Iris	- Circular band of muscles that controls pupil size. The pigmentation of the iris gives "color" to the eye.

	Blue eyes have the least amount of pigment; brown eyes have the most.
Lens	- Transparent tissue that refracts light. The lens bends to focus light.
Pupil	- Hole in the center of the eye where light passes through.
Retina	- Tissue layer at the back of the eye - contains light responsive cells (photoreceptors)
Rods	- Photoreceptors responsive in low light conditions
Cones	- Photoreceptors responsive to color and in bright conditions
Sclera	- Protective coating around the posterior five-sixths of the eyeball
Vitreous Humor	- Clear, jelly-like fluid at the back of the eye. Maintains eye shape

3.2.1 *The Retina (Photoreceptor)*

The retina consists of two kinds of photoreceptors: rods and cones. Rods are most sensitive to light and dark changes, shape and movement. They contain only one type of light-sensitive pigment. Hence they are not good for color vision. In a dim room, rods are mainly used, but "color blind" occurs. Rods are more numerous in the periphery of the retina. Thus use ROD VISION to see dim stars.

Cones are not as sensitive to light as the rods. They are most sensitive to one of three different basic colors (green, red or blue). Signals transmitted to the brain are translated for color perception. This works only in bright light. Color is seen in two ways: subtractive - for example, red is seen on subtraction of green (complementary colors); and additive - for example cyan is seen on adding green and blue. Color blindness occurs in 8% male and 0.5% female.

The central region of the retina, called fovea, contains only cones that are packed close together. It provides the clearest vision. Part of the retina does not contain any photoreceptors. It is the area where optic nerves come together and exit the eye on their way to the brain. Any image falling on this region is NOT seen - "blind spot".

3.2.2 *Vision Correction*

Vision becomes distorted when the light does not focus onto the retina. The usual correction is by using lenses, which may be convex or concave, as shown in the following diagrams.

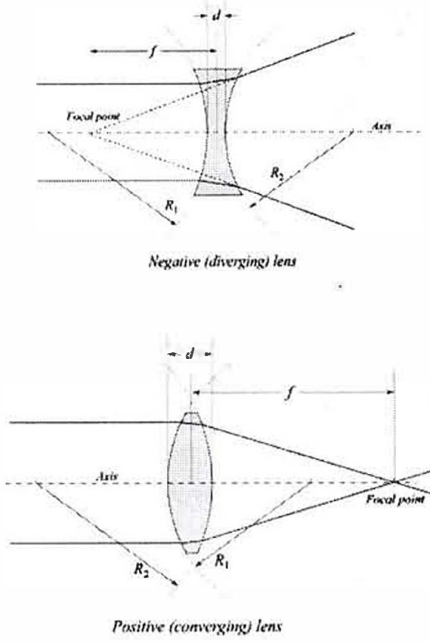

Figure 5: Vision Correction with Lenses

3.3 The Ear

Ear functions include hearing and balance. The eighth cranial nerve (vestibulocochlear nerve = auditory nerve + vestibular nerve) transmits hearing and balance nerve impulses to the brain.

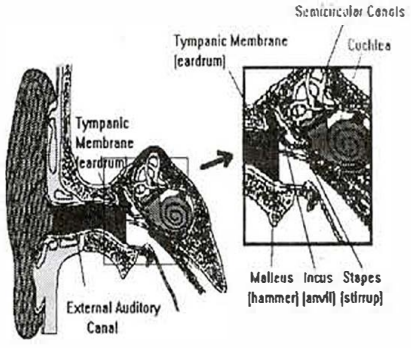

Figure 6: The Ear

Sound waves with frequencies between 20 and 20,000 Hz (the human hearing range) vibrate the tympanic membrane (eardrum) and hearing occurs. The three bones (malleus, incus, stapes) are responsible for balance, they transmit the vibration signals to the cochlea, a snail-shaped, fluid-filled structure in the inner ear (corti is inside the cochlea). Basilar membrane of cochlea contains hair cells - cilia (hair) that contact the tectorial membrane. Excited hair cells vibrate and induce nerve impulses in auditory nerves. The impulses are sent to the brain.

The causes of hearing loss are loud noises, infections, head injuries, brain damage, and genetic disease (common in older people). The three common hearing losses are: Conductive, due to blockage by ear wax, fluid buildup, infection, or abnormal bone growth; Sensorineural due to damaged auditory nerve, caused by head injury, birth defects, blood pressure, or stroke; Presbycusis due to inner ear changes with age.

Loudness, the force of sound waves on the ear, is measured in decibels (dB). Loudness of some common sound sources in dB units are: ticking of a watch 20, whisper 30, normal speech 50-60, car traffic 70, alarm clock 80, lawn mower 95, chain saw 110, jackhammer 120, and jet engine 130.

3.4 **The Nose**

The nose is responsible for olfaction - the detection and perception of chemicals in the air. Chemical molecules enter the nose and dissolve in the mucous of the olfactory epithelium membrane, which is 7 cm into the nose. Hair cell receptors respond to a particular chemical. Small hairs have dendrites called cilia on one side and axon on the other side. Humans have 40 million olfactory receptors.

Electrical activity in the receptors is sent to the olfactory bulb and on to the mitral cells. The signals finally reach the brain areas: olfactory cortex, hippocampus, amygdala, and hypothalamus, etc., which are part of the limbic system that controls emotional behavior and memory. Humans can distinguish between 3,000 and 10,000 different odors.

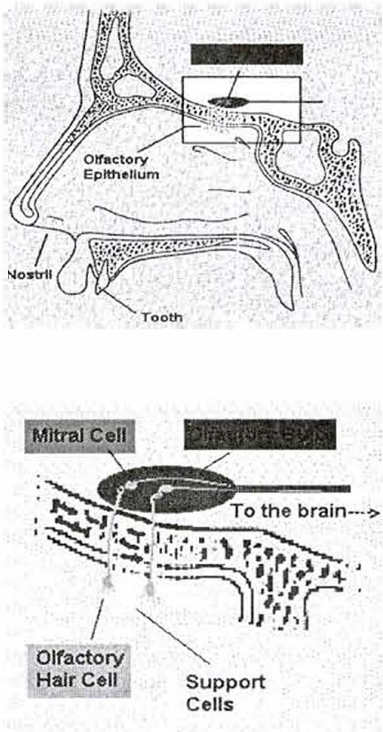

Figure 7: The Nose

3.5 **The Tongue**

Sensing taste is called gestation. Traditionally four basic tastes, sweet, salty, sour, and bitter, are identified. In modern times, a fifth basic taste, umami (MSG taste), is added. Humans have about 10,000 taste buds, each of which has 50-150 receptor cells. The cell life-time is 1-2 weeks. The receptors respond to all tastes, but more to one basic taste. Cranial nerves used for taste are facial nerve (cranial nerve VII) glossopharyngeal nerve (cranial nerve IX) and vagus nerve (X). The signal transmission route is cranial nerve → brain stem (nucleus of the solitary tract) → thalamus → cerebral cortex. Cranial nerve (trigeminal nerve, V) is not used for taste. It is used for touch, pressure, temperature and pain information.

The total disability for taste (ageusia) can be hypogeusia, reduced taste ability or hypergeusia,

enhanced taste ability.

3.6 Receptors

Figure 8 shows a taste receptor cell. Note the five ion channels corresponding to the five basic tastes. The neurotransmitters (chemicals) transmit electrical signals to the brain via a nerve network.

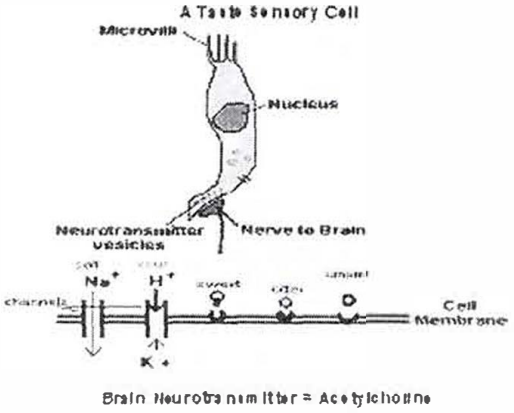

Figure 8: Taste Receptor

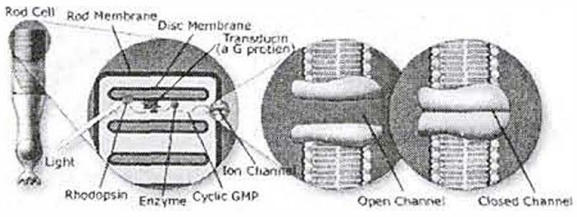

Figure 9: Rod Photoreceptor Cell

The major functions of receptors are detection, transduction, and transmission. Physical, chemical or mechanical signals (external ayatana - eg. image) from the carrier (eg. light) are detected. The signals are converted into electrical signals. This is called transduction.

When ion channel is opened, electric current flows (ON); when ion channel is closed, electric current stops (OFF). This ON/OFF electrical signal code is the Binary Code used in computers. The code is transmitted to the brain, which interprets (understands) these electrical signal codes.

Since there are three types of external ayatana signals (physical, chemical or mechanical) there are three types of transduction: sensory mechanotransduction or mechanosensation alerts the organism to mechanical inputs in the form of touch, pressure, stretch, sound, vibration, and acceleration. Chemitransduction alerts the organism to chemical inputs like smell and taste. And physicotransduction concerns wave inputs like image and sound.

3.7 Observing Human Brains at Work

The following techniques are available for monitoring the brain:

(a) Imaging Techniques - PET (positron emission tomography) - radioisotopes used; fMRI (functional magnetic resonance imaging) - radioisotopes are not needed and is of higher resolution.

(b) Real Time Tracking - MEG (magnetoencephalography) or EEG (electroencephalography) - faster electrical recording techniques.

(c) Next Generation Imaging Technology - functional MRI (fMRI) combined with MEG and EEG

4. THE FIVE SENSING FACTORS (REFER TO FIGURES 10, 11 AND 12)

Consider an artificial sensing machine, the e-nose (electronic nose) that mimics the human nose. Chemical sensors are coupled with artificial intelligence (AI) software like Artificial Neural Nets (ANN). Commercial machines, such as AromaScan, Alpha MOS, FOX 2000, HAZMATCAD, and MOSES (MOdular SEnsor System) are used in food, cosmetics, perfumes, polymers, medical, environmental, chemical & military applications. The general sensing processes of machines, shown in figure 10, can be deduced by examining the e-nose. And the general sensing processes of living beings, shown in figure 10, can be obtained by analogy.

GENERAL SENSING PROCESS

Machines

STIMULI --- INPUT → SENSORS → C → DETECTION → PROCESSING → OUTPUT

PROCESSING = RECORDING + MEMORY SEARCH

Living Beings

STIMULI ---- carrier → SENSORS →C →FEELING → PERCEPTION → RESPONSE

---A---------- ---- B--------C--------D----------E----------F------

Figure 10: General Sensing Factors

The following may be regarded as the five general factors present in all of six sensing activities of seeing, hearing, smelling, tasting, touching, and thinking. The five factors are examined below (Figures 1, 2, 3). Point C where signal conversion occurs is a crucial key and is described separately (Figures 13, 14).

4.1 External Ayatanas - Stimuli (Point A in Figure 1)

4.1.1 *The Buddhist Concept*

External ayatana (Bahidayattana): image or light pattern (rupayatana), sound pattern (saddhayatana), smell pattern (ghandayatana), taste pattern (rasayatana), touch pattern (photabayatana), thought (dhammayatana). They are physical, rupakhanda. A common misconception is inclusion of the source. For example, when sugar particles hit the tongue sweet taste occurs. The external ayatana is the sweet taste not the sugar particles and sweetness - it is just the sweetness. So too in hearing a gong, external ayatana is not the gong and sound, it is just the sound wave pattern. In seeing, external ayatana is just the image not the image and object. In flower odor, it is the smell, not the flower and smell. In hand touch, it is not hand and touch, but just touch only. In thinking, it is just the thought, not thought and associated object.

4.1.2 *The Science Concept*

Generally science considers the source object (by implication) and associated signal as stimuli. The latter may be a wave (physical signal = image, sound) or a particle (chemical signal = taste, smell; mechanical signal = touch). Thought is not considered as a stimulus. Buddhism and science concepts are similar, but science ignores thought waves.

However the distinction between wave and particle is not significant as waves and particles are really the same thing with different emphasis. This is shown by the deBroglie equation $\lambda = h/mv$ where λ = wavelength, a wave property; mv = mass x velocity = momentum, a particle property; h = Planck's constant, a physical constant. The equation describes wave-particle dualism by connecting wave property ? and particle property mv.

4.2 Internal Ayatanas - Sensors (Point B in Figure 10)

Buddhism and science are identical, except science ignores manayatana

4.2.1 *The Buddhist Concept*

Internal ayattana (Aijatayatana): eyes (cakkayatana), ear (sotayatana), nose (gandayatana), tongue (jivayatana), body (kayatana), mind (manayatana). Internal ayatana are physical, rupakhanda.

4.2.2 *The Science Concept*

Identical to Buddhist concept, except that manayatana is usually ignored.

4.3 **Vedana - Feeling (Point D)**

Buddhism and Science - differs in seat of consciousness - hadaya and brain

4.3.1 *The Buddhist Concept*

Vedana or feeling is mental, namakhanda. Location is in the heart - hadaya. Of the three mechanisms (vutta: vipaka, kilesa, kamma) that turn the samsara wheel and create rebirth, it is the vipaka vutta that produces vinanna. Here the samsara turning mechanism is vipaka vutta. The source is past kamma. The driver is the lowest intensity sankhara (also called cetana or kamma).

4.3.2 *The Science Concept*

Feeling or consciousness of sensation is seated in the brain. It is a quality of the mind and the ability to perceive the relationship between oneself and one's environment. It is a popular research topic in philosophy of mind, psychology, neurology and cognitive science. Some philosophers prefer to divide consciousness into phenomenal consciousness (experience itself) and access consciousness (processing of the things in experience). Many cultures and religions say the soul is the seat of consciousness. But many scientists and philosophers consider consciousness as intimately linked to the neural functioning of the brain - it dictates how the world is experienced. Others like John Locke, famous philosopher, says consciousness is not soul or matter (brain), but the basis of personal id. Currently neuroscientists are realizing that consciousness is a brain activity and not a separate entity, not a soul!

4.4 **Perception (Point E): Buddhism and science concepts are different**

4.4.1 *The Buddhist Concept*

Sanna, sankhara and vinanna identifies sources as external ayatanas and wrongly label them as mine, me, I, he, she, they, us, etc. They are namakhanda. Here the samsara turning mechanism is kilesa vutta. The source is mano vinanna, which creates this illusion of ego, driven by mid-intensity sankhara, called ahbisankhara.

4.2.2 *The Science Concept*

Perception is the process of acquiring, interpreting, selecting, and organizing sensory information. Study methods range from essentially biological or physiological approaches, through psychological approaches to the often abstract thought (Gendakin) experiments of mental philosophy.

4.5 **Response (Point F)**

Buddhism and science concepts have different emphasis - cause/effect versus mechanism.

4.5.1 *The Buddhist Concept*

Three kinds of vedana (sukha - like, dukkha - dislike, uppekha - neutral) compounded with sanna, sankhara and vinanna, causes tanha (attachment), upadana (clinging or intense attachment) and finally KAMMA: actions that can be mental, verbal, or physical.

Kamma actions are based on greed (loba), anger (dosa) and delusion (moha). Good (kusala), bad (akusala) and neutral (abyakata) kammas are partly namakhanda (mental actions - loba, dosa, moha) and partly rupakhanda (verbal actions and physical actions). Here the samsara turning mechanism is kamma vutta. The source is manovinnana. The driver is the highest intensity sankhara, called kammasankhara. A summary of the above facts is shown in figure 11 and 12.

4.5.2 *The Science Concept*

Physiology is able to describe how responses occur. Various brain areas are responsible for different emotions and actions. For example the frontal lobe concerns emotions; the occipital lobe concerns vision; frontal lobe concerns reasoning, planning, parts of speech and movement (motor cortex), emotions, and problem-solving; parietal lobe concerns stimuli perception related to touch, pressure, temperature and pain;

Temporal lobe concerns perception and recognition of auditory stimuli (hearing) and memory (hippocampus).

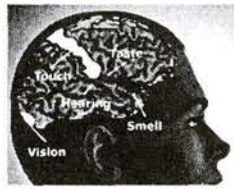

Figure: Brain Functions

Summary of The Buddhist Concept

STIMULI --- carrier → SENSORS → C → FEELING → PERCEPTION → RESPONSE

←A --------Rupakhanda---B--------→ C← --------D----Namakhanda-----E----------F-----→

Name: Bahidayatana	Aijatayatana	Vedana	Sanna#	Kamma
Machinery.....		Vipaka wutta	Kilesa wutta	Kamma wutta
Domain		Past kamma	Manovinanna	Manovinanna
Driver		Sankhara	Ahbisankhara	kammasankhara

C = Pasadas: Rupakhanda → Namakhanda
#(Sanna + Sankhara + Vinanna)
NO SEPARATE ENTITY PERFORMING SENSING = ANATTA

Figure 11: Buddhist Concept of Sensing

Summary of The Science Concept

STIMULI --- carrier → SENSORS → C → FEELING → PERCEPTION → RESPONSE

←A----------B-------- →C← ----------D----------E----------F→

Source + signal sensors in brain process info. brain control
phenoml., access

C = Transducers: Phy/Chem/Mech Signal (wave, ptl) → Elect Signal (wave)

Figure 12: Science Concept of Sensing

4.6 POINT C

6.1 *The Buddhist Concept*

In figure 2 it is seen that the section from A to point C is the rupakhanda part and the section from point C to F is the namakhanda part. They overlap at point C and this is where the rupakhanda is converted into namakhanda (Figure 13).

External → PASADAS → *Internal* → HADAYA → 3-step handling → RAW → D, E, F
Ayattanas (Convert khanda) *Ayattana* Sanpadesana OUTPUT
→ Rupakhanda → Namakhanda → Santiyattana
C Vuthtapana

Figure 13: Signal Conversion and Transmission - Buddhist Concept

For example in seeing, this is where rupayatana (rupakhanda) forwards data to cakkayatana (namakhanda); or in hearing this is where saddhayatana (rupakhanda) forwards data to sotayatana (namakhanda); etc. The mechanism of this conversion of rupakhanda into namakhanda is detailed in the pitakas and described below.

How does rupakhanda to namakhanda conversion occur? Consider seeing. The external ayatana, rupayatana (image - rupakhanda) is carried by a carrier (light) and hits the cakkupasada (light sensor/converter). The cakkupasada converts the impact signal into an appropriate form, which is a namakhanda. The converted signal is then passed on to the internal ayatana, cakkayatana.

Similarly in hearing, saddhayatana (sound - rupakhanda) is carried by a carrier (air) and hits the sotapasada (sound sensor/converter), which converts the impact signal into an appropriate form (namakhanda) and sends it to the internal ayatana, sotayatana.

At the signal conversion by the pasadas (cakkupasada, sotapasada, etc.) the following occurs:

Sanpadesana: signal receiving - reception of the impact signal

Santiyatana: signal processing

Vuthtapana: signal setting

The set data is passed to the appropriate center or manodwara (mind door - visual for seeing; audio for hearing, etc.). This is the domain of dhammayatana, which is responsible for signal transmission.

Repetitions, called javana occur seven times with increased intensity each time. Then recording (memory) of the sensation (seeing, hearing, etc.) occurs two times, if the result of the above repetitions is sufficiently intense. This sequence of (set data - repetitions - recording) is repeated numerous times. Only then consciousness becomes apparent - manovinanna. This is followed by the perception step. These two (consciousness and perception) are the domains of manayatana. Then the response step follows. Note that there is no separate entity performing the sensing steps. Hence anatta has been demonstrated.

The Science Concept

Point C is where external signals that impact on the sensors, composed of transducers (signal converters), are converted into electrical signals. The electrical signals travel to the appropriate area of the brain via neural networks. Data reception, processing and setting occurs. The final raw output is forwarded to the appropriate screen, and finally interpreted as man, woman, object, good, bad, like, dislike (Figure 14).

External → TRANSDUCERS → *Internal* → BRAIN → 3-step handling → RAW → D, E, F
Signals (Convert Signals) *Signals* specific Data Receiving OUTPUT
(wave/particle) (electrical) areas Data Processing
C Data Setting

Figure 14: Signal Conversion and Transmission - Science Concept

Consider seeing. The light wave (transverse wave) carries the image associated with a source object to the eye where it passes through the pupil, lens, cornea, iris, vitreous humour, etc. and hits the retina. The retina is a transducer (signal converter) that employs the photoelectric effect - it converts the light into an electrical pulse. Chemical changes occur in the photocells of the retina, and the chemicals produced trigger electrical pulses. The pulses travel along the neural network of optical nerves to the occipital lobe of the brain. The brain then interprets the signal via three data handling steps: data recording, data processing and data setting, resulting in the final output: sensation of seeing.

In hearing, air carries the sound wave (longitudinal wave) associated with a source object to the ear where it hits the ear drum and cochlea producing vibrations that are eventually converted by transducers into electrical signals. The signals travel via neural network to the audio lobe of the brain, which interprets them again via three data handling steps: data recording, data processing and data setting, resulting in the final output: sensation of hearing.

Thus signals caused by impact of sensors and stimuli (waves - light, sound; or particles - taste, touch, smell) are all converted into a single signal type - electrical signals - that travel along neural networks to the brain where data handling occurs via three steps: data recording, data processing and data setting, resulting in the final raw output that is interpreted by the brain, which consequently produce a response.

Brain neural functioning dictates how the world is experienced. Hard to believe? Consider an upright arrow, as shown in figure it appears as an inverted image on the retina, but the brain inverts it and sees an upright arrow.

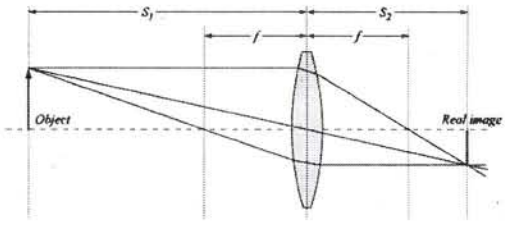

Figure: Image Formation

5. OBSERVATION

It may be observed that stimuli are the external ayattana (Bahidayattana) of Buddhism, which science identifies as source object plus associated signal. The internal ayattana (Aijatayattana) and science sensors are superficially identical, with manayatana being ignored. Awareness or vinanna is located in the heart - hadaya, science contends it is located in the brain. Manovinanna, in the Kamma vutta domain driven by the highest intensity sankhara, kammasankhara initiates the response; science identifies various parts of the brain that are responsible for different emotions and actions.

The pasadas (cakkupasada, sotapasada, etc.) are responsible for converting external signal data into internal signal data; science identifies specific transducers (photoelectric transducer for seeing; acoustic transducer for hearing; etc.). Buddhism is not especially concerned with the signal data, but science pinpoints these. The external signal data may be waves (light, sound) or particles (taste, touch, smell). The transducers (pasadas) all convert them into a single internal signal data type: electrical pulses composed of electrons. These pulses form an electrical code akin to the binary code used in computers.

The electrons are relayed from the transducers (pasadas) via neural networks to the specific area of the brain. Thus some contend that internal ayatanas are not just the eyes, ear, nose, tongue, body, thought, but these plus the associated neural networks plus the associated brain areas are

the internal ayatanas. According to this concept, for seeing, the eye, lens, iris, optical neural nets and the occipital lobe constitute the internal ayatana.

The subsequent three step data handling: data recording, data processing and data setting, and the final raw output is the domain of dhammayattana. In seeing, the raw output is the raw image. The interpretation of the raw output is the domain of manayattana. They result in emotions, recognition as man, woman, friend, foe, like, dislike.

6. CONCLUSION

Scientific "discovery" in relatively recent times support what had been found by Buddha ages ago, amazingly enough, by relying solely on his intellect, without the help of any modern day gadgetry like sophisticated instruments or super computers such as the TeraFlop IBM BlueGene - some factors are in agreement between Buddhism and science.

However, because Buddhism recognizes the importance of mind and subscribes to anatta or soullessness, some factors are different and some are even unique to Buddhism.

The five sense-data limitation in science sees living things as tangibles that exist in space-time continuum. This is relative reality at this coarse consciousness level.

Manovinanna is not limited by time or space, it transcends the five sense-data limitation of science and knows living beings are composed of rupa and nama (citta + cetasika) and recognizes the law governing the components as Anicca (impermanent), Dukkha (stressful), and Anatta (soulless). It is ultimate reality at this lower transcendental consciousness level. It is the domain of vipassana samaditthi.

Manovinanna can go one step further, additional transcending. It gets outside the realm of subject /object (cause/effect) - asankata is reached - emptiness of components is experienced. This emptiness is the timeless-spaceless function called NIBBANA. It is ultimate reality at this upper transcendental consciousness level. It is the domain of Magga Samaditthi and Phala Samaditthi. Transcendental progress is vipassana (insight) development.

Hence Buddhism transcends sense-data limitations and surpasses science.

Acknowledgement

The author is indebted to Maha Chulalongkornrajavidyalaya Buddhist University (MCU) for giving the opportunity to teach Buddhism and Science, as part of the IMAP (International Master of Arts Program), from which this manuscript evolved.

REFERENCES

(# in Myanmar language; the rest in English)

http://faculty.washington.edu/chudler/introb.html#se

http://www.hhmi.org/senses/a110.html

Ashin Gawthiga (2005), One Sassana, *One Life - Mogok Sayadaw Biography*, Mogok Vipassana Dhamma Series and Activity Propagation Unit, 82 Natmauk Rd., Bahan, Yangon, Myanmar. #

Ashin Cekinda (2004-06), *Talks* given at various retreats - tapes & CDs. CekindaRama Monastery, Yangon. #

David Tin Win (2005), *Life, Death & Deliverance-a Scientist's Novel View*. Talk at MCU, Bangkok, 27 August 2005.

David Tin Win, *Life, Death and Deliverance - a Chemist's Novel View*, ABAC Journal, 26 (1), p 49-58.

Egerton C. Baptist (1999), *The Supreme Science of The Buddha*, Myanmar Translation by Dr. Mehm Tin Mon, Myat-Mon-Sarpay,

Yangon, Myanmar. #

Ledi Sayadaw (1965), *The Manuals of Buddhism*, Yangon, Myanmar.

Luangpor Teean (2005), *To One that Feels*, Luangpor Teean Foundation, 52 Moo 5 Tumbol, Taveewattana, Bangkok 10170, 3rd. Ed. Free Distribution.

Mogkok Sayadaw (1958-62), *Sermons* on CDs, Mogkok Vipassana Headquarters, Yangon, Myanmar. #

Taungpulu KapiyaKaraka (1995), *Taungpulu Sayadaw Biography* 3B Khemar Rd., Yangon. #

U Htay Aung (2002), Interpretation of Ledi Sayadaw's Mahasaranagamana, Talk at Samanera Beikhman.

Ven. Dr. K. Sri Dhammananda, *Religion in a Scientific Age*, Buddhism and Science, Selected Articles from Buddhist Digest English Series, Young Buddhist Association of Malaysia. Distributed by Phillipines Phushian Temple, 25 Beverly Hills, Lahug, Cebu City. Free Distribution.

W. F. Jayasuriya, *The Body-Mind Mechanism in Buddhism*, Buddhism and Science, Selected Articles from Buddhist Digest English Series, Young Buddhist Association of Malaysia. Distributed by Phillipines Phushian Temple, 25 Beverly Hills, Lahug, Cebu City. Free Distribution.