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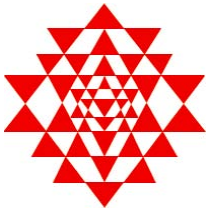
Sound Vision

PATTERNS OF VIBRATION IN SOUND, SYMBOLS AND THE BODY

A Thesis
Submitted in partial fulfilment of the
Master of Design

RACHAEL LINTON



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ABSTRACT

Historical and contemporary views such as those held within Buddhist and Hindu religion support the idea that sound, colour and form in motion have the ability to alter physiological and psychological aspects of human function. Within these, religions, distinctive singing and meditation techniques can be used to aid concentration, calm and balance the mind, and soothe the body. A meditative technique adopted by Hindu and Buddhist practitioners is to draw the mind into a centred point of focus, blocking out external distractions that inhibit concentration. The sound based meditation *Om*, for example, is a most powerful *mantra*, capable of healing and elevating consciousness (Beck, 1995). Vocal sounding and chant as well as gazing at or visualising images are techniques that have been utilised in ancient religious practice to aid people to develop their natural capabilities to shift energy within body and mind.

Contemporary neuroscientists are interested in the states of mind that Buddhist monks claim to enter into while sounding. Equipped with technology for analysing brainwave activity, experiments have revealed that electromagnetic stimuli such as sound, light and colour can have physical affect upon the practitioner's brain. Researchers have developed new therapeutic tools and techniques to benefit the health and well-being of individuals from these findings.

This thesis traces the therapeutic use of sound, light, colour and form in motion from ancient Hindu and Buddhist religion into its use in complementary therapy. *Sound Vision* is the name of the film which fulfils the practical component of this research. Inspired by the visual form and motion of sound, this thesis contemplates: if we could see sound, what would it look like and could those images function as a healing art form? *Sound Vision* translates ancient and contemporary techniques of therapy into a digital audio/visual medium to function as visual therapy and aid for meditation.

The themes of this research are foremost to visualise sound and secondly to deduce aspects of sound and vision that have therapeutic qualities. Chapter Three of this thesis thematically outlines qualities of sound that have been found to be capable of exciting or calming its listener. The same process has been applied for vision, specifically how light and colour affect the viewer as well as for form in motion.

An interim presentation of the preliminary film, *Dance of Light*, was exhibited in November 2008 and here formative feedback was gained through unobtrusive observation and discussions with viewers toward the development of Sound Vision. Aspects of the film were found to provoke feelings of unease and tension while other aspects incited focus and calm.

Sound Vision, serves as a prototype apply healing using light therapy to create positive physical and psychological outcomes. From the research presented within this thesis, *Sound Vision* employs various digital methods and techniques which are recognised with ability towards healing. Explorations to further this thesis' research may include Neurological brainwave analysis and patient testing to determine which kinds of video footage produce particular desirable results.

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CHAPTER ONE

1.1 INTRODUCTION

1.1.1 VIBRATIONAL THERAPIES

Vibrational therapy is becoming an increasingly popular choice in contemporary medicine for patients suffering from psychological and neurological disorders such as attention deficit hyperactivity disorder (ADHD), addictions, anxiety, dementia, migraines, pain, premenstrual syndrome (PMS), post traumatic stress disorder, stroke complications and more (Pigott, 2006). Neurological studies carried out by Christopher Barber (1999), Brian Brady (1997), Len Oschs (1994) and others, support research developing the concept that electromagnetic vibrations of sound and light create positive healing changes in humans.

As early as 1900, experimental psychologist Pierre Janet discovered that strobe light could be soothing to patients (Pigott, 2006). In 1959 this work was reinforced by Gysin who created a device wherein light and colour was organised in specific moving patterns to stimulate or soothe human response systems. Similarly, flashing light has been found to entrain brainwaves (Anderson, 1989). Entrain means synchronization, when a periodic frequency stimulus such as aural, as in the case of binaural beats or else visual, as with a Dreamachine or electromagnetic radiation and aims to cause brainwave frequencies to fall into step with the exciting stimulus, having a frequency corresponding to the intended Delta, Theta, Alpha or Beta brainwave state. Brainwave entrainment depends upon a frequency-following response, where the human brain has a natural tendency to change its dominant EEG frequency to correspond with the frequency of a dominant external stimulus. Entrainment refers to brainwave entrainment or brainwave. Robert Monroe developed the concept of entrainment in 1975 when he used pulsating rhythmic sounds, otherwise known as binaural beating, to entrain brainwaves for healing. EEG neurointegration is a contemporary system that combines light stimulation and binaural beat techniques into a therapeutic tool. Although neurointegration has been found to be capable of a variety of therapeutic effects it may not particularly desirable because of its mechanical and computer generated nature.

1.1.2 THE 'FORM' OF SOUND

Since ancient times philosophers, mystics, scientists and artists have attempted to provide illustrative interpretations of how they envision sound, some also extend on how certain images hold potential for healing experiences to the viewing practitioner. Speculation that sounds are waves, propagated in air was first raised by Aristotle (384–322 BC) in the 4th century BC as he observed the motion of waves in water (Caleon, Subramaniam, 2007, p. 174). Artworks by Pythagoras', such as his linear geometry (James, 1993), Kandinsky's abstract symbols (Leggio, 2002) and Hans Jenny's sonorous photographs (Jenny, 2001) each adopt different methods to visually interpret sound, a phenomena which cannot physically be seen. Interestingly, there are structural and aesthetic similarities within their artworks, especially geometric circles, squares and triangular shapes.

Pythagoras, who is credited with having laid down the fundamental principles of the nature of sound, conducted many scientific investigations with various vibrating objects. He described sound using mathematical ratio and was the first to scientifically calculate the generation of sound by vibrating force (Caleon, Subramaniam, 2007, p. 174). Aristotle and Pythagoras (c.580–c.500 BC) emphasised that the generation of sound was produced when the air is set in motion by, for example, a vibrating string (Caleon, Subramaniam, 2007, p. 174). *Figure 1* shows the Pythagorean view of the universe illustrated visually using lines depicting the harmonic distribution of musical intervals.

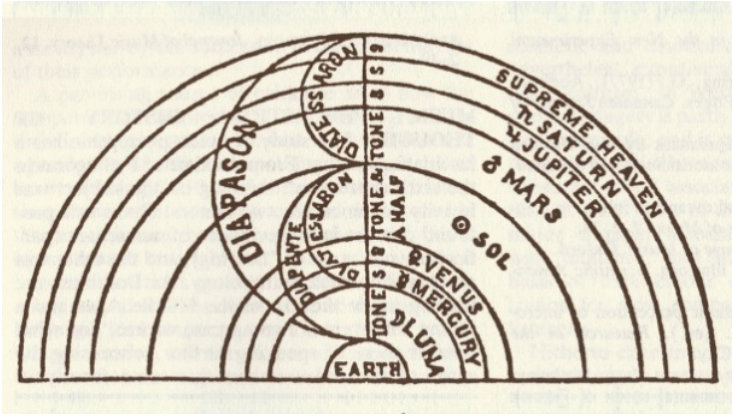


Figure 1. Pythagorean view of the universe in musical intervals.

On July 8, 1680, Robert Hooke (1635–1703), an English natural philosopher and polymath 'broke the visible sound barrier' (Volk, 2008) when he spread flour on a glass plate and then vibrated it by passing a violin bow along its edge. As he did so Hooke noticed the flour configured itself into oval shapes and reoriented itself on the surface. As he bowed the plate in different ways the configurations of flour would change. Ernst Chladni and Margaret Watts Hughes continued similar experiments, forming visual patterns based upon Hooke's methods and in the 1950s cymatics emerged as a distinct discipline. Hans Jenny coined the term 'cymatics' (*kymatics* in German) from the Greek word 'kyma' (pertaining to waves), when he published *Cymatics: The Study of Wave Phenomena* in 1967.

John Stuart Reid, currently a leader in the field of cymatics, continues to develop the ideas of early researchers, investigating the vibrating patterns which form in water. Reids research is particularly interested in how cymatics may be healing, a concept which was first presented by Jenny. Reid is an English acoustics engineer, scientist and inventor whose 30 years of research into sound led him to invent the CymaScope, a 21st century tool that transforms sound into visible geometric pattern. This tool is creating breakthroughs in acoustic science, sonar, linguistics and speech therapy. Deaf people, for example, can be taught how to create words using the cymascope as they watch patterns form as they create sounds into the machine. The more structural the visual shape, the user will learn how correspond shape to sound with perfect resonant vibration. Reid says, that sound resembles resonating bubbles of spherically shaped holographic-like energy, that perpetuates away from its point of creation, expanding in size and lessening in intensity as it reaches further from its epicentre (Reid, 2007). Contained within the sound bubble a lattice framework of geometric shapes writhe in motion and contain data describing the sound such as tone, frequency, pitch, timbre, resonance and volume.

1.1.3 INSPIRATION FOR THE THESIS

The inspiration for this thesis came as one day I played a flamenco guitar and I saw, within the vibration of a silver string, brilliant red and green colour. Green fluctuated from top to bottom while red oscillated in complementary motion to the green from bottom to top. The colours moved distinctly, passing through each other in an oscillatory motion, to create a third, interference pattern. When I subsequently studied papers on the interaction of light frequencies I formed a hypothesis that the phantom colour may have been caused as the vibrating string reflected and diffracted light from the fluorescent lights I was sitting beneath while playing.

As I researched the effects created by interacting vibrational frequencies in sound and light, it was Goethe's concept (1810) that I became most interested in. Goethes philosophy on human visual perception is that neither sound nor light is perceptible to the human without the human consciousness to perceive it. Human psychology and perception; consciousness alongside brainwave activity; and the body, soon became clear components of this thesis. By reading the work of Deak (1990), Campbell (1995), Demarco and Clarke (2001), Barber (1999), Anderson (1989), Khalsa (2001), Hollwich (1979), Pigott (2006) and Oschs (1994) I became interested in their philosophies; how rhythm, repetition, harmony and rates of vibration interact with brainwave activity. This led me to my key Question: Could the visual form of sound be therapeutic?

My hypothesis then developed upon the research of other artists and neuroscientists whose motivation was to implement sound, light and colour to benefit human health and wellbeing. The innate powers of sound as a healer have been studied for this thesis with special regard to the human voice; with the thought that reader, might practice the techniques for their own healing. Deak (1990), Holroyd (2003) and Ricard (2004) offer their expertise in song, hypnosis and mediation respectively making worthy contributions about how the voice can focus attention on positive healing outcomes. Their essays highlight how psychological and physical changes can be incurred through various methods of self exploration. Margaret Deak, for example, suggests that 'the voice alone may be able to function as the body's own internal tuning mechanism' (Deak 1990).

1.2 CENTRAL PROPOSITION

Frequencies of sound, light, colour and form in motion can be utilised to interact with human biological frequencies. In response to sense stimulus such as sound and coloured light, the human body may respond both physically and psychologically to facilitate changes towards better health and well being. An audio visual experience can be created for the viewer by utilising sound and visual techniques that have been used successfully withinn ancient healing traditions as well as contemporary therapy, to heal.

1.3 RESEARCH AIMS AND QUESTIONS

What does sound look like?
Could the visual form of sound be therapeutic?

The primary research aim is to determine if sound, colour, form and motion could have therapeutic effects such as pain relief, calming and focusing.

1.3.1 WHAT DOES SOUND LOOK LIKE?

Historical research has been employed to explore ancient visual images that convey sound, energetic vibration and wave motion. Ritual symbols such as the Sri Yantra for example, used for meditation in Hindu religion, have remarkable resemblance to current visualizations of sound. A Yantra is a tantric symbol associated with mantras, rituals and meditation techniques. It is a power diagram which holds multiple layers of metaphysical meaning and is similar in form and composition to the Buddhist Mandala.

The philosophers Plato, Aristotle, Pythagoras, Newton and Goethe were interested in sound and developed the theoretical foundations on which contemporary philosophers continue to develop (Boyce-Tillman, 2000, Campbell, 2000, Volk, 2008). Cymatics is the study of wave phenomena and is a popular new and advancing field of scientific research which expresses sound as a phenomenon with a direct visual counterpart. Cymatics shows forms in motion, created by sound which vibrates matter such as water and sand into geometric

formations. Newton and Goethe proposed that sound also had direct correlations with the colour properties of light. The early philosophers drew relationships between sound and colour because frequencies exist on the same electromagnetic scale. The human ear can sense sounds between 20–20,000 Hertz (Hz) and therefore occupies that section of the electromagnetic spectrum. Colour or visible light is the section of the electromagnetic spectrum to which the eye is sensitive, which is between 400 to 700 nanometre (nm).

Instead of calculating the harmonic intervals mathematically to transpose sound into colour vibration, I have taken a Goethean perspective which considers that it is via human sense that we perceive sound and colour.
By determining the emotion and psychological response that sound and colour distinctly incite, parallels between them have been drawn. For example:
What sounds facilitate calm and soothing effects?
What colours facilitate calm and soothing effects?

The Background research – Chapter 2.1 on *Sound* – outlines the aspects of sound noted to induce emotion/psychological responses from ancient to contemporary.

On the electromagnetic scale, brainwaves are situated in what is called extremely low frequencies (ELF), between 3–40 Hz. Brainwaves are electrical wave patterns set up by neurochemical activity within the living brain (Brady, 1997). Brainwaves inside the brain physically influence neurochemicals to cause emotional and psychological responses.

Vibrational therapy is a field of medicine that utilises electromagnetic waveforms such as sound and light to alter biological waveforms such as brainwaves and cellular function. These therapies have been carried out by Oschs (1994), Barber (1999), Monroe (Lewis, Osborn, Ram Roth, 2004) and Pigott (2006).

1.3.3 AUDITORY AND VISUAL TECHNIQUES TOWARDS FOCUS, CALM AND BALANCE

Chapter 3.3 is a detailed description of films created with the intention of being harmonious.
How the invigorating or harmonious aspects outlined in Chapter Two, have been applied to film is described in Chapter Three. The film, *Dance of Light,* shows a series of films which apply properties of sound, light and colour to digital video. The techniques employed aim to create emotional/psychological response within the viewer.

An understanding of the aural and optic senses was gained so that aspects of sound, light, colour and form in motion could be applied with the intention of eliciting emotional/psychological response.

Fulfillment of these research aims has enabled me to create visual melody, rhythmic pattern and harmony, using sound, light, colour and form in motion in film that be useful to induce therapeutic effects.

CHAPTER TWO

2. BACKGROUND RESEARCH

I divide this section into 3 sections and a subsequent case study. Section one (2.1) concerns the first aspect of sound–the audio aspect–and its connection with the body through rhythmic productions. Section two (2.2) examines research into Goethe, Pancoast, Kandinsky and Itten's colour theories. Emotional, psychological and therapeutic aspects of light and vision, and the contemporary use of colour in contemporary vibrational medicine are outlined. Section three (2.3) extend concepts mentioned earlier (Hindu, Buddhist, etc) to define a therapeutic image by connecting to natural forms of motion, hence its title: Visual: Form, Motion and the Body.

2.1 AUDIO – SOUND

> 'From the first spark of life, Prana (life air) sparks with the Agni (fire) in the body of the singer to create audible sound' (Beck, 1995, p. 39).

In many mythological creation stories, existence came into being through sound. In Sanskrit, Nada Brahman translates as the world is sound, God is sound or sound is divine, and that sound which was responsible for all creation was *Om*.

Hindu and Buddhist practitioners are well aware of the sonic effects of vibration for the purpose of healing. A Mantra is a word or series of sounds chanted or sung repetitively as an incantation or prayer and are commonly used in Hindu and Buddhist ritual meditation. Chanting, overtone singing, Gregorian chant and Tuvan throat singing are all techniques recognised to assist the practitioner to block out external distractions in order to maintain focus. Human vocal sounds in particular entice the observer to relax. 'Delving deep into their consciousness to focus on the self' was a concept the Brahmanas (Vedic priests and seers) taught their devotees, 'to orient their senses of perception towards the inner acoustic space of the unseen' (Beck, 1995 p. 23). The sound *Om* otherwise known as *Prava* signifies liberation and is the most prevalent vocalic symbol of sacred sound throughout the entire Vedic, yoga and Hindu traditions. *Om* has been the

cynosure of religious chant up to the present day (Beck, p. 9). Meditation and chanting, like light and colour, are all methods still used in complementary medicine to create emotional, neurological and physical changes. 'External stimuli, like sound, light and colour can interfere with and/or cancel out other incoming sense stimulus and can clear thought activity' (Ellingson, 1979, p. 149). 'Sounds can also modulate simultaneous changes in the autonomic, immune, endocrine, and neuropeptide systems' (Campbell, 2000, p. 148). Buddhist adepts of sound chant *Om*, a syllable they consider to be sacred for its ability to draw the practitioner into a meditative state, bringing focus and concentration. As a chant, the sound *Om* is voiced in three parts, A, U, M and intends to lead the adept towards their highest faculty of consciousness. 'A' stands for the waking state of consciousness, 'U' for the dream state of consciousness and 'M' for the deep sleep phase of consciousness.

Elocution and phonetic treatment are regarded to be important factors when attempting to achieve desired brain-mind outcomes. Kay Gardner (1941–2002), was a musician, composer, author, and musical producer involved in creating music for healing purposes. Gardner identified drone, repetition, harmonics, harmony, vibration, vibrato, melody, resonance, rhythm and beat as musical elements which can psychologically impact on humans (Gardner 1990, pp. 227–229 cited by Bergquist, 1997). Some sounds can be produced in a resonant and nasal manner while others are full and resonant. Mantra yoga is an art of chanting in which precise mouth postures (formants) and repetition of exact intervals are adopted. The sound, if created with clear intent and execution can elevate the perceptual sensitivity of the performer, transforming their sensibility, way of thinking, state of soul and moral character. 'All vowels should be pronounced strong and sonant and with the thought affirmation of intent' (Beck, 1995, p. 27). If the phoneme is properly constructed with the mouth, a plethora of harmonics can be created, which vibrate within the practitioner; a sensation beyond standard experience.

> The *mantric* energy condensed in the Sanskrit *chakra* letters is seen as vested with a spiritual power beyond human comprehension. Pronounced correctly, joined and with the correct rhythm, accent, intonation and mental attitude a mantra becomes the soul of the Yantra, utilising forces within the mind of the seeker (Khanna, 1979).

Figure 2. Om symbol.

As a visual symbol, *Om* often appears on Yantra and Mandala to instruct the practitioner to tone the sound *Om*. *Figure 2* shows the symbol *Om*, of which the different parts of the form signify different metaphorical concepts. The *Bindu* or dot at the top is the origin point and means silence and focus, it is a diacritic sign which instructs that the previous vowel should sound nasalised. In meditation the practitioner is guided towards positing their psychological awareness upon centres in their body, namely the *chakras*, whilst repeating the sound. *Chakra* translates as wheel or circle and in traditional Hindu and Buddhist healing therapies these are the main healing energy centres. Today complementary therapies such as acupuncture, Shiatsu (pressure point acupuncture) and colour puncture (a kind of acupuncture that uses coloured lights), follow the *chakra* energy system. The placement of the *chakras* corresponds to harmonic divisions within the human body and the symbols which represent those centres are shapes like *Yantras*, *Mandalas* and cymatics. The common denominator between these three visual themes is harmonic distribution, which occurs naturally in vibration.

HARMONIC OVERTONES/ TUVAN, BUDDHIST

The technique of Tuvan throat singing aims to use deep and controlled resonation of the throat, glottis, mouth and lips to produce harmonic overtones. These overtones vibrate the skull in ways that normal singing doesn't, reaching deeper into the brain. Research into vibrational therapy by Schelde confirms that overtone singing affects the cranium and the entire brain, balancing the left and right hemispheres, influencing the respiratory system, the spinal fluid and Kundalini energy (Schelde, 2006. p. 88). Overtone harmonics are also produced during the sound meditation of Buddhist practitioners who chant *Om*.

BENEDICTINE TO TOMATIS

Wilson states that 'Benedictine monks chant from six to eight hours a day, in order to 'charge' themselves' (Wilson cited in Campbell, 1991, p. 13). Recognised for his experimental breakthroughs in the field of auditory neuropsychology, it was the French physician Alfred Tomatis (1991) who stated these 'Sounds can charge the central nervous system and the cerebral cortex with energy', just like charging up a battery with energy (Tomatis, quoted in Boyce-Tillman, 2000, p. 194). This re-charging especially 'effects the neocortex which
is involved in our higher functions such as sensory perception, generation of motor commands, spatial reasoning, conscious thought and, in humans, language' (Tomatis cited in Campbell, 2000, p. 17).

Tomatic saw the sounds of Gregorian chant to be uniquely, a fantastic energy food' (Gilmor, Madaule, and Thompson, 1989), for this reason he made the link between auditory and visual cognition. When he noticed
a similarity of symptoms exhibited by hearing impaired factory workers and the scotomas (spots before their eyes) suffered by opera singers, Tomatis formulated the law describing the feedback loop between the larynx and the ear where 'one can produce vocally only those sounds the human ear is capable of detecting' (Weeks cited in Campbell, 1991, p. 42). This discovery became recognised as the Tomatis Effect. Gregorian chant for example contains all the frequencies of the voice spectrum from 70 cycles per second up to 9,000 cycles per second (Tomatis cited in Campbell, 2000, p. 18).

GREGORIAN CHANT OR PLAINCHANT

Campbell stated that in Gregorian chant or plainchant there is no tempo, there is only rhythm.
'If one listens carefully to Gregorian chant they will notice that it follows the beat of a calm heart, the rhythm of a tranquil heartbeat, systole and diastole' (Campbell, 2000, pp. 19–21). The sound created follows the

relaxed and natural rhythms of the singer's body who takes long slow deep breaths in to sound long, slow, powerful notes out.

> If you look closely at the Gregorian inflection, if you take Alleluia for example, you have the impression that the subject never breathes. This slowest possible breathing is a sort of respiratory yoga, which means that the subject must be in a state of absolute tranquillity in order to be able to do it. And by inducing the listener to enter into the same deep breathing, you lead him little by little to something of the same tranquillity (Tomatis cited in Campbell, 2000, p. 19).

Deak suggests that 'the voice alone may be able to function as the body's own internal tuning mechanism' (Deak, 1990). Deak offers techniques that can be used to overcome emotional depression through sound intonation. She cites that in the role of health maintenance, vocal expression can increase vigour and reduce stress by lowering blood pressure.

2.1.2 *OM* NEUROSCIENCE?

In the last ten to twenty years interest in the field of energy medicine has blossomed as doctors of medicine, neuroscientists and quantum physicists have teamed up with Buddhist meditators and other singers to measure how their brains change when they sing 'sounds'. Frequencies of colour vibration and its affect upon the 'brain-mind', as Stafford terms it, have been mapped and measured using a variety of brainwave analysis technologies (Stafford, 2007, p. 106). Scientists studying long-term Buddhist practitioners of sound *Om* meditation and Glossolalia singers use electroencephalography (EEG) and magnetic resonance imaging (MRI) to provide pictures and data of the brain as it is effected by sound. These tools enable minute analysis of the physical blood flow, chemical and electrical activity of the brain.

The brainwave frequencies and associated emotional traits that correspond with those frequencies are shown in Appendix 1. When certain frequencies are reached and sustained the brain produces hormones such as serotonin and melatonin which in turn affect emotions.

Figure 3. Buddhist monk with EEG to test brainwave activity during meditation.

It has been found that long-term meditators can self-induce high amplitude brainwave synchrony during mental practice (Lutz, Greischar, Rawlings, Ricard and Davidson, 2004). Tests reveal that gamma oscillations can be evoked by the slow chant *Om* where rhythms generally oscillate between 4–13 Hz. These frequencies provide a complementary function to fast brainwave rhythms. Lutz, Greischar, Rawlings, Ricard and Davidson reveal that long-term meditators in their 2004 study had physically developed neocortexes where the lining was substantially thicker in those who practiced meditation regularly compared to individuals who did not meditate. The neo-cortex of the brain protects and houses the pituitary gland, which is responsible for regulating the secreting of hormones that control human emotions.

> Meditation increases our hypometabolic state where the metabolism is in an even deeper state of rest than during sleep. Meditation is the only activity that reduces blood lactate, a marker of stress and anxiety. The calming hormone melatonin and serotonin are increased by meditation and the stress hormone cortisol is decreased (Khalsa, 2001).

Greischar, Rawlings, Ricard and Davidson's findings (2004) show there was an *increase* in frontal lobe activity during attention-focusing tasks such as meditation (Frith et al., 1991; Pardo et al., 1991). In comparison to tests with Glossolalia singers whose practice consists of a highly active state, Newberg, Wintering, Morgana and Waldman (2006) found there to be a *decrease* in frontal lobe activity.

Historically, Glossolalia has been regularly used among Christian church practices and is commonly referred to as speaking in tongues. A study by Newberg, Wintering, Morgana and Waldman (2006) hypothesised that because Glossolalia is a highly active and emotional state, associated with the perceived loss of intentional control, EEG tests would show *increased* activity of cerebral blood flow in the brain; instead their test measured *decreased* activity during the Glossolalia state (Newberg, Wintering, Morgana, Waldman, 2006).

Glossolalia was also tested by cognitive neuroscience researcher and University professor Michael Persinger, who is like Newberg, interested in the cognitive effects in people who practice spiritual activities.

Persingers research uses contemporary brain analysis technology, EEG, fMRI, positron emission tomography (PET), and single photon emission tomography SPET to determine if spiritual experiences may result from a hallucinogenic neurochemical release from the pineal organ (Persinger, Hill, 2003). Persinger's numerous reports analysed cerebral blood flow during Glossolalia (1984), transcendental meditation (1993), meditative prayer and Buddhist meditation (2003) to determine if spiritual activities may have been responsible for altered states of consciousness.

2.1.3 BINAURAL BEATING AND NEURO-INTEGRATION

From the harmonic sounds of *Om*, a sound technique for altering brainwave states, comes the contemporary tool, binaural beating. Binaural beats are auditory processing artefacts, or apparent sounds that are perceived only in the brain as a result of physical stimuli. Discovered by Heinrich Wilhelm Dove in 1839, Binural beating was later developed by Robert Monroe, an American business executive and researcher of human consciousness, who in 1975 registered a patent for Hemi-Sync binaural beat technology. Hemi-Sync is an audio apparatus which involves the simultaneous play of two pulsating rhythmic tones that differ by 15 decibels in each ear, as well as positive verbal messages (Lewis, Osborn, Ram Roth, 2004). Monroe's invention 'HemiSync', is today a popular choice of complementary therapy in the USA.Pure and precise audio signals of different frequencies are delivered to the brain through stereo headphones; the two hemispheres of the brain function together to 'hear' not the actual administered sounds but a phantom third signal–a binaural beat (Boyce-Tillman, 2000, p. 193). The combination of the two sounds creates the perception of the 'superposed vibrato' ('binaural beating') (www.monroeinstitute.com). Electroencephalograph (EEG) research results show that parts of the brain begin to resonate sympathetically to this 'phantom' binaural beat (Boyce-Tillman, 2000, p. 193).

Binaural beats at a frequency of 10.5 Hz have been shown to enhance the production of alpha brain waves that are associated with a relaxed and focused state (*Sound for Healing*, 2004). The website *Sound for Healing* states that listening to binaural beats at a frequency of 4–7 Hz, which is indicative of a deep meditative state, has been shown to increase the production of theta brain waves. According to the positive results of Lewis, Osborn and Ram Roth's experiments (2004), Monroe's Hemi-Sync may be a promising and novel way to cancel out pain during surgical operations and thus eliminate the need for anaesthetics.

Friedman suggests that as a result of neurochemicle release healing-specific changes using extremely precise frequencies produced by binaural beating can have a direct effect on cells by causing the release of healing specific neurochemicles Boyce-Tillman, 2000, p. 193).

> The sensory neural pathways which carry the neuronal coding of colour and sound pass through the thalamus where they are implicated in either the inhibition or enhanced action of several neurotransmitters. Some of these neurotransmitters act upon the physiological aspects of tension and stress such as heart rate, muscle tension and blood pressure, while others impact upon mental and emotional aspects (Barber, 1999, p. 445).

> A neurotransmitter chain reaction is established, resulting in enhanced dendrite receptivity thus enhanced action of the neurotransmitters such as acetylcholine. Acetylcholine act on the parasympathetic autonomic nervous system, decreasing heart rate, blood pressure and muscle tension, thus aiding physical and bodily relaxation (Barber, 1999, p. 444).

EEG NeuroIntegration is a system that utilises both a sound based binaural beat soundtrack and photic light stimulation to guide brainwaves into a correct pattern. NeuroIntegration Therapy works like a mind mirror, because the recipient is connected to an EEG machine which visually shows the recipient how their brain is functioning while translating the EEG data into biofeedback. The biological data is processed, amplified and then fed back to the brain where the brain responds to it. Eventually, the brainwave activity is 'shaped' towards more desirable and regulated performance (Clear Mind Centre, 2008).

The emerging field of molecular science which merges all the aspects mentioned in this chapter is called psychoneuroimmunology (PNI) which studies the interaction between emotions, neurological and immune systems. One aspect of PNI incorporates the use of music and colour as behaviour modifiers to encourage mental, emotional and physical calmness. The link between the psychological functioning of the mind and the neuroimmune system is also an important component of PNI.

2.1.4 CORRESPONDENCES OF MUSICAL NOTES TO COLOUR AND FORM

Plato, Aristotle and Pythagoras have each dedicated study towards the relationship between harmonic musical ratios and colour. Sir Isaac Newton's (1642–1726) treatise *Optiks (1704)* was the first publishing of ideas dealing with parallels between the colours of the spectrum and the notes of the Western musical scale (*Figure 4*). Newton mathematically divided the visible light spectrum into seven colours and their noted mathematical relationships.

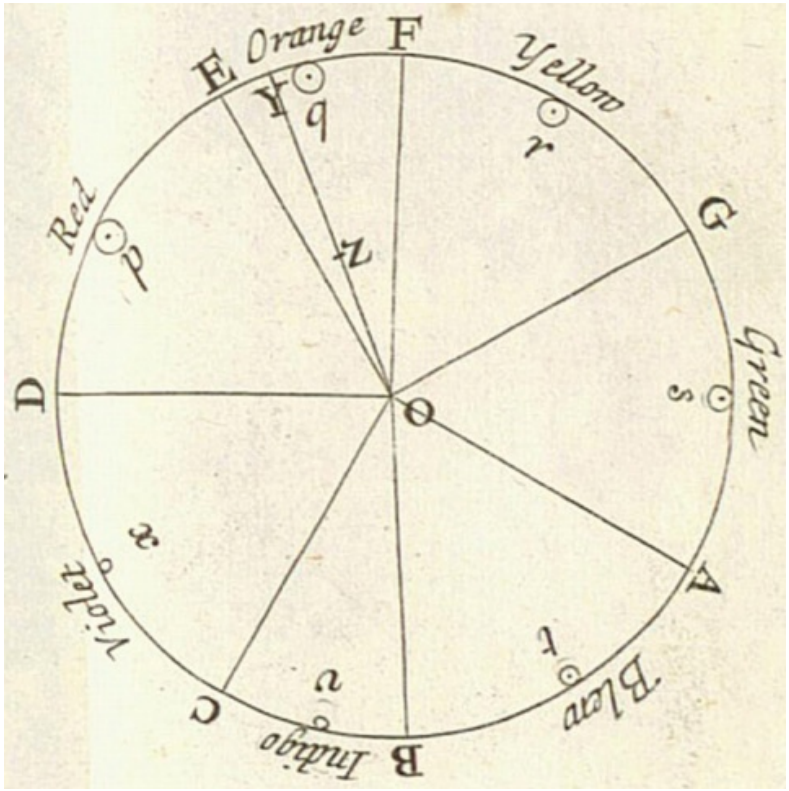


Figure 4. Colours correlated with musical notes and symbols for planets. Newton. 1704.

Artists have been influenced by such methods. In New Zealand, Michael Smither, an artist and musician, has dedicated years to the visual form of sound and the sound of colour. His paintings are abstract, colourful shapes, circles, waves and patterns. Some of his images function as musical compositions using colour to notate the spectrum of visible colour to the octave of sound (*Figure 5*). An octave is achieved by a doubling of a note's vibration time and the spectrum of colour is a parallel of this phenomenon (Smither, 2008, p. 6). Similarly, the Swiss expressionist painter Johannes Itten (1888–1967), says that 'the harmonic interval from red to violet is approximately the double; i.e. an octave (Itten, 1973, p. 18). Smither has also used visitors to his exhibitions experimentally to glean information about the human body's ability to pick up resonant

information and to guess colours without being able to see them. Blind people are especially good at differentiating the frequencies of colour by touch because they have more finely attuned their vibratory perception through this method. In the 1980s Smither exhibited a show called *Light, Sound and Dance* and proposed that the following musical notes correspond to these specific colours. A = red, Bflat = red/orange, B= orange, C= yellow/orange, C#=yellow, D = yellow/green, Eflat = green, E = blue/green, F = blue, F# = blue/violet, G = violet and G# = red /violet (Smither, 2008, p. 8).

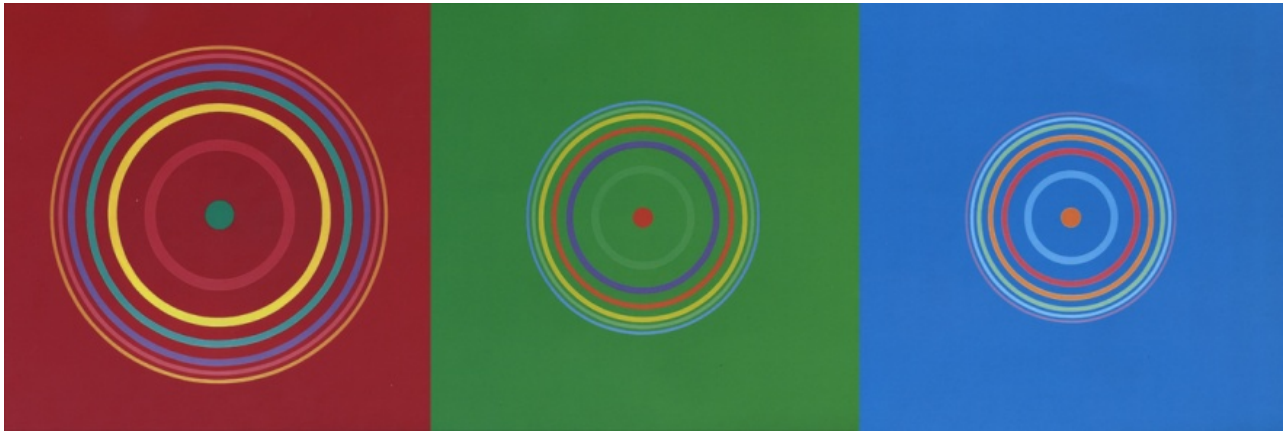


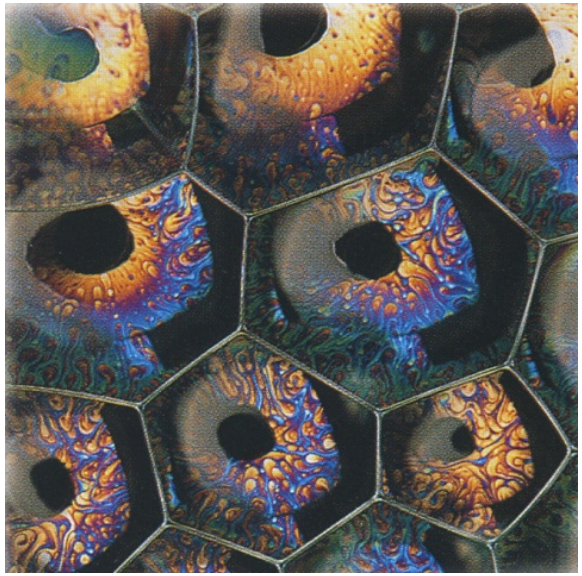
Figure 5. Red, Green and Blue. Smither. 2008.

2.2 VISUAL – LIGHT AND COLOUR

2.2.1 COLOUR

Sir Isaac Newton (1642–1738) was the first to acknowledge that colour was a component of light when in1660 he discovered in a prism, even a simple prism like a soap bubble; that white light could be broken down into a rainbow of coloured lights (Norman, 1990, p. 47). 'The thin film, such as in this soap bubble, breaks up white light into colours. The colour depends on the thinness of the film, for example, film as thin as a blue wavelength appears blue' (Coghill, 2000, p. 75) (*Figure 6*).

Through his systematic observations of light Newton provided the first calculations of the various frequencies of light colour in terms of wavelength. Figure 7 shows wave lengths of white light are stated in Angstroms (Å). 1 Å = .000 000 0001m or 10^{-10}m. Frequencies of white light are stated in nanometres (nm). 1 nm = 0.000 000 001m or 10^{-9}m or one millionth of a millimetre (*Figure 7*).



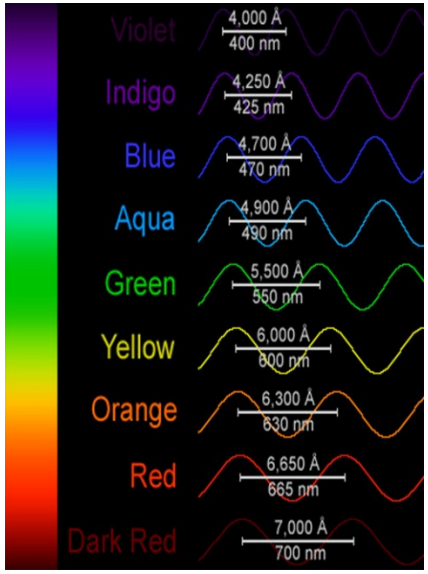


Figure 6. Soap bubble. Coghill. 2000.
Figure 7. Visible light frequencies of the electromagnetic spectrum.

Johann Wolfgang Von Goethe's 1810 publication *Theory of Colours* inclined towards the viewer's perception of colour rather than Newton's analytical perception. Goethe's theories include how colours affect people psychologically and the emotional feelings that colours can evoke. The painting entitled *A Matter of Perception* (*Figure 8*) is my interpretation of Goethe's colour theory; a simple standpoint, that colour would not exist without the viewer to perceive it. Goethe's focus on subjective interpretation, the experience of colour and the concept of polarities, led me towards the idea of implementing complementary colours in a series of paintings. Both Goethe (1749–1832) and Russian-born French expressionist painter Wassily Kandinsky (1866–1944) expressed the nature of colour as pairs of opposing ideas. Itten called these 'complimentary contrasts: both colours and ideas are in opposition, in equal balance, they neutralise each other' (Norman, 1990, p. 139). Goethe was the first to introduce the phenomenon of colour balancing.

> When the eye catches a colour, it automatically brings forth another colour that together with the first completes the whole colour circle. In striving for totality, the eye seeks a colorless room beside every coloured one, in which to produce the colour wished for. Here lies the fundamental principle for colour harmonies (Goethe, 1810).

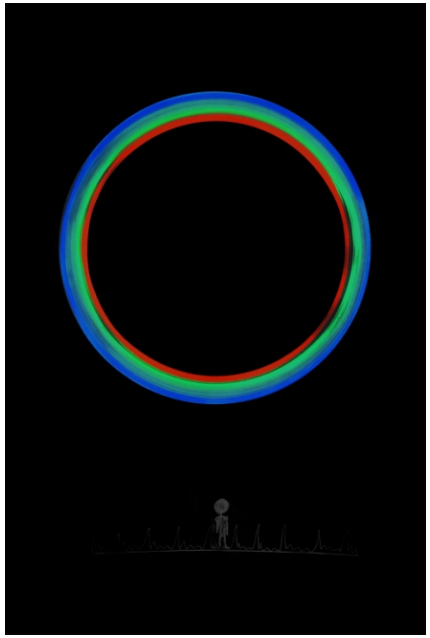


Figure 8. A Matter of Perception. Linton. 2008.

Following Goethe, the psychological aspects of colour were a topic of great interest to Kandinsky and Itten. The art critic Poling states that Kandinsky's ideas were predominantly influenced by Goethe and when Kandinsky wrote his list of colours along with the emotions they evoked, they were virtually indistinguishable from Goethe's (Poling cited in Norman, 1990, p. 139).

Appendix 2 shows theoretical notes from an unpublished journal on psychological harmonies, written by Stanley Linton (1922–1983) in 1968. Linton was a painter and theorist on topics of colour, health (especially cancer research), and the physical sciences. From his own observations Linton provides colour combinations which he believed to be harmonious to the human eye. In this journal Linton drew diagrams and figures which simply and visually illustrate the fundamental forms and motions of electromagnetic waves. Linton recorded Rene Thom discussing how electromagnetic phenomena can be illustrated in a variety of ways to describe the 'refraction of light as it passes through rain drops to form rainbows, to provide insights on the nature of cell division in embryos, to predict certain kinds of behavioral patterns in nervous disorders, the development of sonar, the flow of fluids and for solving problems within the field of linguistics' (Rene Thom, cited by Linton, 1964, p. 51).

2.2.2 PSYCHOLOGICAL COLOUR HARMONIES

Johannes Itten developed a 12-hue colour circle (*Figure 9*) and considered the subjective feelings that were associated with objective colour as well as the psychic and emotional values of colours. Itten's twelve-part colour circle shows the different ways that colour harmonies can be created, which he described as chords. 'Colour chords may be formed of two, three or four or more tones; we shall refer to such chords as dyads, triads, tetrads etc' (Itten, 1973, p.118). When mixed together, the chords should always aim to create medium grey, which is said to generate a state of equilibrium in the eye (Herring cited in Itten 1970, p. 20). Using the 12-hue colour circle as a visual aid, harmonious dyads, triads and tetrads can be created in the following way: a four colour harmony is created when orange/red, violet/red, violet/blue and yellow/green are arranged together to form a square on the circle. The illusory triangle or square may be rotated into any position on the colour circle and the colours at each corner retain their harmonious balance.

Figure 9. 12 hue colour circle. Itten. 1961.

Figure 10 is a reference diagram for the selection of hues within the hue, saturation, brightness colour model (HSB) which is used in work in digital images and computer systems. The hue is represented by angular degrees around the circle, starting and ending at red = 0 or 360. The triangles may be aligned to select harmonious colour triads (*Figure 10*).

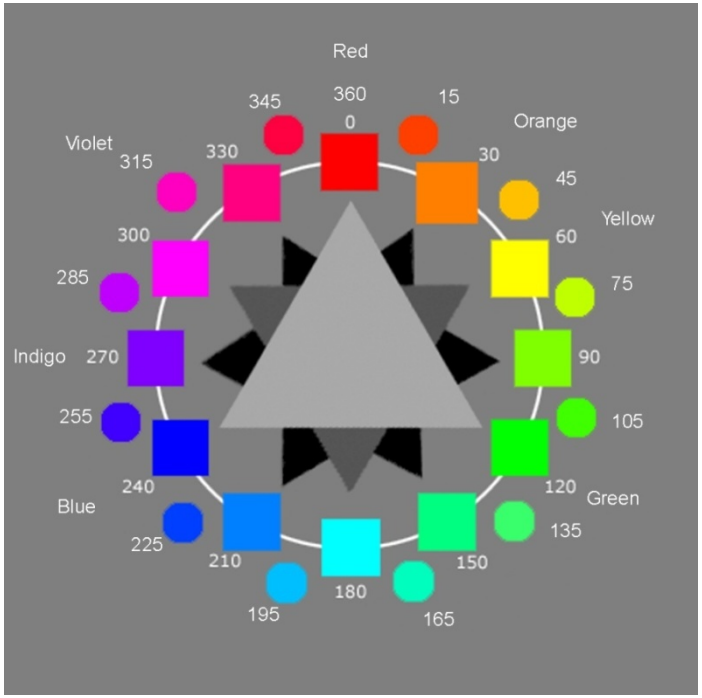


Figure 10. Reference diagram for the selection of colour hue's.

Barber explains that the 'cold colours' blue and green as described by Itten, allude to spirituality, contentment and tranquility and are sedative in effect; they are therefore analogous to the colours of choice in when achieving a calmer state. 'The 'warm colours' of red and orange, both of which allude to radiant activity and passion, act as stimulants and thus are to be avoided if seeking calmness (Barber, 1999, p. 444). And these can be linked to psychology through behavioural psychology: Baker-Miller pink (bubble-gum pink) has been found to have an extraordinary calming effect and has been tested on violent and aggressive prisoners in holding cells

and in juvenile reform centres. Baker-Miller pink is now used in many correctional institutions around the world (Demarco and Clarke, 2001).

Dr Seth Pancoast (1823–1889), a prominent physician from Philadelphia, U.S.A, was the first to publish a book specifically about the therapeutic effects of light and colour. In 1877 his book, *Light and its Rays of Medicine* deals mainly with the stimulating red and the soothing blue rays and their effects on humans. Pancoast had considerable experience in healing and developed his knowledge from 30 years studying Hebrew Kabbala and occult science. Pancoast describes how he used sunlight filtered through panes of red or blue glass to accelerate or relax the nervous system to creating balance within the body (*Figure 11*). Pancoast cites ten remarkable cures which advocate the successful use of colour in healing.

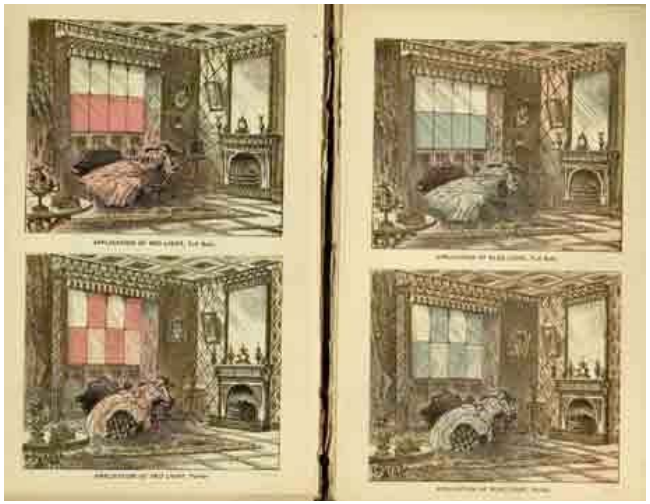


Figure 11. Fashionable lady bathing in red and blue light. Pancoast. 1877.

One year later the American teacher and mesmerist, Edwin Babbit, published his own increasingly complex colour theory on *The Principles of Light and Color* (1878). Babbit's comprehensive theory of healing with colour attracted worldwide attention, unlike pancoasts. Babbit invented a device to restore equilibrium, which he called the Chromolume, a stained-glass window composed of sixteen colours. The case histories detailed by Pancoast and Babbit in their respective books indicate that the methods they used with coloured glass filters

served efficiently for the successful treatment of ailments in the 19th Century, to similar effect as many present day light therapies claim to achieve. Later, in the 1940s, Russian scientist, S.V. Krakov conducted a series of experiments in which he separated wavelengths of coloured light to show how colour can affect the autonomic nervous system. He observed that red light stimulates the sympathetic part of the autonomic nervous system– the adrenal glands–to raise blood pressure and pulse rate. He found also that blue and white light impact the parasympathetic part of the autonomic nervous system to have a calming effect (Demarco and Clarke, 2001).

2.2.3 THE THERAPEUTIC EFFECTS OF COLOUR and FLICKERING LIGHT

In the early 1900s, experimental psychologist Pierre Janet was among the first to experiment with a method of treatment whereby he encouraged psychotic patients to look at a spinning fan with a light shining on it. He found the effects of gazing at the strobe-lit fan to be profoundly soothing to the patients (Pigott, 2006). Later, in 1959, artist Brion Gysin developed a flicker device to produce hypnotic visual stimuli. The concept was inspired by a kaleidoscopic vision Gysin experienced one day as he was driven past a long avenue of trees with his eyes closed. To replicate the effect Gysin created the Dreamachine, a cylinder with slits cut in the sides. When placed on a record turntable and rotated, light from a bulb suspended in the centre of the cylinder projected through the slits. The similarity of the technique and the results of the effects caused by Janet's and Gysin's experimental devices are interesting. When light and colour were organised in specific moving patterns such as spinning, oscillating and flicking they stimulated or soothed the viewer's physiological and/or psychological symptoms. The rhythmic and repetitive techniques using light to affect the brain and mind have also been achieved with sound, as described earlier with Monroe's pulsating rhythmic sound technique which entrains brainwaves.

From a neuroscientific perspective, Hollwich (1979), Anderson (1989) and Piggott (2006), all reveal cases where light and colour frequency have been successfully utilised to reduce pain and increase strength and stamina in patients suffering from disorders such as ADHD, migraines, Alzheimer's, Parkinson's disease and cancer. Further, Demarco and Clarke outline its use in treating other conditions:

Coloured strobe lights are being used with great effect to treat a whole range of disorders, including for example learning disorders, anxiety, phobias, dyslexia, obsessive-compulsive disorders, depression and post-traumatic stress syndrome (Demarco and Clarke, 2001).

Figure 12. Variable frequency photo-stimulation goggles. Coghill. 2000.

Flickering red light has been successfully used for migraine and PMS pain relief and to help aid the focus of ADHD sufferers (Anderson 1989, Demarco and Clarke, 2001). Variable frequency photo-stimulation (VFP) goggles (*Figure 12*) are a form of portable stroboscope which use red light emitting diodes to alternately illuminate the right and left eyes. The rate of the light as it flicks on and off, and the frequency of the colour of light, hold separate and distinct values. Both together and separately these aspects can alter brainwave frequencies to change physical and psychological states. Its chemical effect is described as follows:

> When the colour red strikes the retina, the psychoneuroimmuno response from the body is to emit a brain chemical called serotonin from the pineal gland in the brain. Serotonin and melatonin are both calming hormones. The pineal gland, which sits close to the pituitary and hypothalamus in the brain has recently been shown to be the body's 'light metre' due the fact that it directly responds to light information received via the eyes. (Demarco and Clarke, 2001, p. 96).

The pineal gland is predominantly responsible for our emotional states (Hollwich, 1979). It controls the secretion of the hormone melatonin and thus the body's numerous biological rhythms. (Demarco and Clarke, 2001). Melatonin has been found to be an anticonvulsant and has been found to decrease epileptic manifestations in humans (Anton-Tay, 1974).

In an essay titled *Electrophysiological correlates of flicker-induced colour Hallucinations* (2008), researchers Becker, Gramann, Müller and Elliott used flickering light stimulus to measure how it affects the brain.
Their subjects stared at a white light, induced using square-wave light pulses going on and off rapidly and intermittently at a set frequency. They asked their subjects to gaze at the flickering light and when they experienced the colour red, for example, as a hallucination, they were to notify the analysts. During this experiment the participants' brain activity was measured using an EEG, enabling the researchers to draw correlations between the frequencies of the flicker to certain colours. They were also able to correlate the site in the brain where the activity was centred while the hallucinations were taking place with which colour was perceived. Their findings reveal frequency changes especially within alpha and gamma brainwaves. In regards to this thesis, Becker, Gramann, Müller and Elliott's research provides a record of the fact that flickering light frequencies can produce visual hallucinations and colours that can be associated with the activation of particular parts of the brain.

2.2.4 SEEING COLOUR

When we see colour we perceive distinct frequencies of visible light through our eyes which are capable of sensing the visible spectrum range from approximately 380 to 740 nm. Colour processing begins at the retina and contains two types of photoreceptor in which light is transduced to yield a neural signal: rods which allow monochrome vision and cones allow colour vision. The term transduce means: to translate or convert one form of energy to another, e.g. the pressure, temperature, or pulse to an electrical signal. There are three types of cones in the retina each capable of different spectral responses in the short, medium and long wavelengths of the visible spectrum (Freeman, Hull, 2003, p. 516). Spectral colour is a term used to describe colour that is evoked by a single wavelength of light within the visible spectrum, or by a relatively narrow band of wavelengths of the visible spectrum of light energy. Thomas Young was the first to propose, in 1801 that the retina's three types of cones are preferentially sensitive to blue, green and red, this was reinforced by Hermann von Helmholtz (1821–1894). The final discovery of the three optical proteins firmly established the trichromatic theory in 1959.

Table 1. **Cone cells in the human eye**

Cone type	Name	Range	Peak wavelength
S (short)	β	400–500 nm	420–440 nm
M (medium)	γ	450–630 nm	534–545 nm
L (long wavelengths)	ρ	500–700 nm	564–580 nm

The cognitive process for colour is as follows: external stimuli excites the retina, the cones receive the frequency of light then ganglia convert the waveforms in the cones into electrochemical information, then the optic nerve carries the signal back to the visual cortex at the back of the brain, for cognition.

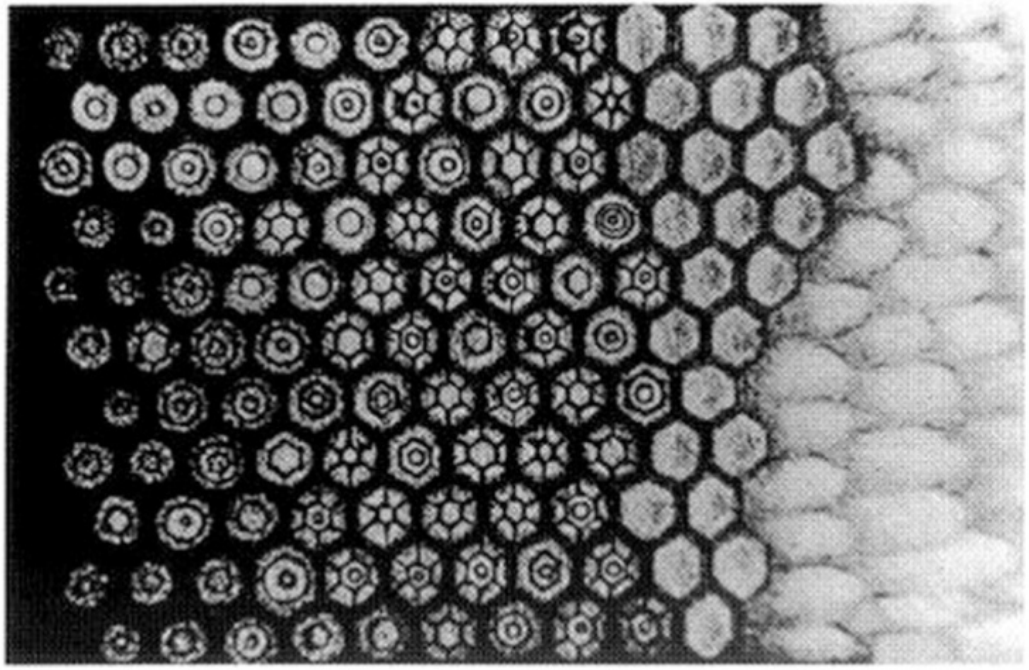


Figure 13. Drawing of a frog's retina. Hannover. 1843.

The retina of a frog is illustrated in *Figure 13*. The star shaped patterns are hand drawings of the frog's outer segments of photoreceptors, viewed end-on by A. Hannover (1843) as he looked through a microscope. In the 1840s Hannover thought these patterns must represent anatomical structures but today laser physicists recognise these shapes as typical, changeable light patterns called waveguide modes (Harris, 2008). This image held a significant role in my development and understanding of energetic waveforms and has led me to create imagery that is synonymous with this geometric structure. The aim of some of the experiments I carried out for *Sound Vision* was to capture the crystalline structure of waveguide mode patterns. Vibration in water using sound, and filming objects through crystal lenses, as well as replicating moving forms into kaleidoscopic patterns in post production are all methods employed towards this effect. The anatomical structure of the human eye with its crystalline lens, and retina are also associated with the imagery created for *Sound Vision.*

2.3 VISUAL – FORM, MOTION AND THE BODY

2.3.1 FORM AND MOTION

The following forms are the themes from which I derived the visual form of sound as an outcome of this research. The forms and motions of all energy vibration can appear visually as patterns: resonating, oscillating and transducing through space. The Mandala, Yantra and the platonic solids, *chakra* symbols, cymatics, waveguides and the forms of geometric visual hallucinations all exhibit forms in their configurations that look like, and are homogenous to cellular constructions. Each of these images tells a story about vibrational content or rhythmic structure in its geometric form.

2.3.2 CYMATICS

By vibrating a pool of water with sound, imagery can be created. Cymatics is the study of wave phenomena, which emerged as a distinct scientific discipline in the 1950s and has since undergone a 'concentrated tour de force of exciting development' (Volk, 2008, p. 16). Robert Hooke, Ernst Chladni, Margaret Watts Hughes and Hans Jenny were the initiators of cymatics each of whom found wonder in the changing patterns as they animated matter reacting to sound. As different sounds resonate through either a pool of water or on a plate of sand, defined and dynamically changing geometric patterns appear. As water (or sand), is subjected to gradually increasing frequencies, standing waves form. Standing waves are stationary points that, as moving water ripples past them, form geometric patterns on the surface of the water. The complexity of the patterns increases with the increasing pitch of the exciting tone and at a critical pitch the structured geometric pattern dissolves into chaos, only to re-configure into a higher order of complexity, as the tone continues to ascend. 'This process of chaos and re-integration is seen throughout nature, from the valence fields of electrons within an atom, to complex weather patterns, to intricate physiological processes within our bodies'
(Volk, 2008, p. 14).

Hans Jenny (1904–1972), Swiss physician and natural scientist, is considered to be the father of cymatics, the study of wave phenomena. Through his study of cymatics, Jenny developed a theory that molecules inside each cell of our body can be positively affected by sound vibration. Peter Guy Manners, a British osteopath,

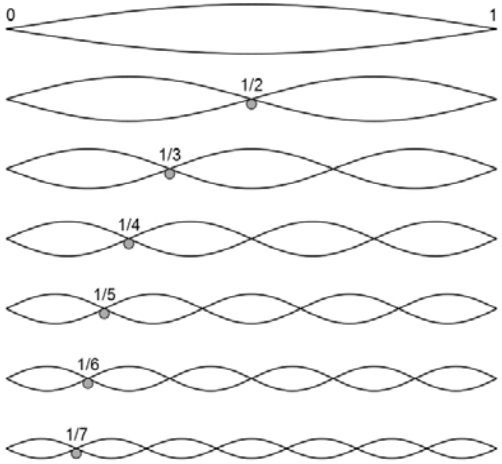
developed this idea further to create a link between sound vibration and cells in the human body. He states that 'disease is an out of tuneness in some part of the body' (Manners, cited in Boyce-Tillman, 2000, p. 193).
A healthy organ will have its molecules working together in a harmonious relationship with each other and all of the same pattern. If different sound patterns enter the organ, the harmonious relationship could be upset. If these frequencies are weak in their vibration, they will be overcome by the stronger vibrations of the native ones.

> If, on the other hand, the foreign energy proves to be stronger, they may establish their disharmonious pattern in the organ, bone, tissue, etc. and this will have what we call disease. If therefore a treatment contains a harmonic frequency pattern that will reinforce the organs, the vibrations of the intruder will be neutralised and the correct pattern for that organ re-established, this could constitute a curative reaction (Manners, quoted in Boyce-Tillman, 2000, p. 193).

Based on the production of visual images with cymaticsm Jim Reid developed the CymaScope, a 21st century invention. This machine produces patterns on its membrane surface to allow the participant to see shapes form as they create sounds or words into the CymaScope. The emerging patterns provide important visual feedback allowing participants to know when they are pronouncing words and sounds correctly. This system is useful for teaching many speech-impaired people to speak more clearly. (Reid, 2008).

2.3.3 WAVEGUIDE MODES AND LASERLIGHT

In electromagnetic and acoustic science, the term waveguide refers to any linear structure that guides electromagnetic waves, for example, through a hollow pipe such as a flute, a resonant cavity like a didgeridoo, or the human trachea, as well as light through fibreoptics. The differing shapes of waveguide modes are defined by the shape and size of the structure they travel through as well as the length and polarisation of the wave itself. The longitudinal flow of energy through a waveguide forms standing wave patterns in the cavity (*Figure 14*) This can be illustrated by looking at the standing waves produced by a string (*Figure 15*). The cross section of a longitudinal flow of energy is called the fundamental transverse wave mode (*Figure 16*).



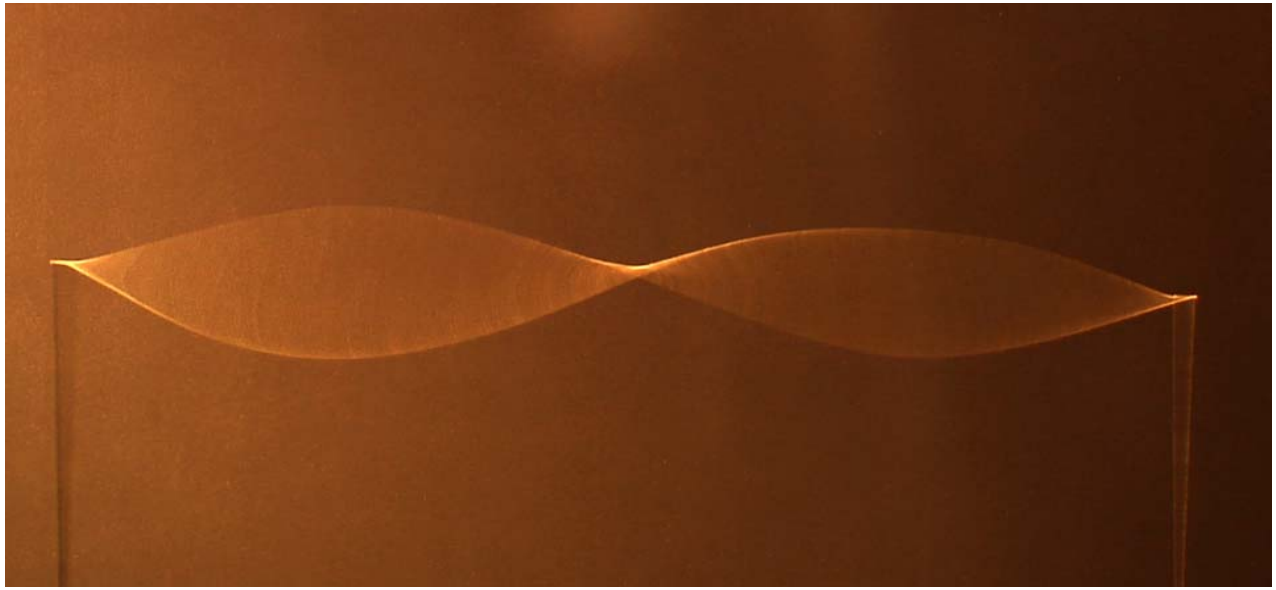


Figure 14. Longitudinal modes of Vibration.
Figure 15. Standing wave in a vibrating string. Nicholas–Designer, Linton–Photographer. 2008.

Illustrating the 'Electric field amplitude profiles for all the guided modes of an optical fibre, the two colours in Figure 16 indicate different signs of electric field values. The lowest-order mode has an intensity profile which is similar to that of a Gaussian beam. In general, light launched into a multimode fibre will excite a superposition of different modes, which can have a complicated shape' (Paschotta, 2008). Superposition is a term used to describe the overlapping of waves to produce another wave which combines the frequencies of the two. Constructive, or destructive interference will occur during superposition.

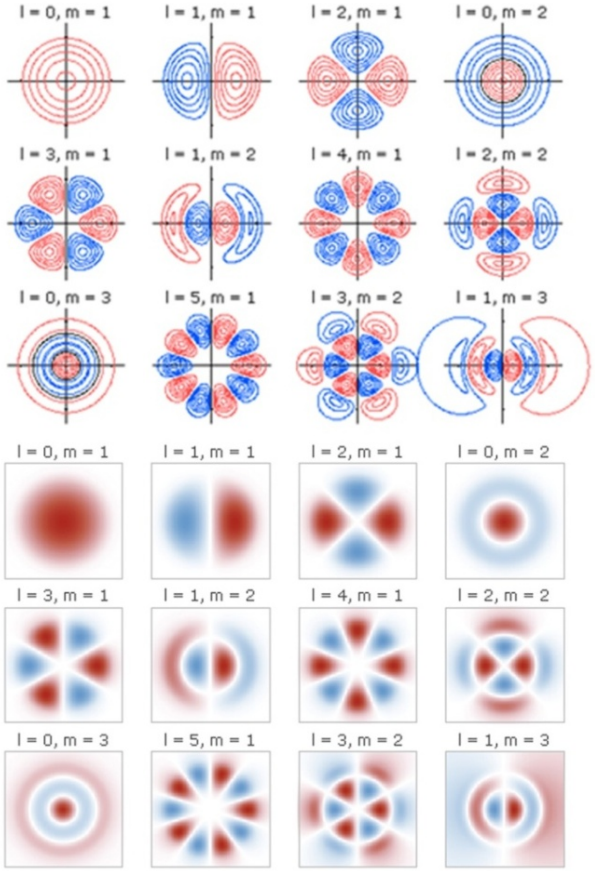


Figure 16. Fundamental transverse waveguide modes. Paschotta. 2008.

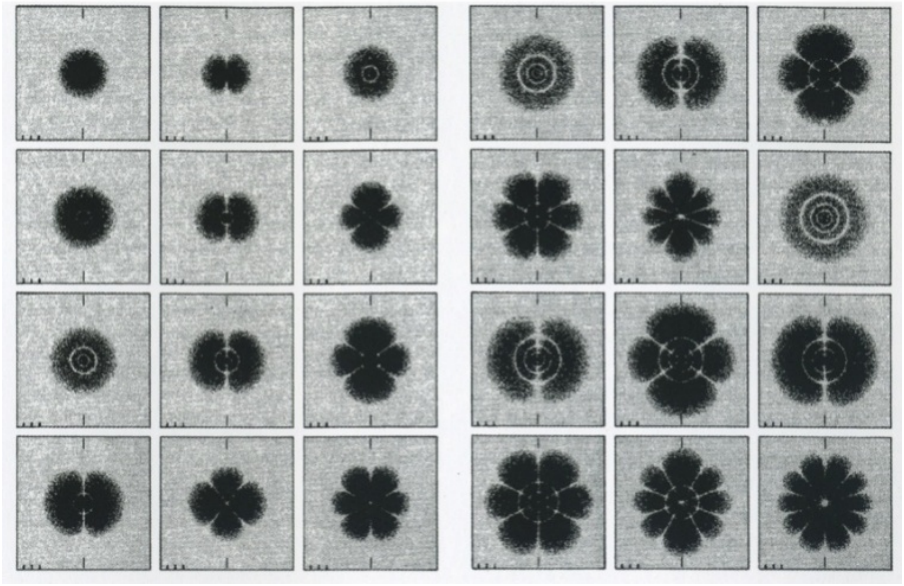


Figure 17. States of an oscillating hydrogen atom. Lauterwasser. 2007.

Figures 14–17 capture still shots of the motion of sound. The patterns range from the simplest single lobe structure (*Figure 16*, 1=0, m=1) and increase in complexity as conditions such as the phase and velocity of energy change. Each of the other illustrations in this figure show concentric rings and angular divisions which occur as the frequency and intensity of energy changes and in turn change the pattern. Superposition of two different modes will also create either constructive or destructive interference patterns.

These fundamental waveguide modes provide a visual diagram of the motion of a perfect membrane on a drum, how a hydrogen atom oscillates, and how optical waves such as laser beams are transmitted and reflected in an optical cavity. An optical cavity (optical resonator) is an arrangement of mirrors which form a standing wave cavity for light waves to resonate in. Freeman and Hall indicate the laser is 'a special source where the motion approaches that of a single wave' (Freeman, Hull, 2003, p. 439). Observation of standing-wave patterns by Thomas Young, the English polymath (1773–1829), in 1803, enabled him to develop the theory that light moves in waves. Like Aristotle, Young examined waves in water. Young created

a ripple tank to demonstrate the idea of interference in water and the two-slit, or double-slit experiment, to demonstrate interference of light as a wave. In these experiments the interference patterns formed into geometric shapes like stars squares and circles, similar to magnetised iron filings and Mandala.

2.3.4 MANDALA

Mandala literally means circle; a visual representation of the universe. Philosopher and psychoanalyst Carl Jung (1875–1961), saw the Mandala as a representation of the unconscious self and stated that the point at the centre of the circle refers to the 'vital centre of the personality from which the whole structural development of consciousness stems' (Jung, 1978, p. 169). The geometric shapes and mathematically proportioned framework within the Mandala are arranged within a circular configuration to represent many different notions of harmony, such as peace, unity and totality. There are many different types of Mandala – often visualised or imagined during Tibetan Buddhist meditation for different purposes. Each Mandala, or Yantra is also referred to as a 'power diagram' (Khanna, 1976). The fundamental forms referred to frequently in this thesis are the reoccurring archetypal shapes based upon the division of the circle. The bindu or dot at the centre serves as a centre of focus, providing optical guide-lines. The vesica piscis, triangle, square, diamond, pentagon, hexagon, stars, the rays that radiate out from the centre point of the circle as well as the 3D counterparts, such as the platonic solids, are of interest to this study. These formations can be distinguished in the motion of naturally occurring energetic phenomena such as sound and light.

In *The Mandala of Sound*, an unpublished Ph.D. dissertation (1979), author Terry Ellingson refers to a conceptual set of three Mandala which are relevent to the human being: the Mandala of the body, voice and mind. Ellingson describes the process whereby transformations can be attained in three different ways: through symbolic body gestures exerted in dance; using the voice to sing mantras or other evocative vocalisations and by using the mind in meditation. Through singing and dance, these ideas are taken through to *Sound Vision* to create a filmic meditation.

2.3.5 YANTRA

Throughout this thesis I have continually revisited the Sri Yantra which is believed by some to be a direct derivative from sound. Blair (1976, p. 131), Goldman (Goldman, 1992–2009) and Nameth (Khanna, 1979 p. 116) claim that the image of the Sri Yantra can be formed using sound vibration and more specifically the vocal sound *Om* (*Figure 18*). A Tonoscope is an apparatus which employs the concept of cymatics, to render sound visible by vibrating sand or water on its membrane to form geometric images. According to Blair, Goldman and Nameth, when the sound *Om*, when correctly uttered into the tonoscope, it produces the circle 'O', which is then filled in with concentric squares and triangles, finally producing, when the last traces of the 'm' have died away, a 'Yantra', the formal geometrical expression of sacred vibration (Blair, 1976. pp 115).

Figure 18. Sri Yantra formed by the sound *Om*. Khanna. 1979.

2.3.6 KUNDALINI AND CHAKRAS

The human body is considered to be the best of all Yantra. The seven *chakras* on the axis of the spine are activated in sequence during meditation. From the root *chakra* upwards (*Figure 19*) they are known as Mūlādhāra, Svādishthāna, Manipūra, Anāhata, Viśuddha, Ājūa and Sahasrāra (Khanna, 1979, p. 124).

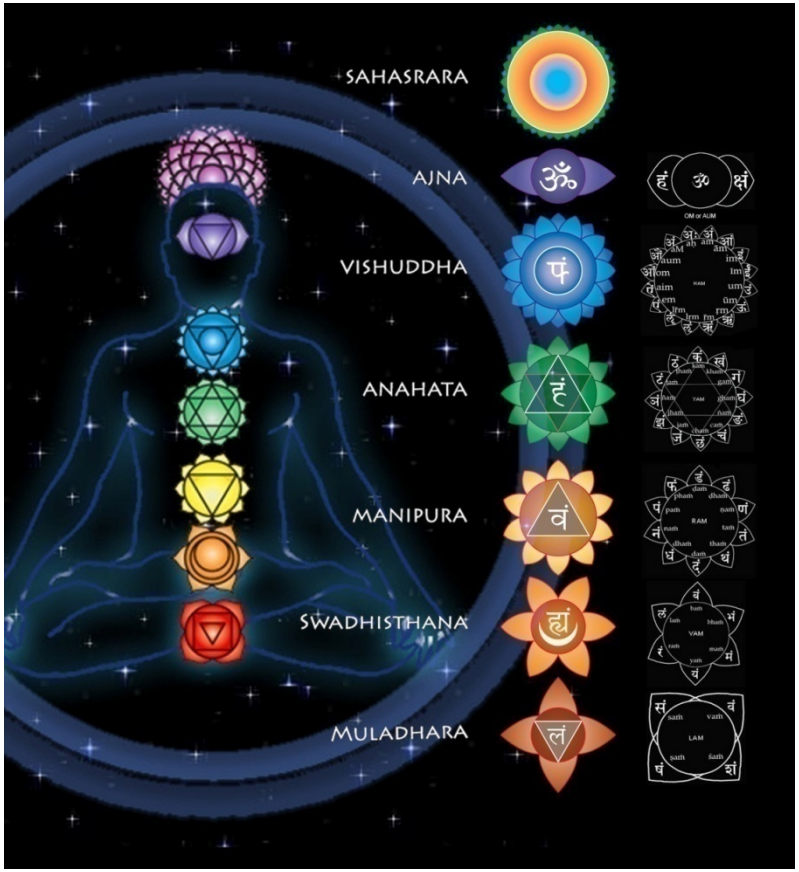


Figure 19. Chakra correlations between the body, sound, light, colour and form.

Kundalini, otherwise known as the *Chakra* energy system, is an ancient Hindu and Chinese science in which the body's flow of energy has been intricately mapped. In Chinese medicine large healing centres are called *chakras* and smaller points are called meridians and are invisible paths along which energy flows in the body. Chinese medicine possesses centuries-old knowledge on the meridian system. Modern biophotonic research has been able to provide reinforcing ideas about how energetic resonance can be transferred across the electromagnetic spectrum to produce healing changes. Biophotonics is a field of scientific investigation that studies the electromagnetic activity of cells, specifically frequencies of light. Current healing therapies which manipulate the energy within the body include acupuncture, shiatsu, reiki, tai chi, acupressure and colour puncture. These techniques can be used to treat patients for many psychological and physical complaints.

In Kundalini, 'each of the seven *chakras* corresponds to a part of the body which are associated with parts of the endocrine system' (Maman, 1997, p. 38). Practice of Kundalini meditation encourages the participant to visualise a form or symbol while chanting the sound or mantra associated with that symbol. In order to form visual rhetoric, knowledge of sound-to-symbol correspondences is necessary to learn how healing can be initiated through the ancient system. The geometric shapes of the *chakra* symbols and in the Sanskrit *chakra* symbols that represent *Om, Ham, Yam, Ram, Vam* and *Lam* hold within their compositions instructions which describe vocalic techniques which a practitioner may chant to entice overtones that can be psychically and physically beneficial to the body.

2.3.7 THE BODY IN SPIRITUAL FORM AND MOTION

Several spiritual practices have contributed to the outcome of this thesis, predominantly Eurhythmy, the whirling of Dervishes and Mudra, hand and body postures. Eurhythmy is an expressive movement that was initiated by Rudolf Steiner in 1911. The purpose of the motions of eurhythmy is to stimulate and strengthen one's expressive capacities through movement. Rudolf Steiner was a great advocate of the body's inherent need for movement and developed eurhythmy to compensate for somatic and psychological imbalances by strengthening the organism's salutogenic capacity to heal itself (Poplawski, 1998). The term Salutogenic is an alternative medicine concept which refers to the body's capacity for self-healing and self-regulation. The concept Salutogenesis focuses on factors that support human health and well-being rather than on factors that cause disease (pathogenesis). In eurhythmic dancing, for example, a performer is guided to focus their attention toward bringing their body into harmony with the piece they are articulating, whether it is to music,

the spoken word or even silence. The pedagogical exercises in eurhythmy begin by forming the body into straight lines and curves and proceed through successively more complicated geometric forms to develop coordination and concentration. Eurhythmy has been used successfully to improve the attention and learning capacities of school children especially within the Waldorf teaching curriculum, also initiated by Steiner, in 1919. Often in eurhythmic dance the performers wear long flowing dresses made of light weight fabric so that as their figures move they create waves and ripples in their wake.

Figure 20. Whirling Dervishes. Teobius. 2008.

The Whirling Dervish (*Figure 20*) is a ritual Sufi practice where the performer turns or whirls seamlessly. The costumes worn by the Whirling Dervish are dresses which, as when they spin, flair out into a full circle. The concentration and training is obvious as their bodily posture and arm movements balance them in centripetal motion.

'Ancient Hindu people realised that certain sounds released postural phenomena' (Campbell, 2000, p. 16), this is Mudra. Mudra can be either hand postures such as the one often exhibited in displays of Hindu deities, or full body Mudra, where all the limbs are focused into a figurative pose. Mudra formations trigger focus and a greater connection to the self within the mind. The shapes created by hand and body postures aid the mind to retain focus.

2.3.8 GEOMETRIC SHAPES AND EMOTIONAL STATES?

Barbara Stafford is a visual communicator and neuroscientist who suggests that specific shapes have cognitive significance within the human psyche. Stafford says that the brain, especially the temporal lobes, recruit the same areas and structures over and over again in the process of building our experiences. This process may be why the same visual forms arise repeatedly in art. 'Shape and colour radicals might awaken memories of a distant cognitive heritage' (Stafford, 2007, p. 34). Stafford recognised that it is thae same shapes and forms that are repeatitively scribed in art from the earliest rock carvings, written in alphabetic languages, art and architecture. These shapes, Stafford says, have been used repeatedly throughout time from Ancient Egypt, through Chinese medicine, Tantric religion, chemistry, alchemy, physics and cymatics to mathematics. It is for this reason that Stafford suggests that it is a basic human instinct to intuitively connect shapes with emotional states (Stafford, 2001, p. 34).

The forms that arise during these hallucinations can be likened to those seen in drug induced and migrainous hallucinations. In 1926 Hienrich Kluver grouped perceived geometric structures into a set called 'form constants'. Visual hallucinations, whether drug induced or entoptic (visual effects whose source is within the eye itself), Kluver says, are generally similar in form and he defined the following 'form constants':

1. Lattices including grating, fretwork, filigree, honeycomb, checkerboards and triangles.
2. Cobweb figures.
3. Tunnels, funnels, alleys, cone, vessels.
4. Spirals

Fritz Hollwich (born 1909), author, researcher and professor, discovered that the levels of stress hormones, adrenocorticotropic hormone (ACTH) and cortisol, in people working under artificial 'cool-white' fluorescent tubes was significantly increased. Due to his findings fluorescent tubes were banned in German medical establishments (Demarco and Clarke, 2001). Hollwich invented the full-spectrum fluorescent tube which produces significantly less stress hormones, ACTH and cortisol, than the standard cool-white lamps. From the standpoint of health, this broad spectrum tube is better tolerated regarding the endocrine response of the human body (Hollwich, 1979, p. 94). Doctors at the Hammersmith Hospital in London have been using light and colour in a more directly physical way than that described above. They have found polarized full spectrum light to be highly effective to treat a variety of cases. They reported that a combination of red and blue light is

effective in the treatment of acne. Psoriasis has been treated successfully for a number of years with ultra-violet light. Blue light (around 450 nanometres) has been used for many years in neonatal units for the treatment of neonatal jaundice and in the treatment of arthritis (Demarco and Clarke, 2001).

2.4 ARTIST CASE STUDY – ARTE NOMADE

Arte Nomade is an audio/visual, 3D, digital performance using coloured light in form and motion. I was developing similar concepts for the outcome of this thesis so I returned to film and talk with them to find out if they were aware of the healing properties of coloured light, forms and motions. Rivero said that she was aware of therapy in regards to applying sound and coloured light but that their current performances are entertainment and not directed to achieve specific healing responses. Arte Nomade's digital audio/visual art instillation performances are an example of the preferred light and sound setup to guide the viewer into a meditative state with therapeutic outcomes. During the show, viewers wear chromatech 3D glasses, which enhance the illusion of colour depth, drawing them into the whirlpool of light (*Figure 21*), projected onto a fully immersive, 12m long screen. 'The purpose of this art installation is to give the opportunity to the viewer to explore and nourish his/her own imagination and create an exclusive world where personal interpretation leads to an unforgettable and mind opening experience' (Rivero and Schiavi, 2008). Unlike Arte Nomade's 100+ audience, I believe that a therapeutic outcome is better gained from a single viewer in a clinical setting perhaps, intently using the device for focus and healing. It is desirable that the viewer is close to the screen in order to saturate themselves in the imagery, for maximal effect. I gained information about how sensitive the camera, and the eye, is too long and short wavelength and frequencies from filming Arte Nomade.

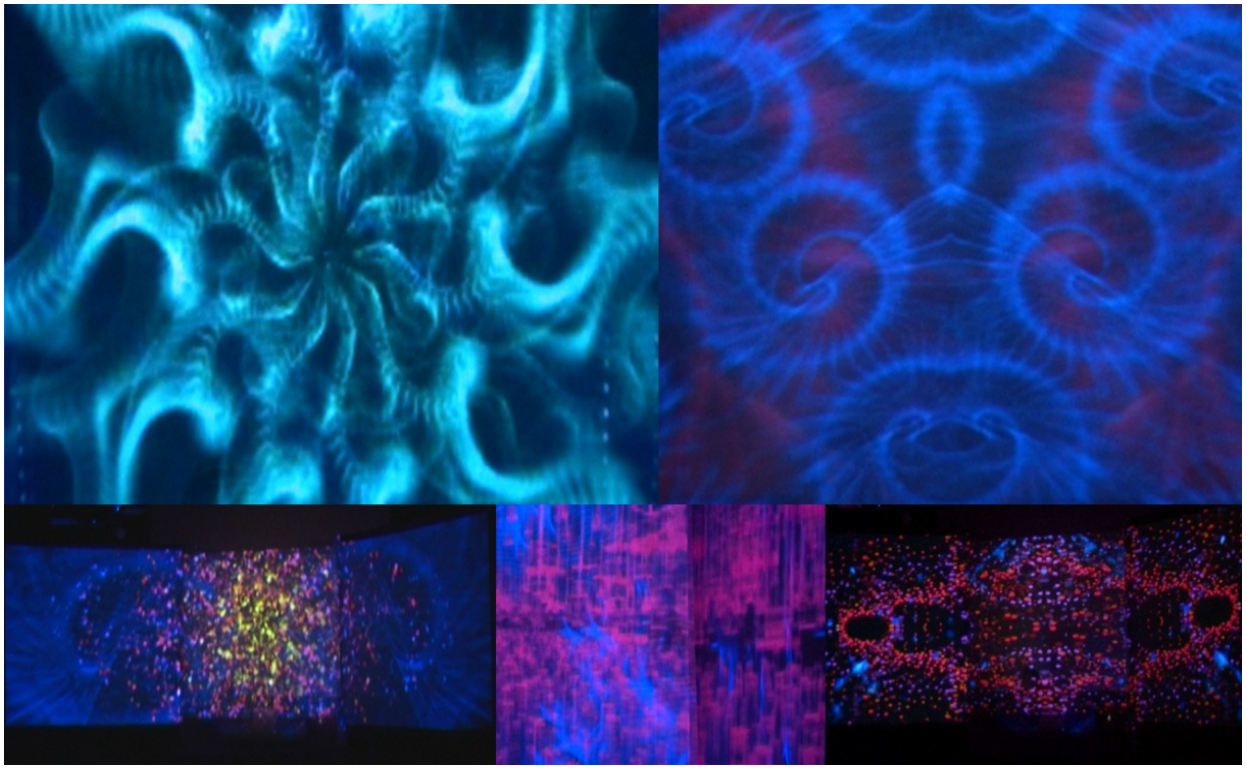


Figure 31. Arte Nomade. Art Nomade–Designer, Linton–Photographer. 2008.

3. METHODS AND PROCESSES

3.1 VIDEO AS THE MEDIUM

Figure 22. A colour box. Lye. 1935.

Digital video captures the nature of sound with fluidity because unlike a still photograph it places form into motion. Digital video has served as a tool for documentation, as a study aid, and as a creative medium, throughout my investigations. By combining digital video with three dimensional (3D) animation, geometric shapes and figurative forms can be given added depth on the screen. I created the illusion of depth and balance by manipulating the colour effects, especially the Hue, Saturation and Brightness. Thoughtful use of colour following the rules of additive colour mixing has been my method due to the fact that a computer screen mixes colour as light.

Sound has long been a topic of fascination for artists who hope to capture its rhythm and form using line, shape, colour and light. Preeminent artists who specialise in visual music for the screen are filmmakers Mary Ellen Bute, Oskar Fischinger, Harry Smith, Norman McLaren, James Whitney and John Whitney (*Figures 23–28*). Len Lye (*Figure 22*), Michael Smither (*Figure 5*), and Tony Nichollas (*Figure 15* and *41*) are New Zealand artists who have created dynamic and kinetic artworks which depict sound. It is interesting to note that the reoccurring imagery evident in each of these filmmaker's work includes the form constants as described by Kluver (1926).

Figure 23. Synchromy no. 2. Bute. 1936.
Figure 24. Early Abstractions Pt 5. Fischinger. 1946.
Figure 25. Early Abstractions, Pt 1. Smith. 1946–57.

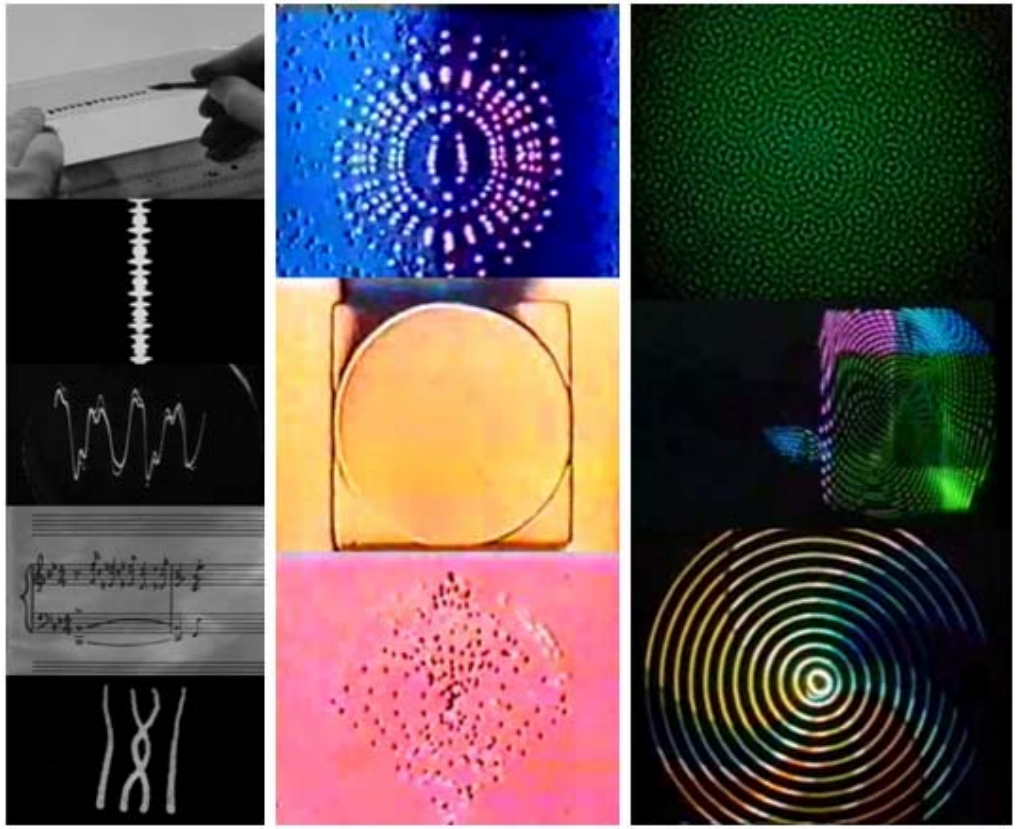


Figure 26. Pen Point Percussion. Norman McLaren. 1951.
Figure 27. Yantra. James Whitney. 1957.
Figure 28. Catalogue. John Whitney. 1961.

Two films were created during this thesis: one, *Dance of Light,* is a visual essay created to inform the development of the second film *Sound Vision*. *Dance of Light* was the first attempt at applying aspects of sound in a visual way incorporating light, colour, form and motion. Aspects of light, colour and form in motion extended into an aesthetically captivating and soothing form.

Filming with a high definition (HD) camera made capturing vibration at fast speeds more acute.
When artists began to use film and technology to express what sound looked like they were able to move away from the still frame into a multi dimensional realm where movement became an addition to the visual equation. By using film as the medium, Stafford says:

> I want to capture the added bounce that brain science contributes to cultural figurations from the hieroglyph to the techno scientific. Visual communication grapples with all levels of cognition to perceptibility by focusing and attuning our attentional mechanism with the moving world (Stafford, 2007, p. 4. pp. 6–7).

3.2 *DANCE OF LIGHT* AND EXHIBITION

With the intent of provoking a range of psychological reactions from the viewer, I created the preliminary outcome of this thesis, a 30 minute visualisation of sound in the form of a film called *Dance of Light*. The film was a series of short video clips, using different filmic techniques that manipulated colour and motion. Some of the films were creative and experimental, interpreting what sound looks like, other films displayed imagery of sound while putting into effect the therapeutic concepts I have researched. This film, along with nine other painted visual works presenting my thesis, were exhibited at the James Wallace Art Gallery in Auckland in November 2008. The paintings which translated my vision of sound into Mandalas, could serve to aid meditation. I explored the visual form of sound, through composition, colour harmony and I employed wave-like lines to excite optical sensation; creating visual movement like the movement of sound.

Some of the filmic imagery in *Dance of Light* employed techniques that have been found to speed or slow brainwave activity as described by Hollwich, 1979, Anderson, 1989, Demarco and Clark, 2001, and Piggott, 2006, to induce hyperactive states or aid relaxation. At this interim stage of production no vocal sound accompanied the film but instead it explored how rhythm, harmony and melody, visually. In order to achieve

aesthetic beauty and harmonic equilibrium, *Dance of Light* employed fundamental shapes, circular forms, waveguides, and centrifugal, rhythmic and repetitive motion. The film utilised structural patterns inspired by Hindu and Buddhist Yantra and Mandala diagrams as well as forms and motions evident in nature such as water, air and fire. The light, colour and form in motion were designed to keep the mind of the viewer in balance and focused. In order to employ Boyce-Tillman's statement 'For it is when the mind is calm and orderly that one can become sensitive to their perceptions to restore parts of their body that are imbalance to their natural frequencies' (Boyce-Tillman 2000, p. 193).

Figure 29. Exhibition opening with fellow exhibitors Sketchy, William Galpin at the James Wallace Arts Trust Gallery in Auckland. Background (left) reveals the small theatre where *Dance of light* was exhibited and nine Mandala paintings on wall (right). Linton. 2008.

The first research design phase demanded a real-world enactment of the work in a setting where I could take time to analyse whether the preliminary design was beginning to show signs of functioning towards my aims. The chance to exhibit motivated me to complete *Dance of Light* to a standard which might be capable of facilitating emotional change. During the three week exhibition I had discussions with over 100 visitors allowing me to reevaluate the design of the film, which have been refined in the second outcome, *Sound Vision*. These improvements enrich the content in *Sound Vision* helping it to more successfully serve as a prototype for visual healing than *Dance of Light*.

Figure 30. Small theatre in which *Dance of Light* was exhibited. Linton. 2008.

I found that the lack of sound was a drawback to this presentation, since half project was about sound. I found some of the sequences too long causing viewers to become bored and leave. I was however present to explain my project to them and explained the images as they came up. I found myself frequently forwarding the film to skip long and monotonous pieces. The flickering footage was too jarring to some viewers and disturbed them as they felt the footage may be harmful. The overall pace of the film was too slow and too long, with little continuity between the different shots. There were too many different types of images and a suggestion was made that the images should follow a similar theme, such as spectral light made with crystals or just the water cymatics.

3.3 DETAIL OF FILMIC VISUAL CONCEPTS IN *DANCE OF LIGHT*

This section describes how the aspects of sound, light, colour and form in motion have been applied to film using analog and digital techniques. Dance of Light was a 30 minute sequence of short video clips, each exploring one of the key kinetic outcomes of research.

3.3.1 CYMATICS

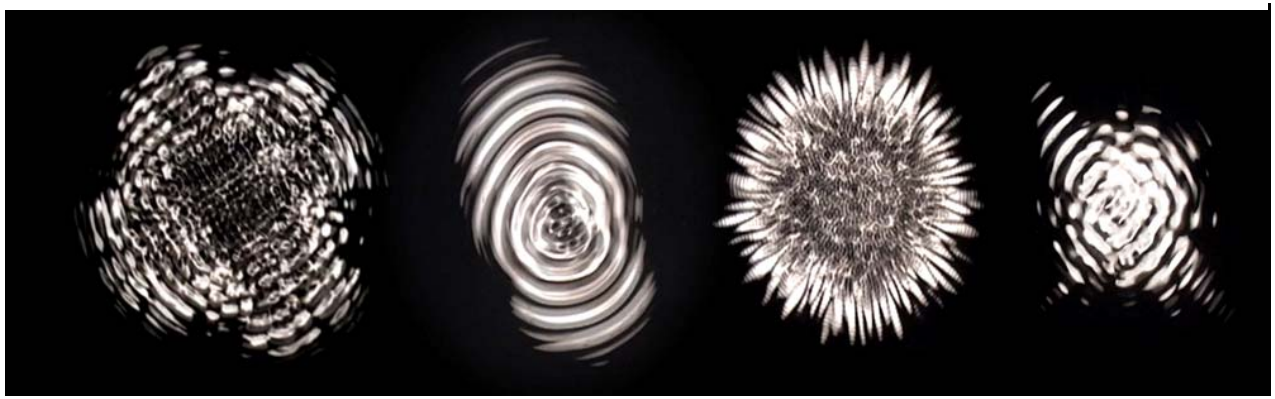
According to Hans Jenny, Guy Manners, Jim Reid and Alexander Lauterwasser, sound can be used for therapeutic purposes, as was already evident by Reid's Cymascope which was used as a tool for speech therapy. The footage of cymatics in *Dance of Light* was filmed at the 2008 fringe event *Fanotron* where director and physicist Thomas Murphy used the device to teach people about Hertz frequencies. A pool of water was set up on top of a speaker through which a tone was sounded by a tone generator. The quality of the sound from the tone generator was a pure sine wave which vibrated the water, forming corresponding geometric shapes.
To capture this footage the light and the camera were situated directly above the pool, about 1.5m away.

Viewers at the exhibition found the cymatics to be awe inspiring and attractive. To some people the images were dazzling, stopping them in their tracks and through capturing the attention of their visual sense,

they focused on the self. By guiding the viewer into a hypnotic trance or meditative state, salutogenic effects may have been be enticed. The Mandala like shape which appeared to emanate out from its central point assisted in drawing the mind into a centred point of focus; to function in a way similar to Hindu Yantra which aids concentration by blocking out external distractions.

Many cymatics experiments have since been carried out. In order to capture the wave motion of the vibrating water from the side, I filmed the cymatic activity through a transparent balloon, filled with water, sitting on the speaker. This technique led to others like filming caustics from sunlight by cast through water onto a flat surface, and filming up from underneath the surface of the water. Caustics are light effects and specular patterns that are cast on surfaces as a result of focused light reflecting off highly reflective surfaces or refracting through translucent surfaces. The light patterns that occur on the bottom of a swimming pool on a sunny day, or the bright areas that occur in the shadow of a glass object as light shines through it are examples of caustics.

Fig*ure 31. Cymatics* from *Dance of Light*. Linton. 2008.



3.3.2 CRYSTAL SPINNING

The aim of this experiment was to capture naturalistic changing spectral colour on film.
The aim of the crystal spinning slowly in the centre of the screen was to create a centre of focus, while colours of light shifted slowly around. Because different colours have different psychological effects, the purpose of this clip was to sustain the viewer's attention upon one colour at a time by utilising form in movement with colour.

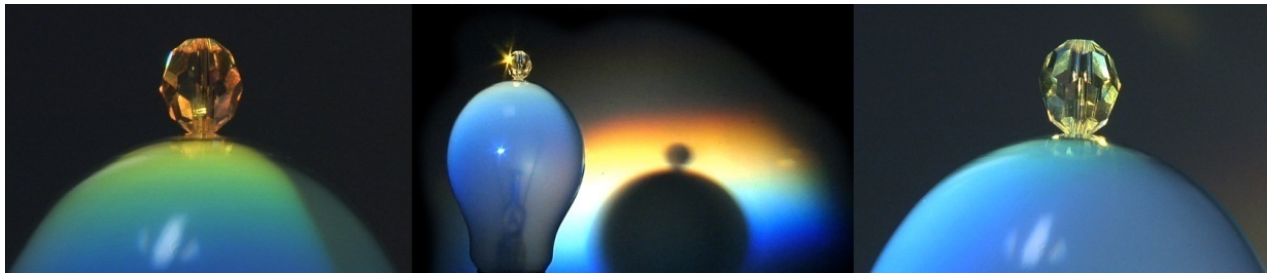


Figure 32. Crystal Spinning from *Dance of Light*. Linton. 2008.

3.3.3 RHYTHMIC FIGURES TURNING

These images used the human body to create a Mandala in coloured light. In these pictures, figures dance in rhythmic motions, creating shapes from light with their bodies. The dancer spun, leaving a circular trail in her wake, with her head, arms and skirt. Pink, red, blue and purple were used in these clips, in an attempt to stimulate different psychological effects.

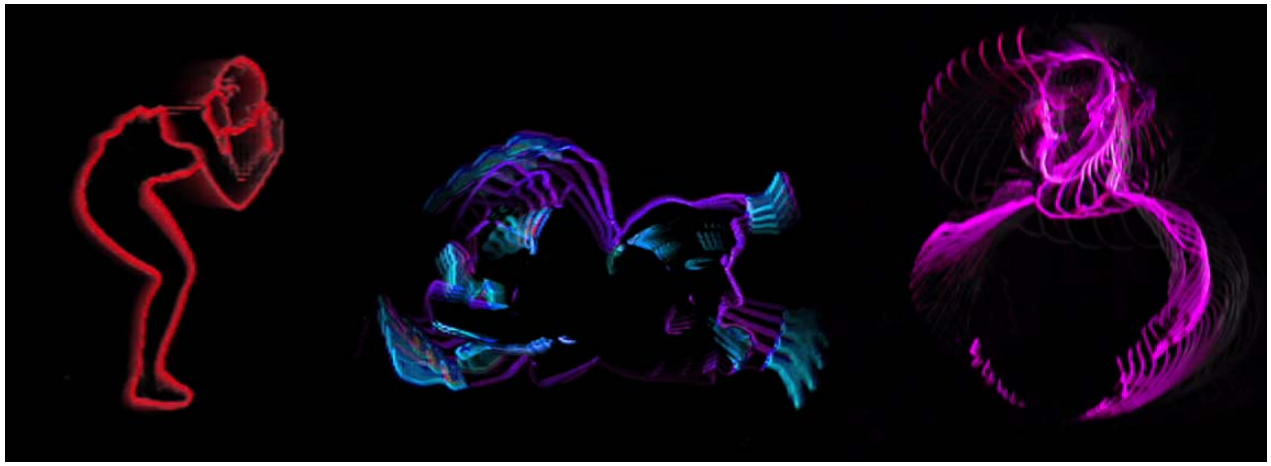


Figure 33. *Rhythmic Figures Turning* from *Dance of Light.* Linton. 2008.

3.3.4 MANDALA DANCERS

Based on the idea that the visual form of sound can be a circle, spiral, torus and cone shape,
the figures dancing have been repeated in circular form, to create this imagery I directed three dancers in a green screen room to create sound-like shapes with their bodies. One of the dancers wore a dress which, when she spun, fanned out like a flower. I filmed this action in slow motion with a HD camera from directly above. Other actions included moving the body in undulating and rhythmic ways, and spinning. A rotating floor was used to capture 360 degree rotation of the figures. Light and effects have been applied in post production to achieve brilliant vivid light. Ideas explored centrifugal motion, balance, Mandala and geometric shapes, with the form of the body in motion. In this image the red and blue colours have been selected for their psychological qualities and to bring equilibrium to the eye.

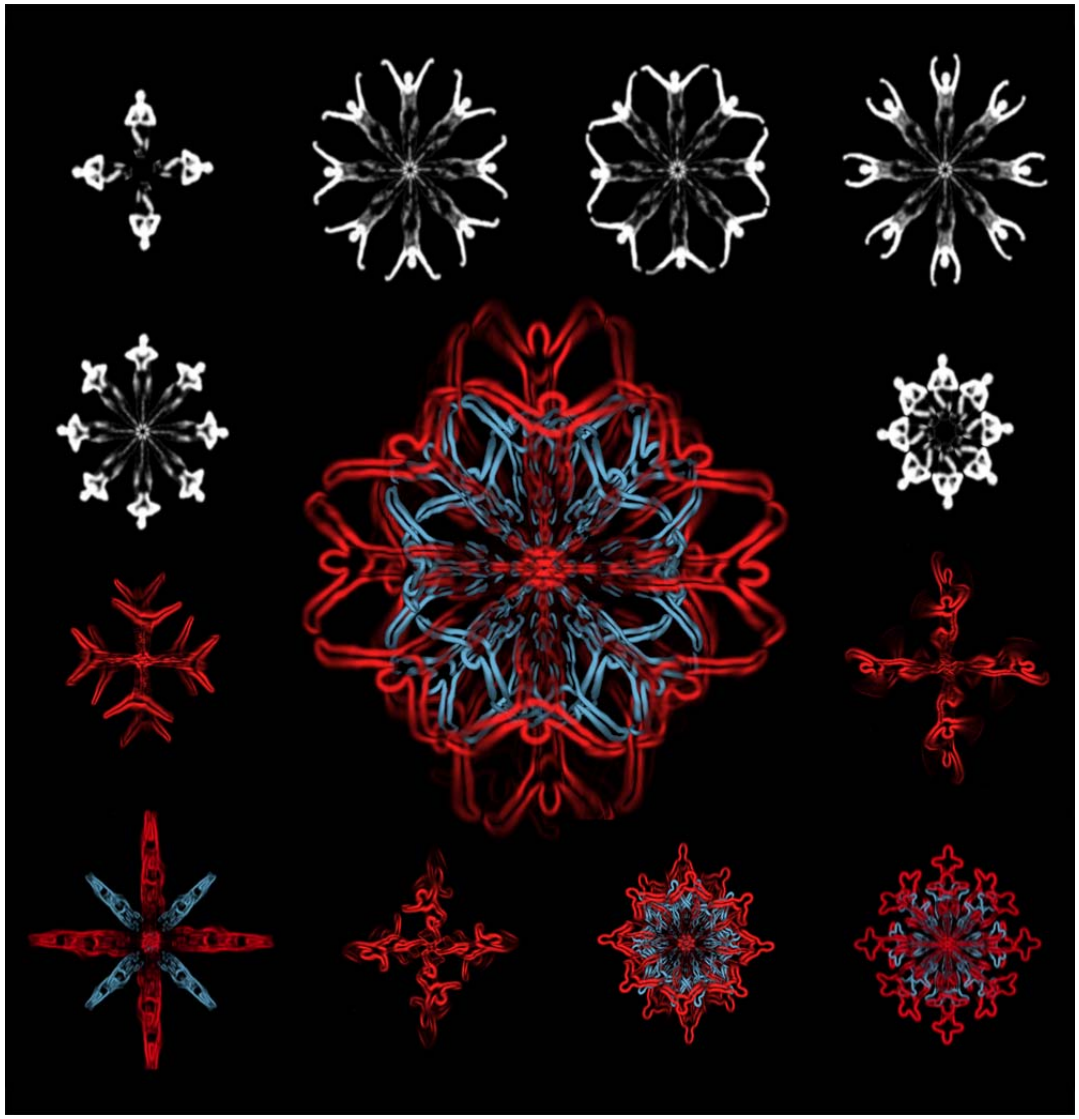


Figure 34. Mandala Dancers from *Dance of Light.* Linton. 2008.

3.3.5 PAINTING SERIES

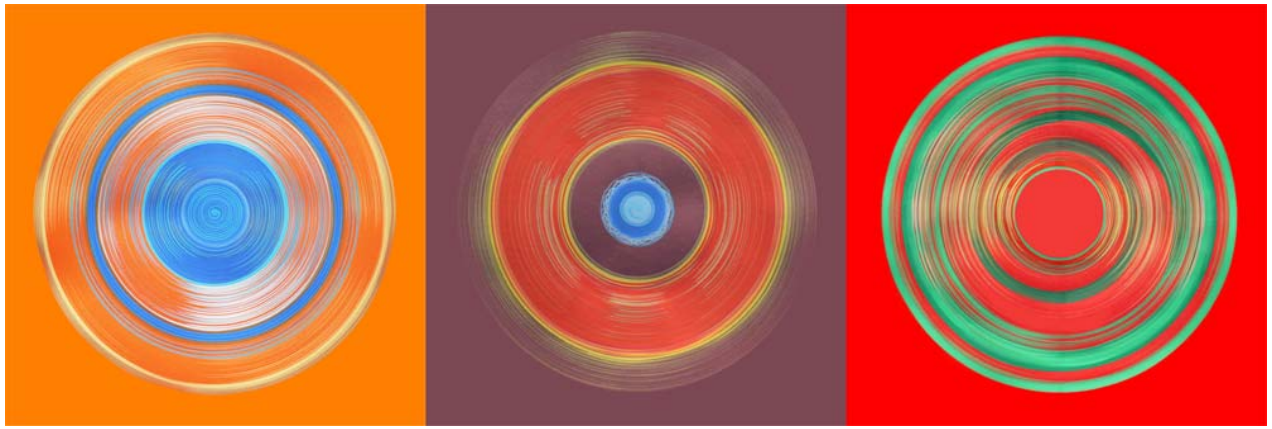


Figure 35. Paintings Turning from *Dance of Light.* Linton. 2008.

I painted a series of nine pictures to experiment with complementary colour, after-images and to explore how visual movement can be created within a static image (as the eye becomes excited by contrasting colours set against each other). Painted with gouache on coloured paper, complementary colours, and gold and silver paint were employed to create after-images, scintillating; that is the flashing effect of light as it flickers on and off as if glittering or sparkling. The circular images were made on various rotating devices such as a lazy susan, record player and spinning fan to achieve different painterly effects at different speeds. Many of the paintings were developed with mathematically proportioned divisions including the green triangles on a red background (*Figure 37*). I also painted some detailed Mandala; one of these images, *Hildegard's vision*, (*Figure 36*)
is a richly coloured and intricately painted ring of forms that when viewed, appears to glow and shimmer.
The concentric rings in this image are also mathematically proportioned to achieve optical harmony.

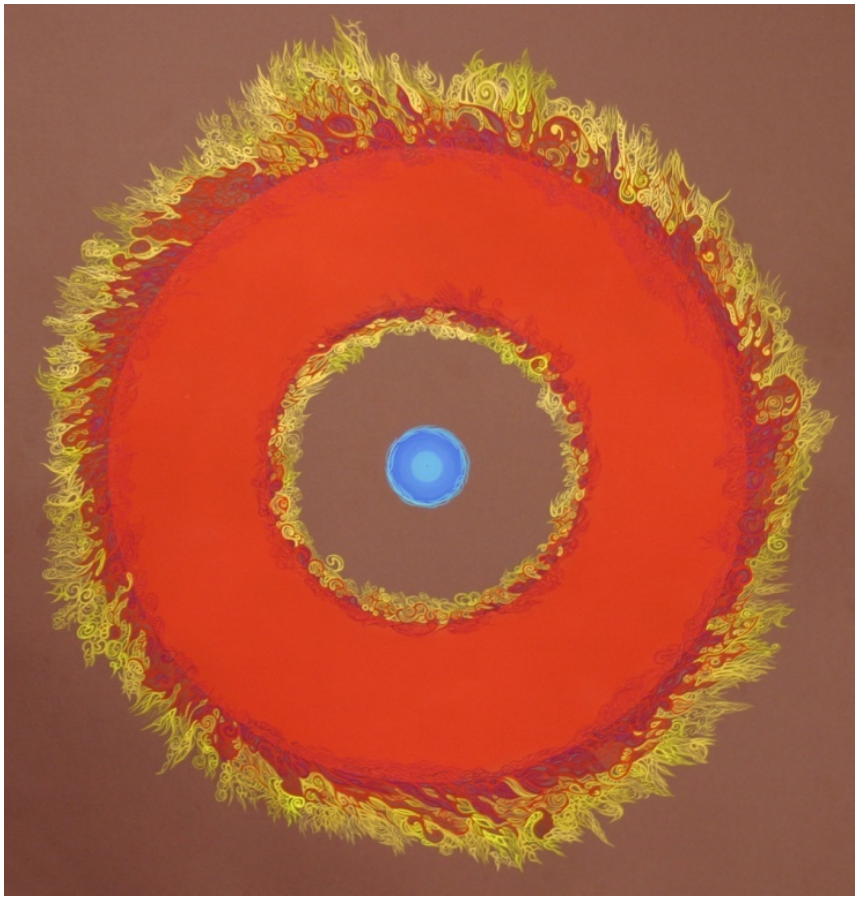


Figure 36. *Hildegard's Vision*, gouache on paper. Linton. 2008.

Four of the nine pictures exhibited at the gallery were included in the dance of light becoming animated by rotating in motion. The aim of placing the paintings on the screen was to see if the light and colours of the images, combined with motion, could enhance soothing effects. Many viewers seemed to like this work, captivated by its simplicity and slow motion; therefore I believe that the transition from still to moving image successfully enhanced its soothing effect.

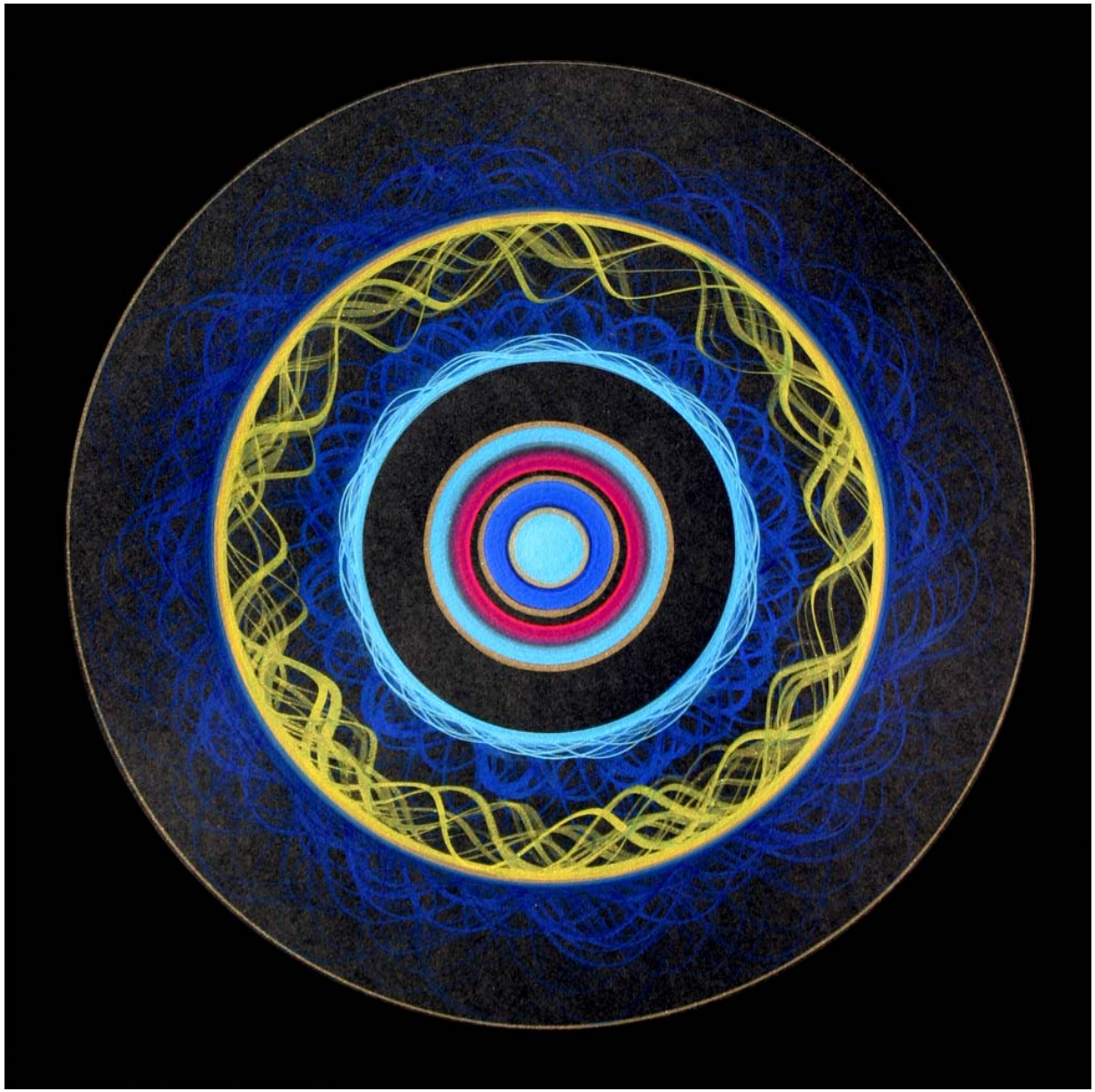


Figure 37. Atomic, Gouache on paper. Linton. 2008.

3.3.6 RED/GREEN TRIANGLE

High definition filming was particularly beneficial for this experiment of a spinning green triangle on a red background. I spun the triangle at three different speeds, slow, medium and fast. Visually, different patterns were perceived during the different speeds of rotation although the original image is just a triangle. According to the speeds, the triangle showed a rotating, scintillating six pointed star, a static triangle, or a faster moving twelve pointed star. This piece of footage, in particular, was found to draw the viewer into an intense sense of focus, for this reason I believe it would be relevant to the heightened perceptual content of the second outcome, *Sound Vision*.

Figure 38. Red/green triangle from *Dance of Light.* Linton. 2008.

3.3.7 GLITTERFAN

The fan was a sparkling, children's toy which, when spun, glittered like a spectral rainbow. Captured on film in HD at a low shutter speed, the colours formed round circles. The fast action combined with all the primary hues created a colour wheel in brilliant dazzling light. The experiment played with light, colour, circles and spinning, to create a visual meditation.

Figure 39. Glitterfan from *Dance of Light.* Linton. 2008.

3.3.8 PAINTING WITH WATER

Water is a medium that acts in a manner like sound as has been discussed. In this experiment coloured paint was dropped onto a pane of glass covered with water and other coloured paints. When new colours were dropped into the mix the original substances moved aside for the new to spread out in a fan-like manner, bleeding into and mixing with the old. By manipulating the water in many ways, hexagonal structures like honeycomb, vortex-shaped whirlpools, and Mandala patterned ripples could be observed; using water as a visual counterpart to sound.

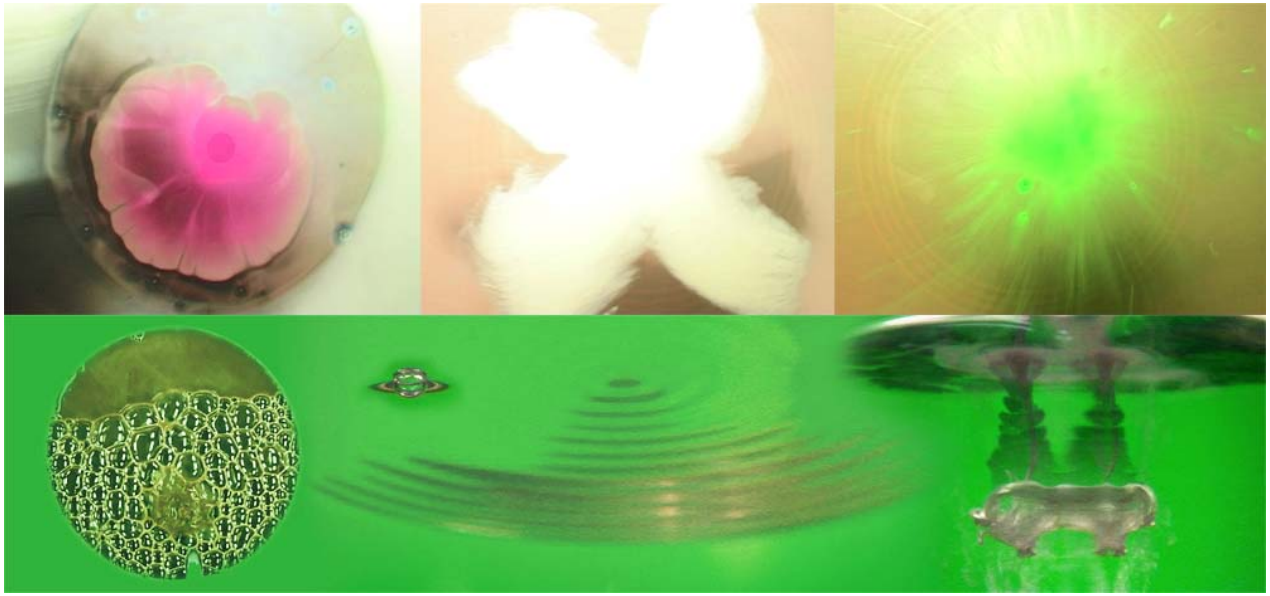


Figure 40. Painting with water from *Dance of Light.* Linton. 2008.

3.3.9 VIBRATING STRINGS

Tony Nichollas, a fellow enthusiast in the visualization of sound vibration, exhibited his work at Enjoy Gallery in Wellington. Nichollas attached strings to wires which were connected to speakers with sound running through them. The strings jumped and quivered in response to sound vibration created by computer generated tones. I filmed the exhibition with a high definition camera in order to pick up the high speed fluctuations of the vibrations which created constructive and destructive interference patterns.

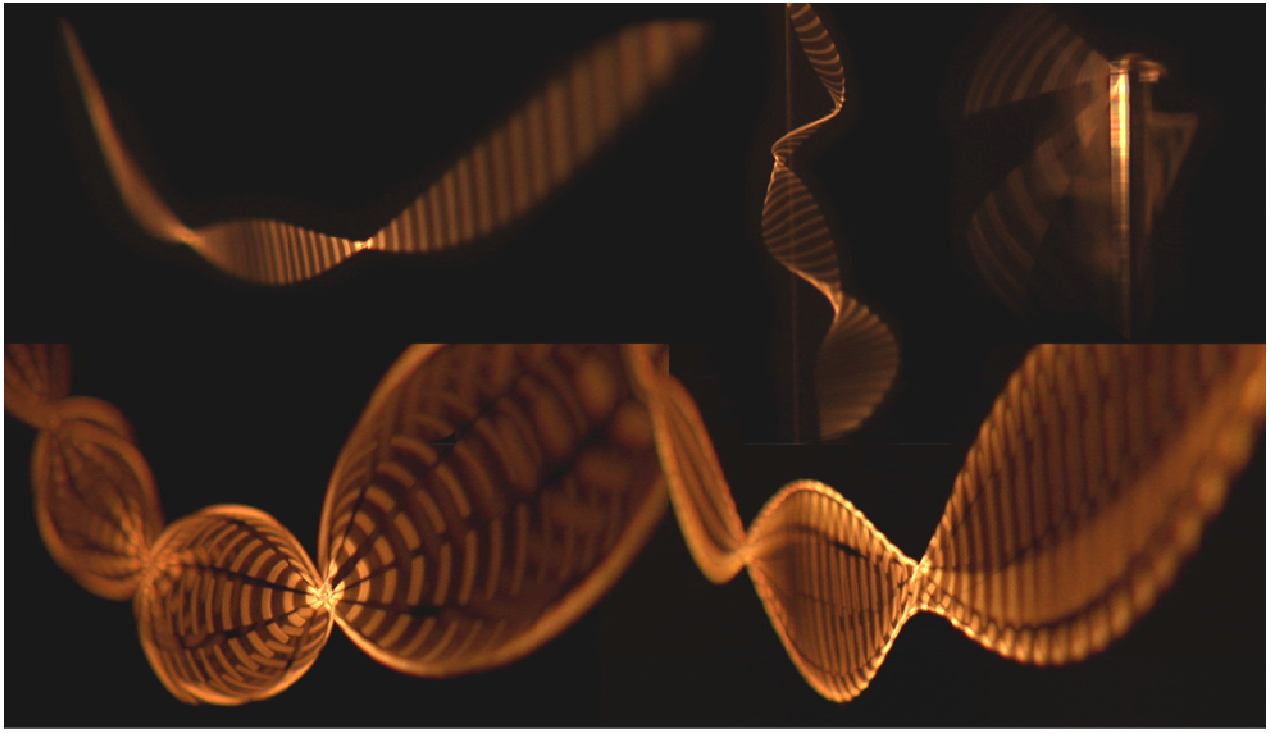


Figure 41. Vibrating strings from *Dance of Light.* Nichollas–Designer. Linton–Photographer. 2008.

3.3.10 GUITAR STRING

The initial inspiration for this thesis was inspired by green and red colours in the vibration of a guitar string. Using high definition digital video I tried to recapture the colour in the vibration beneath a variety of different light settings. Although I did not recapture the vivid red and green, I did capture blue and yellow. This experiment shows how diffracted and refracted light produce different colours and how the observable brilliance of the colour can be enhanced through specific speeds of vibration. There seem to be four strings in this picture, however the middle two are one string, captured in vibrating motion. The different colours were created as light diffracted around the silver string and became more or less brilliant as the frequency of vibration changed. I had most success gaining vivid colour, red and green or blue and yellow, on the A string, tuned to 440 Hz under fluorescent light.

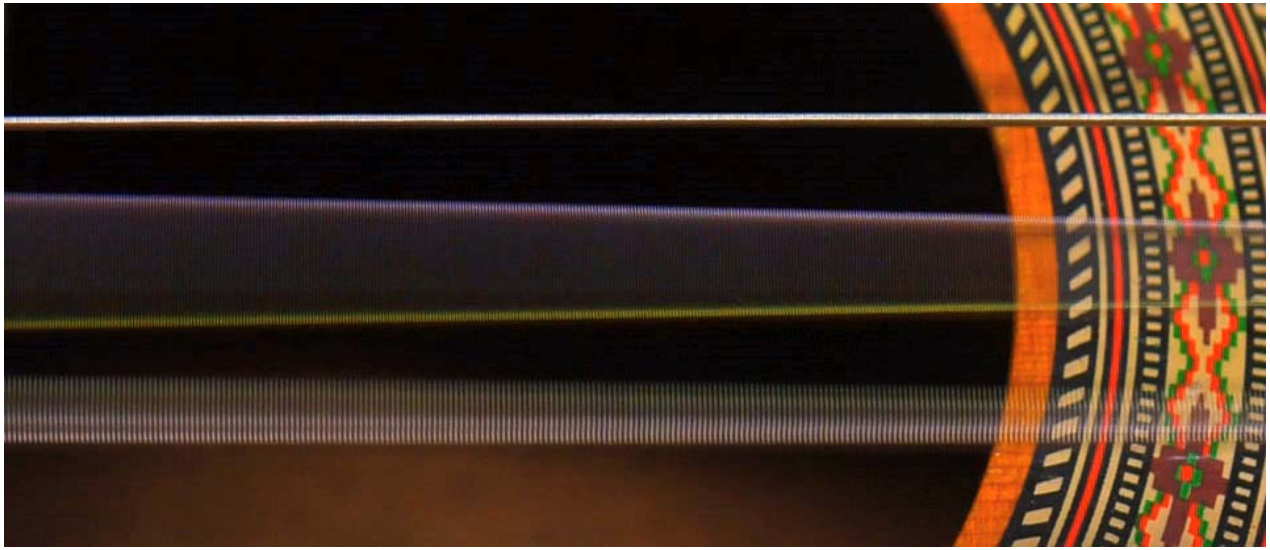


Figure 42. Guitar string from *Dance of Light.* Linton. 2008.

3.3.11 SMOKE

In *Dance of Light* the smoke came after the vibrating guitar string in sequence, to acknowledge a visual relationship between the superposition of the strings vibrating light and the smoke's overlapping wave patterns which created spectral colour.

This imagery served to look like the breath, with spiraling forms which were long, slow and transparent.
As sound created in singing, united with the breath I thought about what the breath looks like. In August 2008, I collaborated with Wellington director Yvonne MacKay to design a visual manifestation sound for the TV documentary *The Silence is Over, Taonga Puoro,* featuring reknowned authority on Traditional Maori musical instruments, Dr. Richard Nunns. The title sequence employed conceptual visuals on slow flowing breath, like blowing into a *Koauau*, Maori wooden flute. Smoke was filmed for its aesthetic similarity to steam coming off the breath and a koru, traditional Maori symbolic form was selected to symbolise sound. The result was a hazy flow of spiraling blue light and the program was released on TV3 in December, 2008.

Figure 43. Title sequence for *The Silence is Over, Taonga Puoro.*
Commissioned by ProductionShed.TV. Linton–Designer. 2008.

3.3.12 CIRCLE OF LIGHT

In this footage rays of sunlight were cast through a round plastic protractor. This experiment allowed me to study the form and motion of a ring of spectral light. By manipulating the distribution of colour in the caustics as well as the shape of the ring of spectral light, I was able to fine-tune methods that would enable me to adequately capture the movement of light and colour on film for the later outcome, *Sound Vision*.

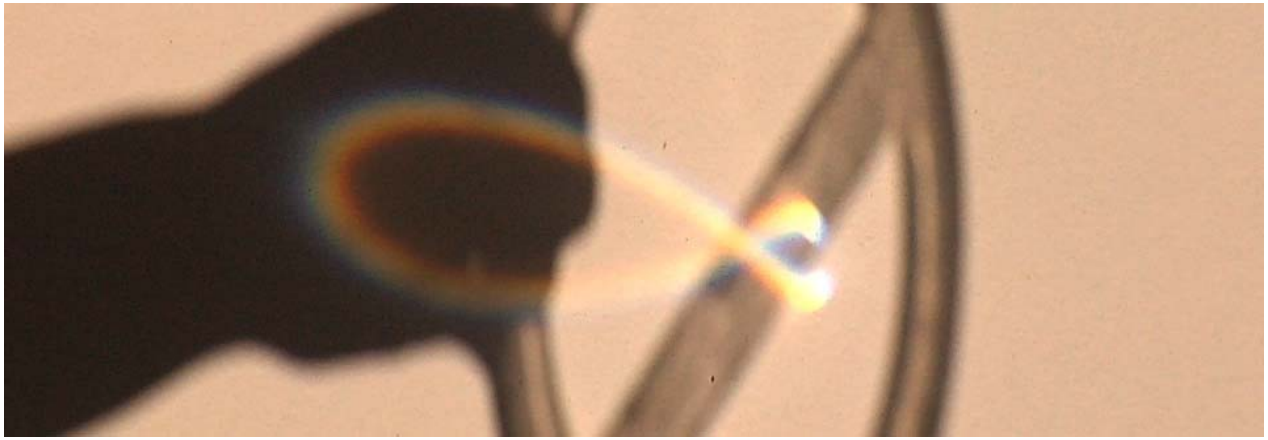


Figure 44. Circle of Light from *Dance of Light.* Linton. 2008.

3.3.13 CRYSTAL CUBE

This effect was created by the interaction of spectral light refracting through a crystal cube in motion (rotating). The caustic formation was captured by a three dimensional light refraction localising to form new shapes. The form and motion contributed to the apparition cast by the ray of light after it passed through the crystal. The cube geometry contributed to the x, y, z planes of light, which were all visible as separate entities, cast onto the shadowed white wall. To capture this footage I set the magic cube rotating on a record player and set the camera on a tripod, filming the coloured light and shadow play on the wall. The dimensional shapes oscillated up and down at different speeds relative to one another. From this experiment I observed a great relationship between light/colour, magic cubes and geometry, which Claude Bragdon (1866–1946) also studied. This experiment led to further explorations using pyramid, star-shaped and spherical crystal objects. From an emotional perspective, this footage relates closely to the deep relaxation stage of the later, *Sound Vision*. The illusion of dimensional planes of colour that seem to form during this process is similar to the illusion of depth that can be seen in the complex geometric shapes of Hindu Vedic Yantra.

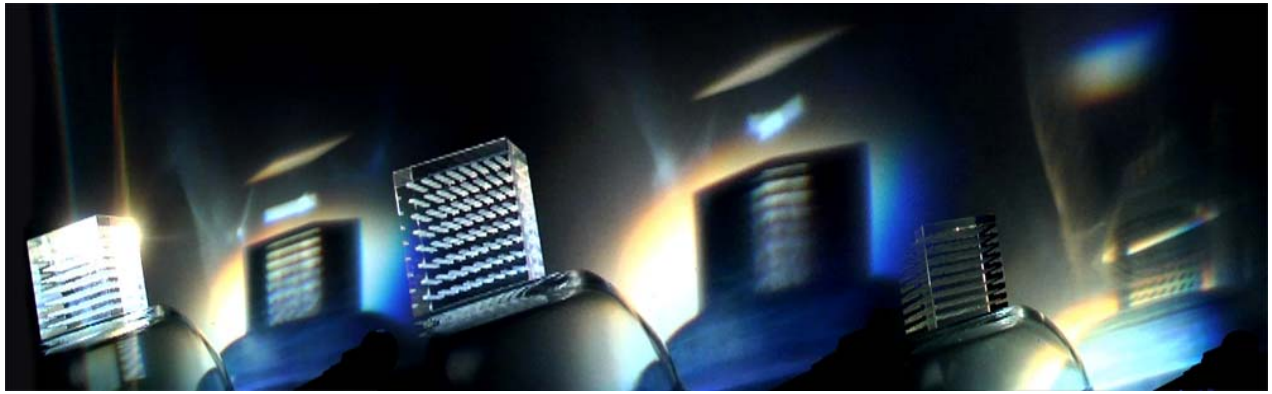


Figure 45. Magic Cube from *Dance of Light.* Linton. 2008.

3.3.14 SPINNING SHAPES

Inspired by the star shapes of *chakras* and the concept that they are spinning vortexes of energy, these photographs captured shapes spinning to capture motion blur. To observe how simple forms in motion can create new complex, spinning shapes such as a trefoil, visca pisces, love heart, and snow flake were studied. Lines were created with silver and gold leaf to reflect light. Precise control of the light and shadows and speed of rotation was controlled to capture specular illumination. The techniques trialed during this process of spinning metallic shapes influenced the development of the other spinning compositions such as the dancers, glitterfan sequined cloth and magic cube.

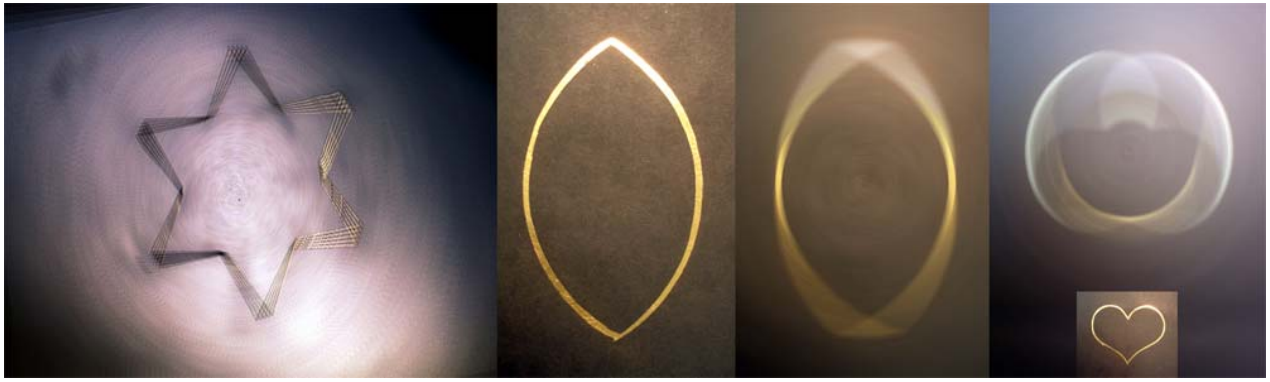


Figure 46. Spinning Shapes from *Dance of Light.* Linton. (2008).

3.3.15 SEQUINED COLOURED CLOTH

This sequence displayed coloured sequined fabric spinning on a fan. Spinning at different speeds caused the fabric to create rippling effects as the speed of the spin changed. Different colours and speeds of rotation varied the scintillating effect of the imagery. This experiment was similar to Janet's soothing strobe fan (Pigott, 2006), therefore it may have the potential to act successfully as a visual therapy. If this project was taken further into collaboration with scientists, tests conducted by measuring the EEG patterns of individuals viewing this colour stimulation at various degrees of scintillation may reveal how physiological and psychological states can change via the visual sense.

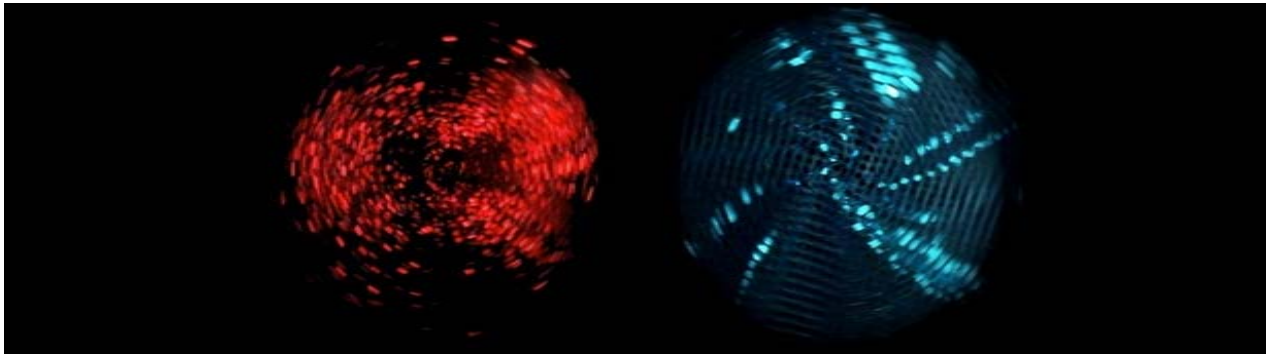


Figure 47. Sequined Coloured Cloth from *Dance of Light.* Linton. 2008.

3.3.16 SILVER DRESS

During the green screen filming of dancing figures for the Mandala Dancers, I was unable to capture the imagery in the way I had envisioned. This allowed me to develop and elaborate upon this pivotal idea before committing to film. The dress was designed for a dancer to spin in, so the skirt spreads into a full circle.
The ripples created by the dress are like waveforms and are visually similar to the imagery of the cymatics. When viewed from above, the circle created by the radiating skirt combined with the dancer's spinning arms and head create Mandala-like shapes. The flowing and undulating motions of the skirt move like water and the dress is reflective of all the experiments I have carried out with water. The flowing and undulating motions of the skirt link with the spiritual Sufi who spins in a spinning movement to keep their mind focused and balanced. The dress is made out of silver grey lycra, selected for its sheen, which captures the light whilst retaining dark shadows. On film this allowed me to capture a dance of light: literally shining light on the figure. Depending on the colour of light I choose to shine on the dress it is possible that reciprocal psychological/emotional reactions may be enticed. Pink, for example, shone on the figure spinning and filmed in slow-motion may produce an aesthetically dazzling and emotionally calming effect.

Figure 48. Silver Dress. Linton. 2008.

3.4 OUTCOME OF EXHIBITION PROCESS

The functional aim of the film, *Dance of Light*, was to facilitate states of calm, focus and concentration in the viewer. This was measured by questioning visitors after they left and by observing them as they watched the film. The imagery in the film seemed to affect everyone differently, some people were unaffected by the imagery as they were uninterested, while others were bewildered. Some were deeply moved by the imagery and others reacted with surprise, satisfaction and awe. Although parts of the film appeared to draw focus,
I accepted that the manner in which it was achieved was a bit aggressive. When I saw viewers' reactions in response to the scintillating imagery I doubted its capacity to be soothing as it appeared to distress them.
I observed one viewer jump back as if stunned when she saw one of my paintings for first time. Painted with fine vivid green lines, the complimentary colour created discord against its red background, to entice
after-images. During the exhibition I was able to determine approximately which films were stimulating, which evoked serenity, and which images had no effect at all. By observing viewers and understanding the concepts of simultaneous colour contrast, I was able to select colours to carry through into the next work – *Sound Vision* – in anticipation of their discordant or harmonious effects on the viewer.

4 SOUND VISION THE FILM

Sound vision was my second outcome, planned to extend successful aspects of the first, test film – *Dance of Light*. *Sound Vision* presented digital video format images which danced in brilliant colour. It conveyed footage with the aim of inducing meditative states and soothing effects within the viewer.
The audio and visual techniques were informed by rhythmic, undulating forms and movements of sound which had been tested successfully, earlier. Wave motion was selected as an aesthetic device and sound waves, light waves and brain waves were considered for their intrinsic link to vibrational therapy. The audio and visual techniques used in *Sound Vision* were selected from spiritual and scientific knowledge. By selecting techniques from practices where the therapeutic characteristics of sound, colour, form and motion are recognized, *Sound Vision* acts to translate them to the screen. The techniques used in the film, which derive from vibrational therapy and brainwave entrainment, are new technologies which have not been extensively researched, although, they have been found to be useful within many programs to enhance the relaxation response (Sound for Healing, 2004).

The film integrates audio and visual aspects of singing, meditation and dance in an abstract, controlled and informed display of filmic light travelling in repetitious and patterned movements.

4.1 SOUND IN SOUND VISION

In *Sound Vision*, pure resonating sound, imitating chant, overtone, Tibetan throat singing and *Om* meditation unite distinct historical vocal sounds which are recognized to have therapeutic capacity. Each of these vocal techniques has been described to elevate or balance the mind of the listener (Campbell, Schelde, Gregory).
The sounds are vocal but non lyrical, harmonic, repetitious and percussive and are set side by side with complementary visual elements. Some of the visual elements directly reflect the sound vibration that creates them while other parts of the film display metaphorical and abstract visuals set to ambient singing. The sound in this piece is deliberately vocally resonant as female and male voices carry the listener weightlessly through the film.

I conducted several sound recording sessions in the Great Hall at Massey University, Wellington. As a vast dramatic space with a roof standing 25m tall, the Great Hall is one of the largest rooms in New Zealand.
The full, echoic and resonant sound assisted in experimenting with sound integration ideas. During one session I directed three professional singers to create vocal sounds that resembled church choir music, Gregorian chant, opera and contemporary *a cappella* jazz. My aim was to listen to how the resonant space affected the percussive qualities of the voices. At various times throughout the session we lulled ourselves into serene and meditative states as well as trancelike and hyperactive states. Remembering Campbells observation that 'Ancient Hindu people realised that certain sounds released postural phenomena' (Campbell, 2000, p. 16),
it was interesting to note our movements which involved stretching and yogic poses, during this two hour singing session. This was also noticeable during another session where four musicians all exhibited the need to stretch out their bodies, especially the spine. This second session employed sound equipment such as loop peddles to create vocal repetitions. The human vocal spectrum was well represented at this session with a soprano, alto, tenor and bass; four-part harmonies were possible. It was during this session that the music was created for *Sound Vision's* soundtrack (*Figure 49*).

Figure 49. Vocalising musicians, Edward van Son, Linda Joy, Hannah Simpson and Warwick Donald in The Great Hall, Massey University, Wellington. Linton. 2008.

The sequence of sound over the duration of these experiments informed the structure, motion and pace of the sound in *Sound Vision*. Different kinds of sounds were placed to define distinct parts of the film, from a swell into hyperactivity to a restful lull. Highly stimulating sounds as well as imagery served to excite the viewer before the release and relaxation phase of the film. An important aspect about the sound throughout *Sound Vision* is that it has flow and movement and does not break. Kahn says:

> The secret of composition lies in sustaining the tone as solidly and as long as possible through all its different degrees. A break destroys its grace, power and magnetism, just as the breath holds life and

> has grace, power and magnetism. There are some notes that need a longer life than others, according to their character and purpose (Khan, 1991, p. 63).

The vocal sound should ideally be listened to through stereo headphones so that an adequate percentage of sound can enter the ears to achieve an enhanced aural experience. The audio track has been designed specifically for headphones. Sound and light can both be beneficial or detrimental on health, depending on the way the stimuli are used. If it is too loud it can damage the eardrum; every person's sensitivity thresholds are different and so whilst listening to *Sound Vision*, if the user feels uncomfortable they are advised to take off the headphones or turn the volume down.

4.2 COMPOSITIONAL STRUCTURE OF SOUND VISION

Jonathan Goldman and Nick Florenza suggest that we need to be cautious with electronically generated frequencies (Campbell, 2000, p. 231) because if they are used for sustained periods, they may trigger and hold a person in psycho-emotional states. Florenza says that certain frequencies can trigger or accentuate conditions of weakness such as suppressed fear, anxiety, or paranoia and for this reason he suggests that when using frequencies for healing purposes, specific frequencies (especially coordinated with colour and sound), should be used in sequences designed to bring a person completely through a healing crisis rather than simply trigger a condition, or worse yet, sustain it (Flornza, 2003).

The sequential structure of *Sound Vision* has been designed with the aim of creating a harmonic equilibrium in the mind. The sequence of the film takes the viewer on an audiovisual journey through a series of emotional states. The time-based flow of the film is shaped into a sine wave beginning from a psychologically neutral state which gradually increases into highly active and alert attention, then releases its tension and the viewer is drawn into a meditative and calm state and then back to neutral. The decision to arrange the progress from high to low frequency was a deliberate choice. One of the overall aims of this project was to bring focus and balance to the viewer to facilitate entropic healing, consciously focusing on one's salutogenic capability to heal. The longest amount of time in the film is spent in the deep meditative phase where delta brainwaves aim to be enitced. Delta activity (0–4 Hz) is associated with deep sleep and can in certain frequencies trigger the release of growth hormones beneficial to healing and regeneration. Each of the states are simulated by applying colour and sound in ways that have been used by ancient practitioners of meditation as well as contemporary

therapists. Colour harmonies in Sound Vision have been composed to generate a state of equilibrium in the eye by balancing complementary colour values to a neutral grey, using the quick colour reference guide, based on Itten's theories, in Appendix 4.

4.3 WHAT IS SPIRITUAL AND WHAT IS SCIENTIFIC SOUND VISION?

Some of the techniques utilised in *Sound Vision* are derived from the ancient Hindu and Chinese science of Kundalini while others draw from the Buddhist construction of the Mandala. From contemporary derivation comes the sound which is inspired by Robert Monroe's Binaural beating.

Both ancient traditions and scientific research provide tried-and-true knowledge for the future of the healing arts. In the design of this work, components of sound, colour and form in motion have been diligently selected. As the resulting formula is in digital video format, all the elements together must be able to be rendered, while retaining their psychological effect, in this context. The final work incorporates auditory and visual elements that are influenced by ancient and scientific methods described to alter conscious perception and biophysical chemistry to propagate healing effects.

The sound is inspired by Gregorian chant, Tibetan throat singing and the primal sound *Om*, uniting sound and space to create an atmosphere conducive to focus and balance the conscious states of mind.

It is imagined that this kind of digital video device would assist people with neuropsychological disorders and could be used safely and successfully within the clinical setting.

4.4 PREPARATION AND SETTING FOR VIEWER

Sound Vision serves to interrupt negative emotional thought patterns such as anger, worry, sadness, irritability and depression by helping the viewer to feel at ease, aiding concentration, calming the mind and soothing the body. These results are not guaranteed as they have not been qualitatively tested at this stage. *Sound vision* is not intended to substitute for consultation with a physician or mental health provider.

Those receiving this audio-photic stimulation are instructed to do as little intentional focusing as they are able. To fully experience *Sound Vision* the viewer is asked to remain attentive to the sounds and the visuals but to let their mind drift and wander as much as possible without direction. It is suggested that the viewer remains in a comfortable sitting position and allows the colours and patterns take them wherever they go.

If the viewer feels like their eyelids are getting sleepy and would like to close their eyes they should feel free to do so, remaining however in an active, conscious state they can focus on entering into a meditative state, experiencing the scintillating light with their eyes closed.

5.1 CONCLUSION

Sound, light, colour and form in motion were the subjects of this investigation to visualise sound within the context of therapy. Historical and contemporary evidence meet to inform how audio and optic excitation can influence human physiological and psychological states.

Sound Vision, the film, was created as the practical component of this thesis and augments creative analogies of the visual form of sound with an audio soundtrack towards anticipated therapeutic outcomes. Electromagnetic vibration was regarded by both historical and contemporary views to contain certain therapeutic qualities and empirical research by Oschs (1994), Barber (1999), Monroe (Lewis, Osborn and Ram Roth, 2004) and Pigott (2006) reveal that sound and light stimulus may have capacities to harmonise energetic imbalances within the body. In order to be informed by scientific as well as long held spiritual beliefs, neurological studies on how sound, light, colour and form affect the psychological and physical body have contributed to this design.
The film unites vocal techniques of overtone harmonic singing and chant, believed in by ancient Hindu and Buddhist religions for their therapeutic capacity, with scintillating light, harmonious colours and geometric shapes to entice psychological and cognitive changes within the viewer.

Further stages of enquiry with *Sound Vision* might entail methods to obtain and evaluate specific data, to measure the viewer's responses to the film capturing EEG data, hormone levels and details of autonomic function to deduce whether the audio and visual content did produce therapeutic changes. Certainly scientific testing would have to be extensive and properly managed to consider the many variables but could the techniques presented in this research, be honed with mathematical precision, to harmonise energetic and cell imbalances within the body to produce controlled physical and psychological changes?

Sound Vision is a contribution to the field of sound and colour therapy through the eyes of a designer, drawing together art, medicine, philosophy, religion, science and acoustics. At the forefront of exciting new developments in the fields of technology and neuroscience, researchers are unraveling new ways to heal.

This experimental film *Sound Vision* grasps the visual form of sound, uniting it with historical and scientific ideas of healing sound and light. The film is a dance of light and colour; composed forms oscillate like waves of sound and undulate like ripples of energy in rhythmic motion. The accumulation of techniques in *Sound Vision* may have the capability to plunge the viewer into a focused meditation through which their aural and visual perception may facilitate calm and balanced states.

This is also a study into the interaction of wave frequencies to discover how aural and visual stimulation, sensed by way of a film, contributes to the field of psychoneuroimmunology. The role which light and colour can play in therapy is an exciting field of research where designers, as visual communicators, have an important role in assisting developing ideas with scientific experts who investigate sound, light and colour to create new modes of healing.

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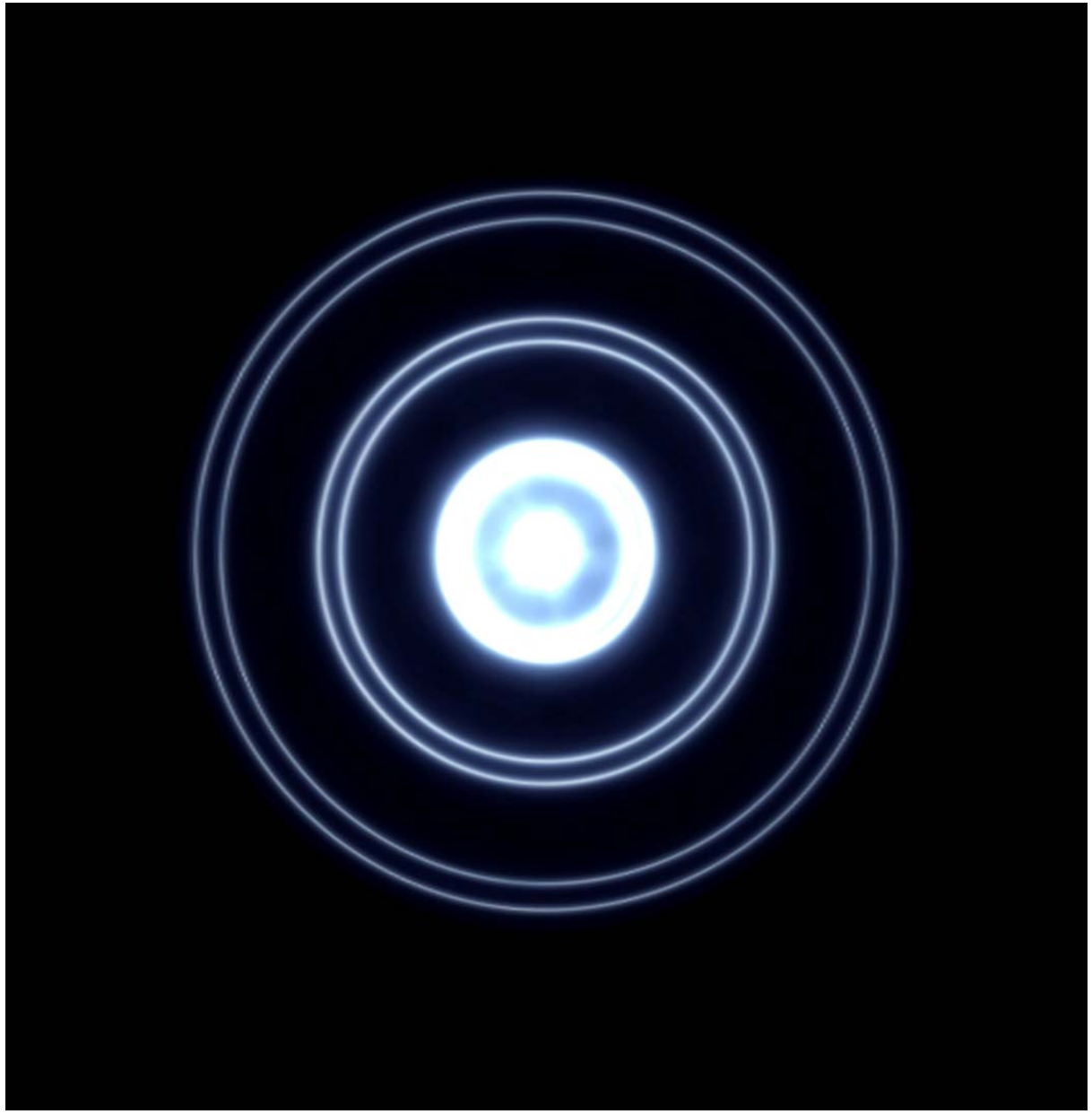
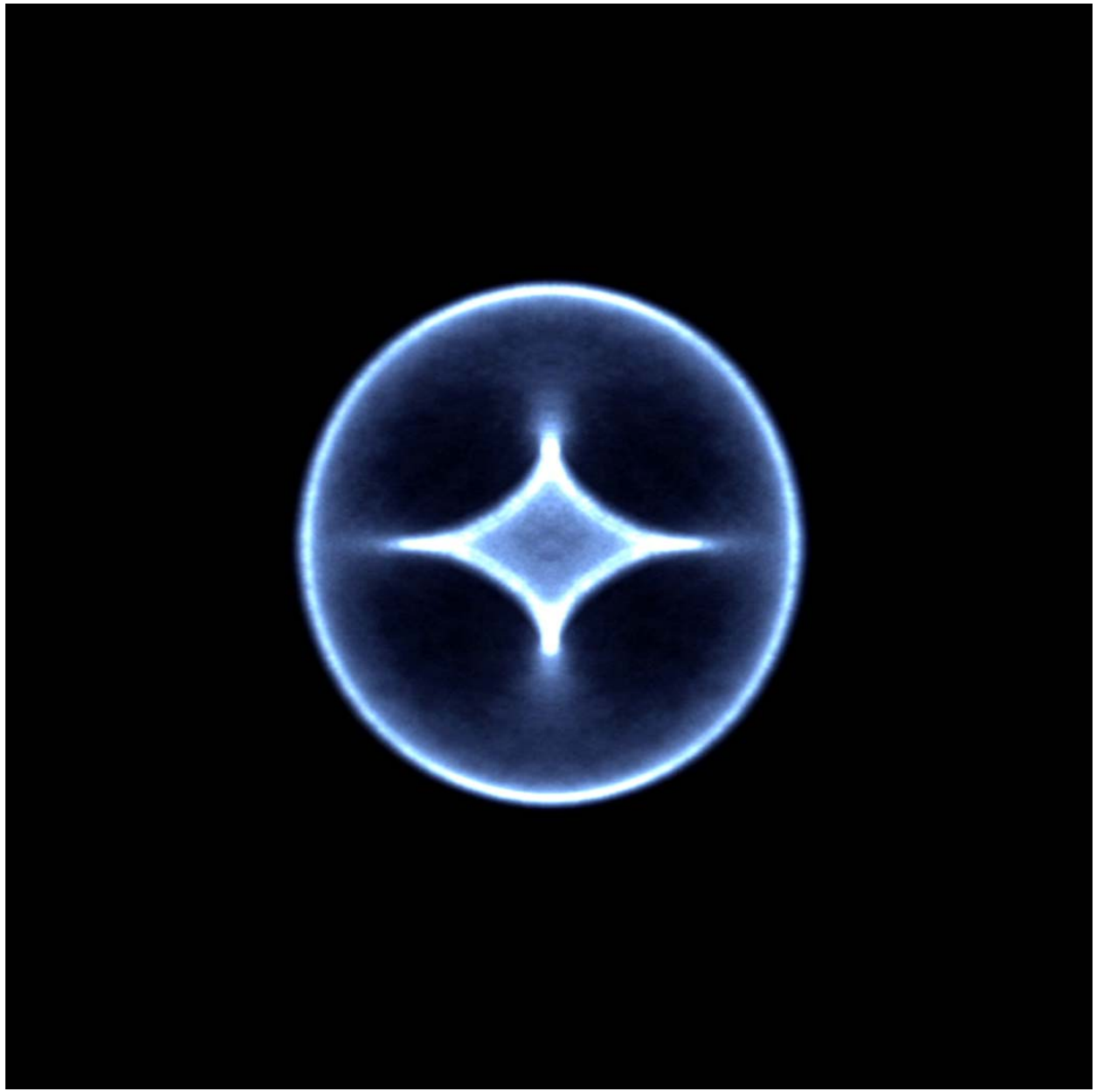
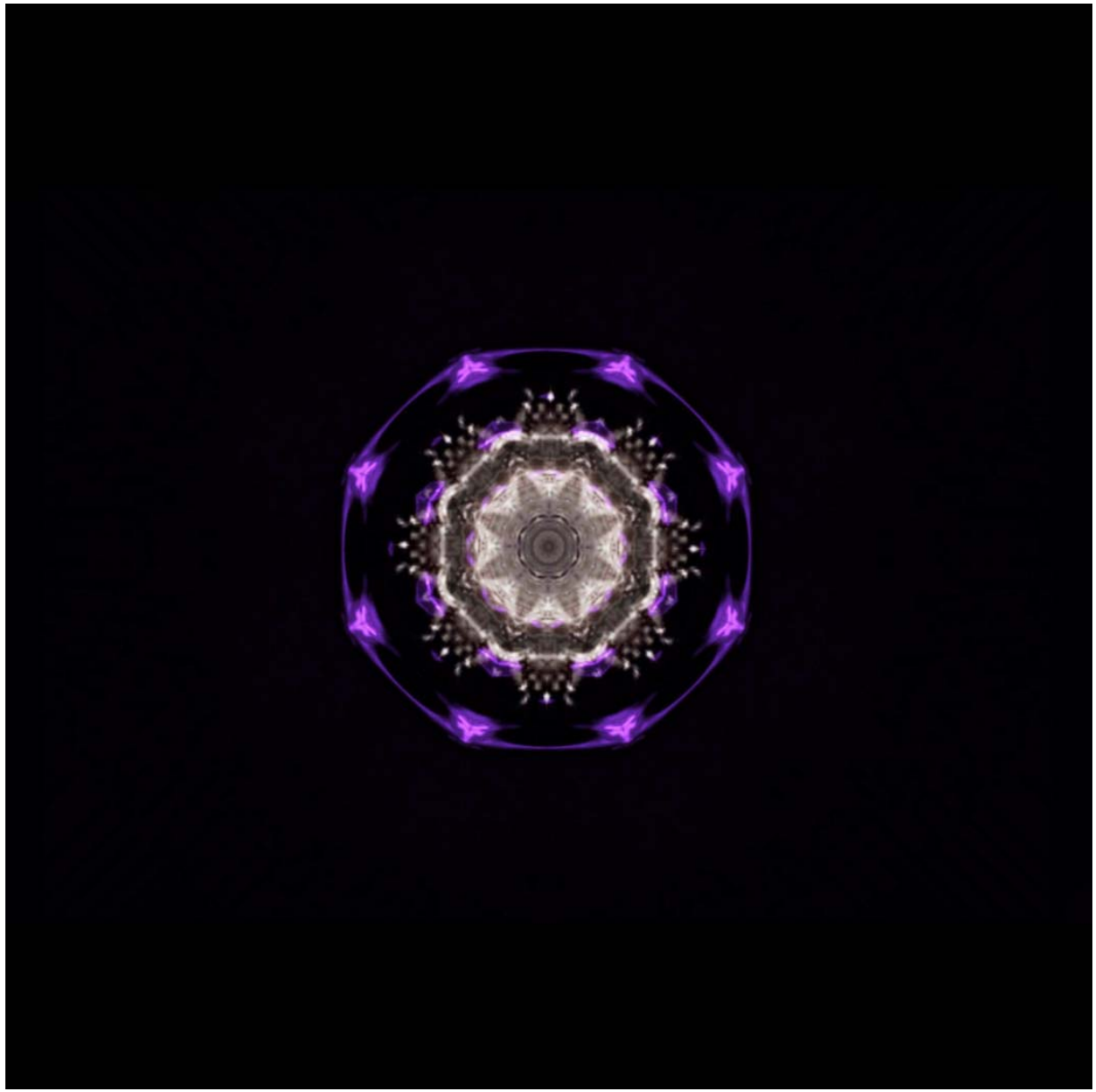
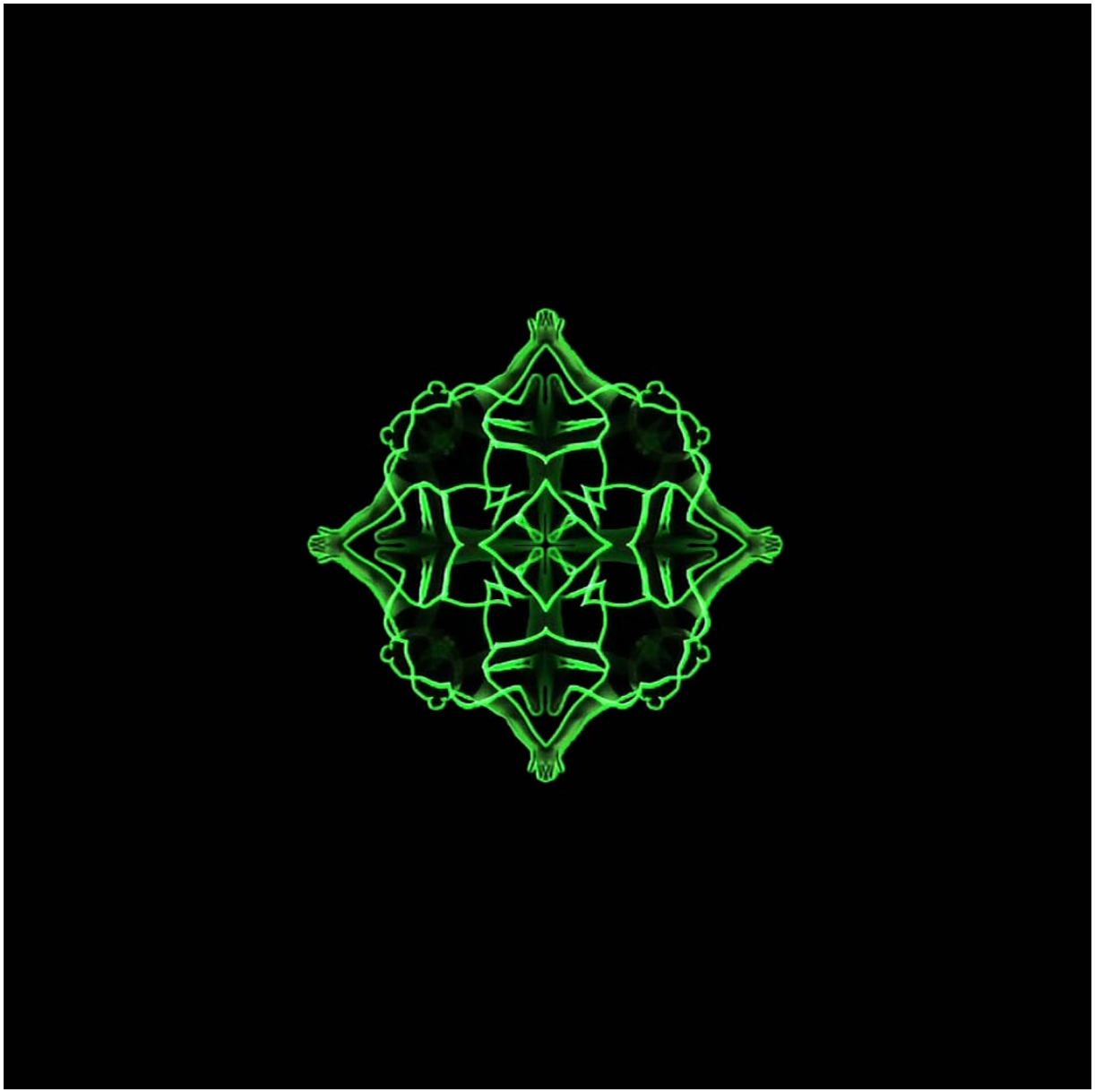
5.3 STILL IMAGES FROM *SOUND VISION*

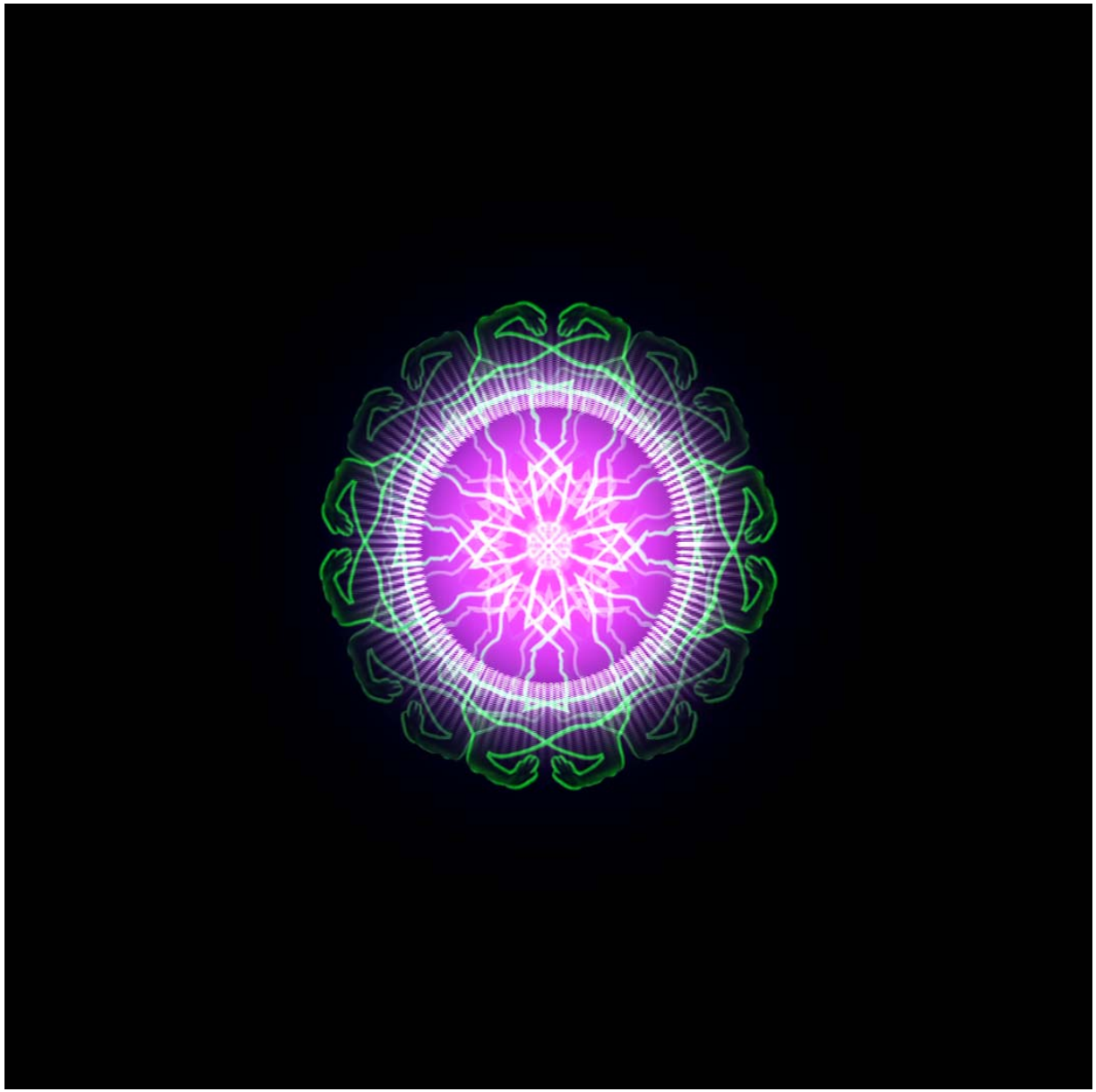
The following pages display some still images from the film *Sound Vision*

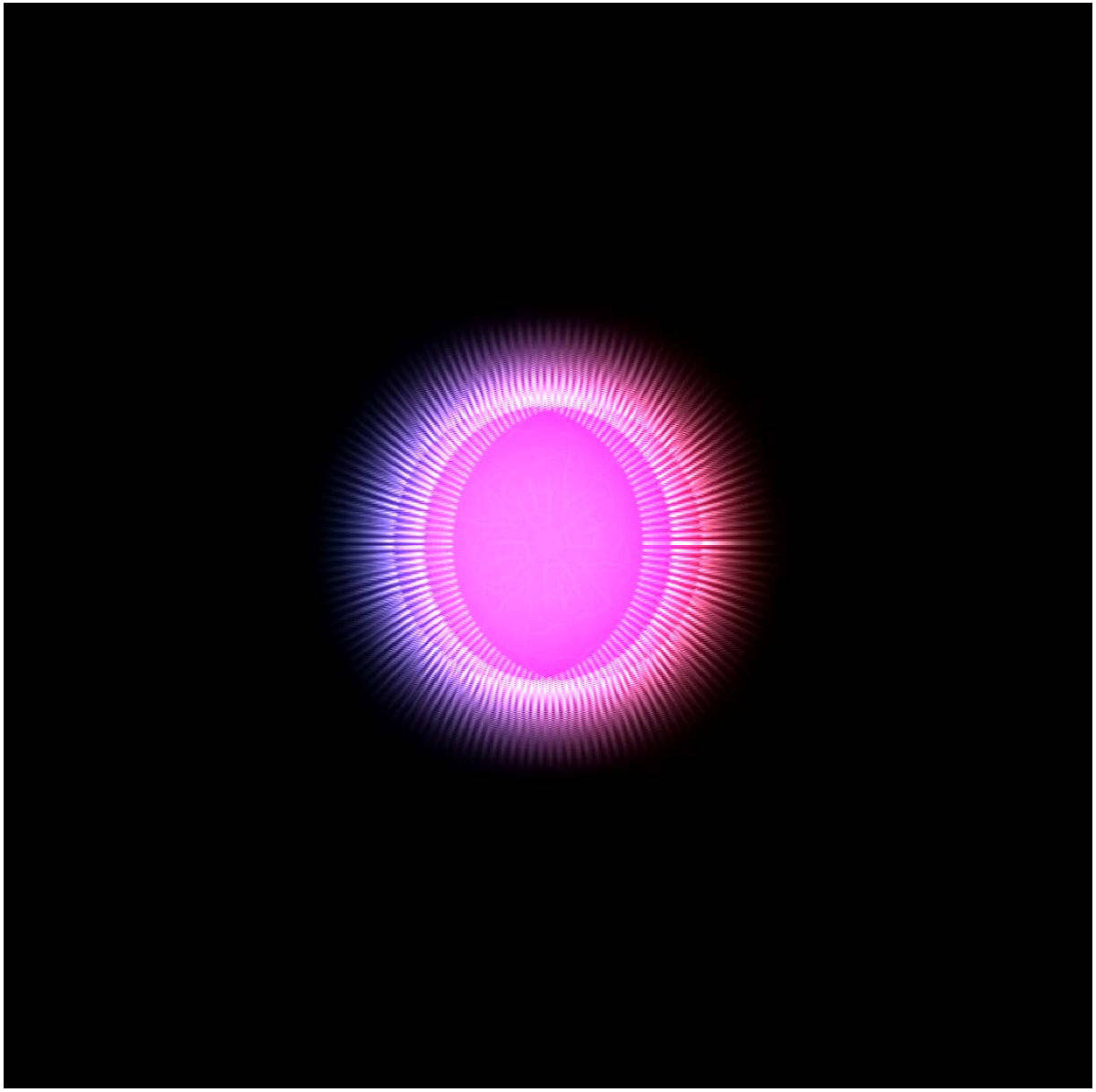


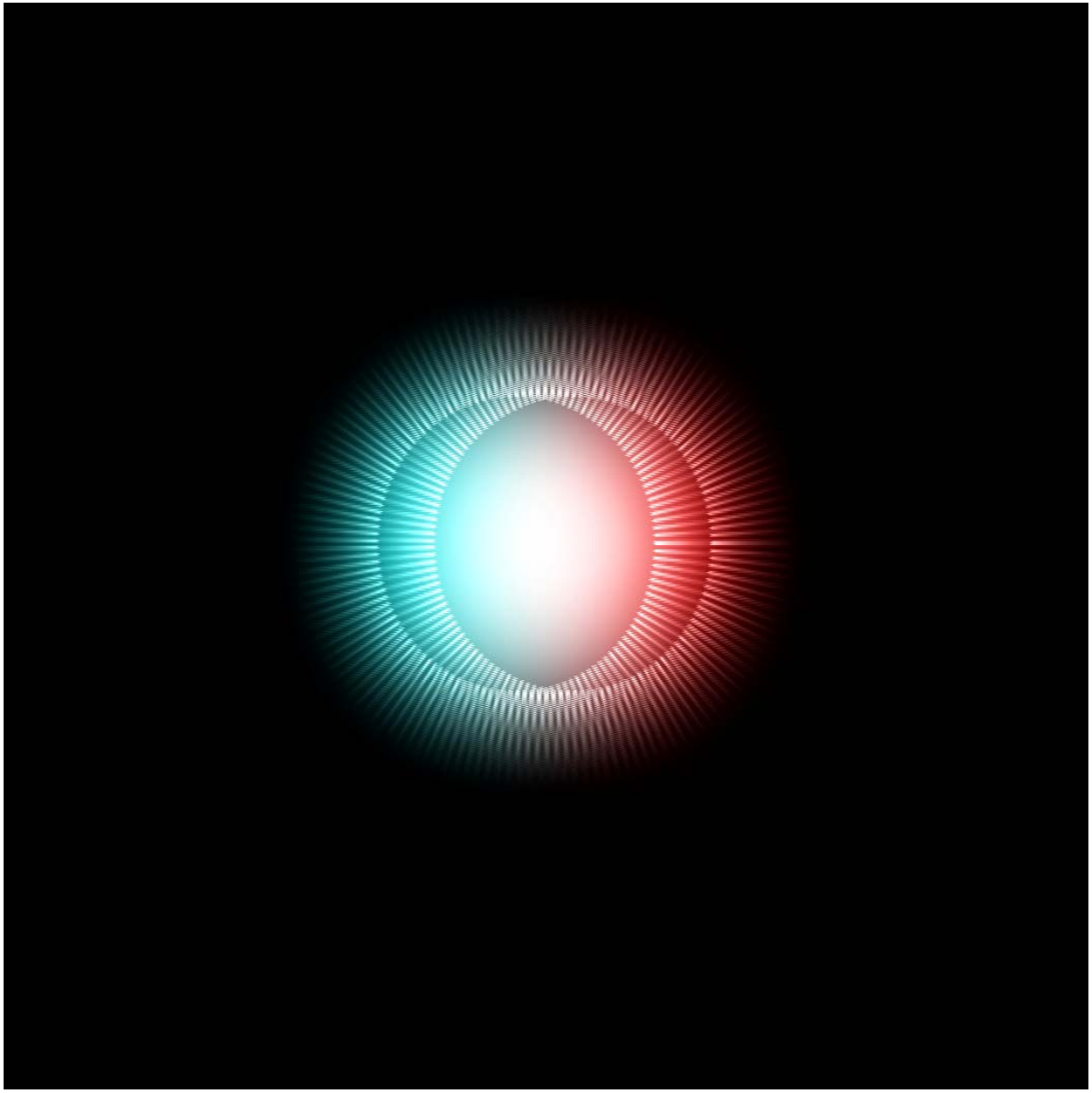


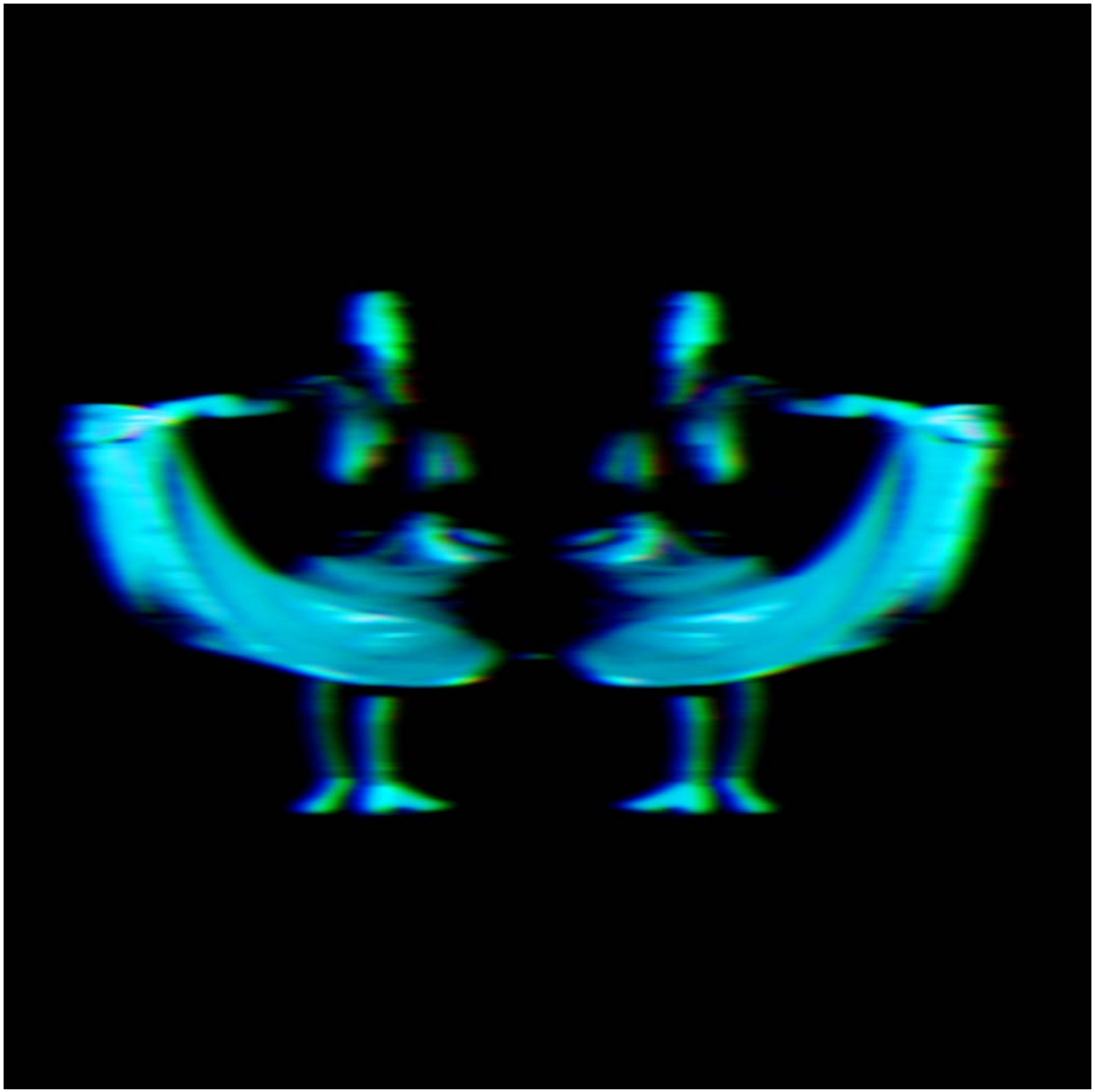


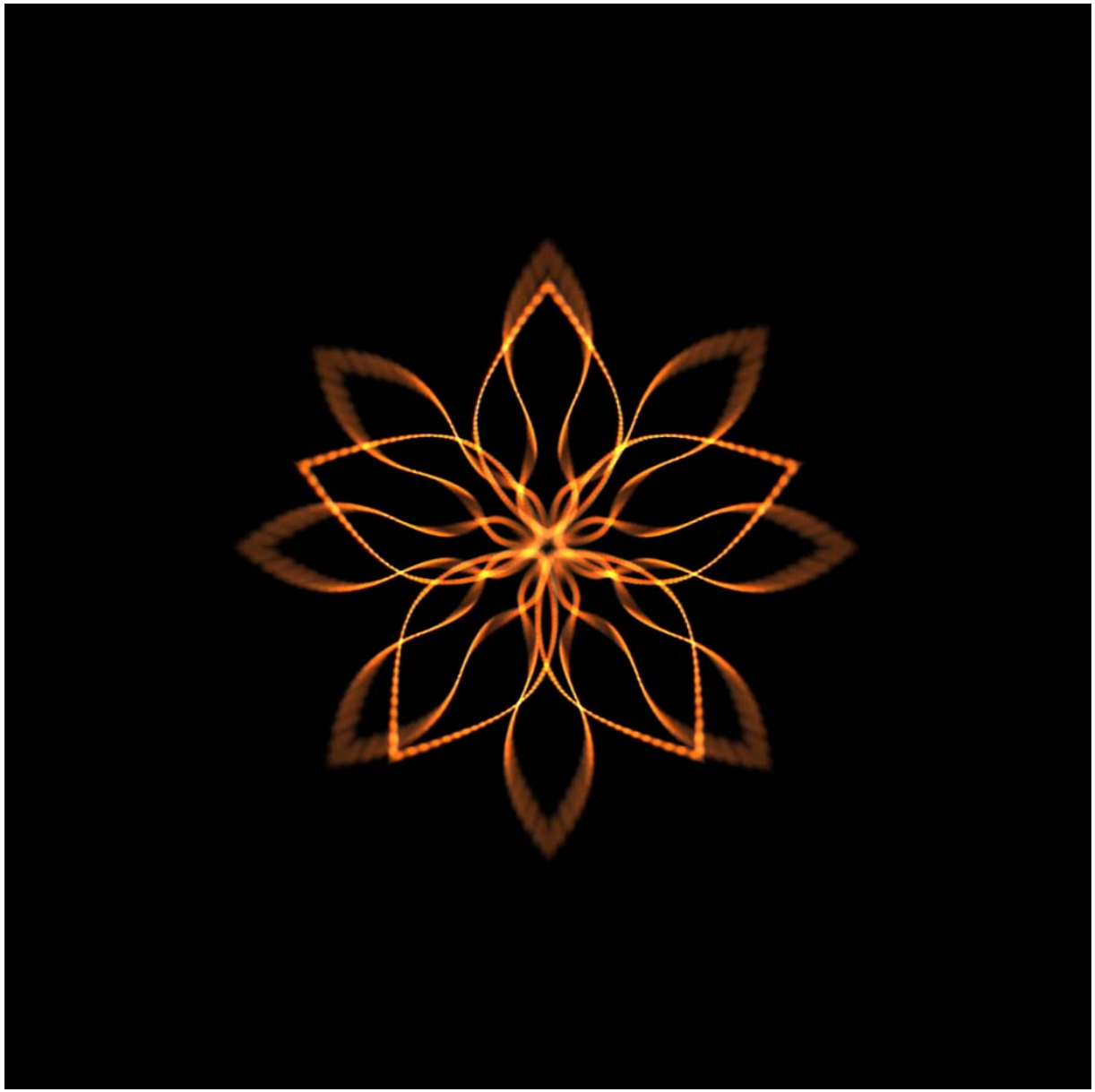












5.4 APPENDIX 1 FOUR CATEGORIES OF BRAINWAVE STATES

DELTA (1-4 Hz)
Dreamless sleep.
Human growth hormone released.
Deep, trance-like, non-physical state, loss of body awareness.
Access to unconscious and 'collective unconscious' mind,
greatest 'push' to brain when induced with Holosync.
Renewal, healing, rejuvenation. Deep, dreamless sleep. Very rewarding.
Said to be the entrance to non physical states of reality.
Best state for immune system function, restoration, and health.

THETA (4-7 Hz)
Dreaming sleep (REM sleep).
Increased production of catecholamine (vital for learning and memory).
Increased creativity. Increased retention of learned material.
Integrative, emotional experiences, potential change of behaviour,
Hypnagogic imagery, trance, deep meditation, access to unconscious mind.
Insight, intuition, inspiration. Answers to important questions can be found.
Feels like you are floating. A wonderful realm to explore. Dream-like imagery.
Good for problem solving. Feel more connected to others.

LOWER ALPHA (8-10 Hz)

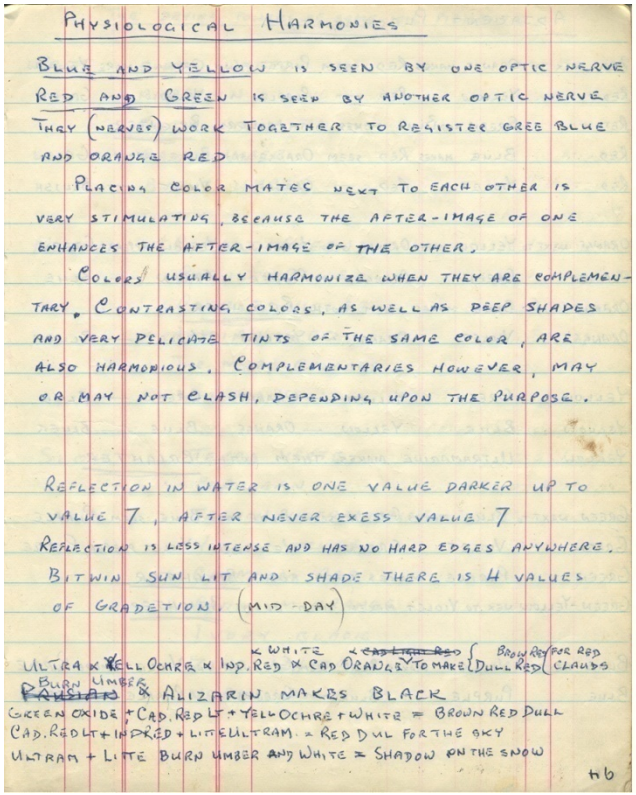
ALPHA (8-13 Hz)
Relaxation, super-learning, relaxed focus, light trance, increased serotonin production.
Pre-sleep, pre-waking drowsiness, meditation, beginning of access to unconscious mind.
Meditation and relaxation begins. Effortless creativity flows. Powerful state for memory.
A harmonious, peaceful state. Habits, fears and phobias begin to melt away.
Tranquillity and calm.

UPPER ALPHA (11-13 Hz)

BETA (13-40 Hz)
Concentration, arousal, alertness, cognition.
Higher levels associated with anxiety, disease.
Associated with worry, stress, paranoia, fear, irritability, moodiness, anger.
Connected to weakened health and immune system. Fully awake and alert.
Nervousness, depression, anxiety.
People spend most of their time in the Beta state.

APPENDIX 2 PSYCHOLOGICAL HARMONIES

(Stanley Linton, 1964, pp. 89, 90, 94)



PHYSIOLOGICAL HARMONIES

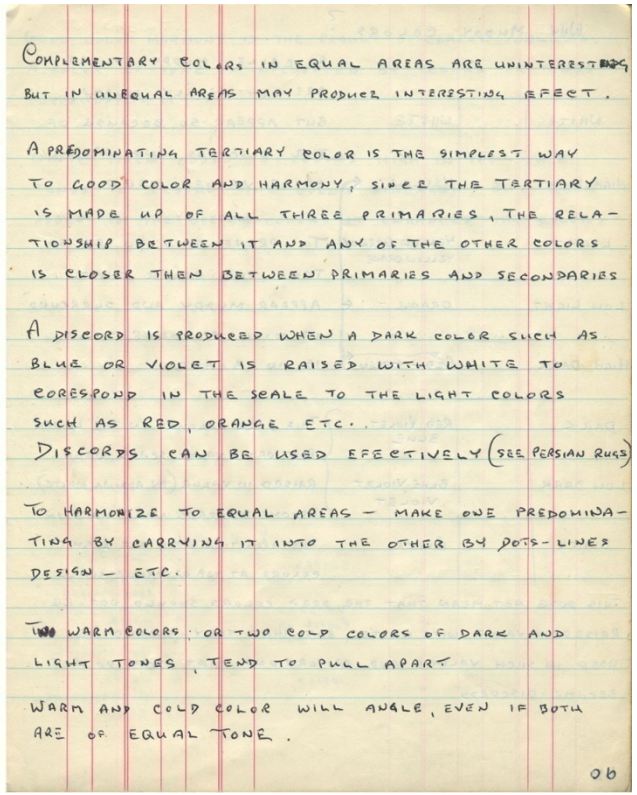
BLUE AND YELLOW IS SEEN BY ONE OPTIC NERVE
RED AND GREEN IS SEEN BY ANOTHER OPTIC NERVE
THEY (NERVES) WORK TOGETHER TO REGISTER GREE BLUE AND ORANGE RED

PLACING COLOR MATES NEXT TO EACH OTHER IS VERY STIMULATING, BECAUSE THE AFTER-IMAGE OF ONE ENHANCES THE AFTER-IMAGE OF ~~THE~~ OTHER.

COLORS USUALLY HARMONIZE WHEN THEY ARE COMPLEMENTARY, CONTRASTING COLORS, AS WELL AS DEEP SHADES AND VERY DELICATE TINTS OF THE SAME COLOR, ARE ALSO HARMONIOUS. COMPLEMENTARIES HOWEVER, MAY OR MAY NOT CLASH, DEPENDING UPON THE PURPOSE.

REFLECTION IN WATER IS ONE VALUE DARKER UP TO VALUE 7, AFTER NEVER EXESS VALUE 7
REFLECTION IS LESS INTENSE AND HAS NO HARD EDGES ANYWHERE.
BITWIN SUN LIT AND SHADE THERE IS 4 VALUES OF GRADETION. (MID-DAY)

ULTRA X YELL OCHRE X IND. RED X WHITE X ~~CAD LIGHT RED~~ X CAD ORANGE } TO MAKE { BROWN RED (FOR RED CLAYS) / DULL RED
~~BURN~~ BURN UMBER ~~PRUSSIAN~~ & ALIZARIN MAKES BLACK
GREEN OXIDE + CAD. RED LT + YELL OCHRE + WHITE = BROWN RED DULL
CAD. RED LT + IND RED + LITE ULTRAM. = RED DUL FOR THE SKY
ULTRAM + LITE BURN UMBER AND WHITE = SHADOW ON THE SNOW



COMPLEMENTARY COLORS IN EQUAL AREAS ARE UNINTERESTING BUT IN UNEQUAL AREAS MAY PRODUCE INTERESTING EFFECT.

A PREDOMINATING TERTIARY COLOR IS THE SIMPLEST WAY TO GOOD COLOR AND HARMONY, SINCE THE TERTIARY IS MADE UP OF ALL THREE PRIMARIES, THE RELATIONSHIP BETWEEN IT AND ANY OF THE OTHER COLORS IS CLOSER THEN BETWEEN PRIMARIES AND SECONDARIES

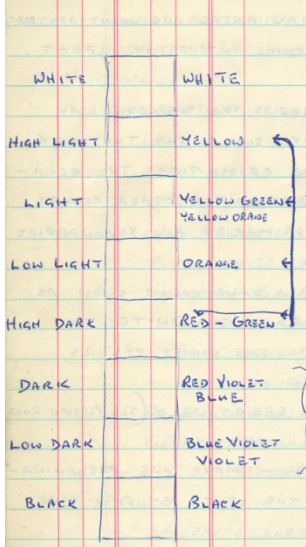
A DISCORD IS PRODUCED WHEN A DARK COLOR SUCH AS BLUE OR VIOLET IS RAISED WITH WHITE TO CORESPOND IN THE SCALE TO THE LIGHT COLORS SUCH AS RED, ORANGE ETC.
DISCORDS CAN BE USED EFFECTIVELY (SEE PERSIAN RUGS)

TO HARMONIZE TO EQUAL AREAS - MAKE ONE PREDOMINATING BY CARRYING IT INTO THE OTHER BY DOTS-LINES DESIGN - ETC.

TWO WARM COLORS OR TWO COLD COLORS OF DARK AND LIGHT TONES, TEND TO PULL APART

WARM AND COLD COLOR WILL ANGLE, EVEN IF BOTH ARE OF EQUAL TONE.

WHY MUDDY COLORS?



SO CALLED MUDDY COLORS ARE NOT REALLY MUDDY, BUT APPEAR SO, BECAUSE OF THE DISCORDS AND WRONG COLOR VALUES USED

TO PROVE THIS TO BE SO, TAKE THE COLOR THAT APPEAR MUDDY AND SURROUND IT WITH A COLOR THAT IS IN SCALE

THIS DARK COLOURS IN THE LOWER PART OF THE VALUE SCALE, WHEN RAISED IN VALUE (BY ADDING WHITE) BECOME DISCORDS WHEN USED IN JUXTAPOSITION WITH THE LIGHT COLORS AT TOP OF VALUE SCALE

THIS DOSE NOT MEAN THAT THE DEEP COLORS SHOULD NOT BE RAISED IN VALUE WITH WHITE, BUT THAT THEY SHOULD BE USED IN SUCH VALUES AND PROPORTIONS THAT THEY DO NOT BECOME DISCORDS.

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GOOD COLOR HARMONY IS THE RESULT OF CORRECT VALUES. A COLOR OR TONE IS INFLUENCED BY COLORS OR TONES SURROUNDING IT.

WHITE WHEN ADDED TO COLORS HIGH IN THE SCALE TENDS TO DESTROY THE COLOR STRENGTH, BUT WHEN ADDED TO THE DEEPER COLORS IT ENHANCES THE COLOR

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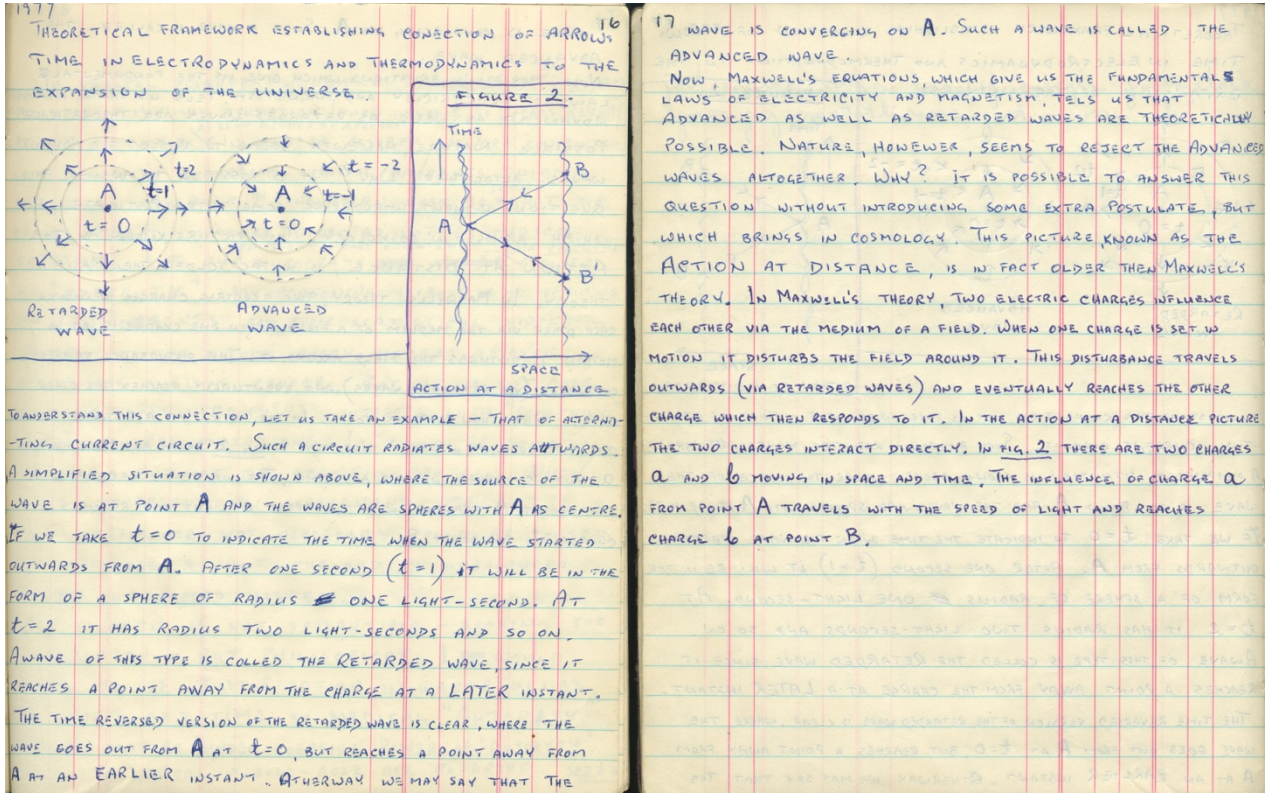
APPENDIX 2b FORM AND MOTION OF ELECTROMAGNETIC PHENOMENA

(Stanley Linton, 1964, pp. 16-17, 51).



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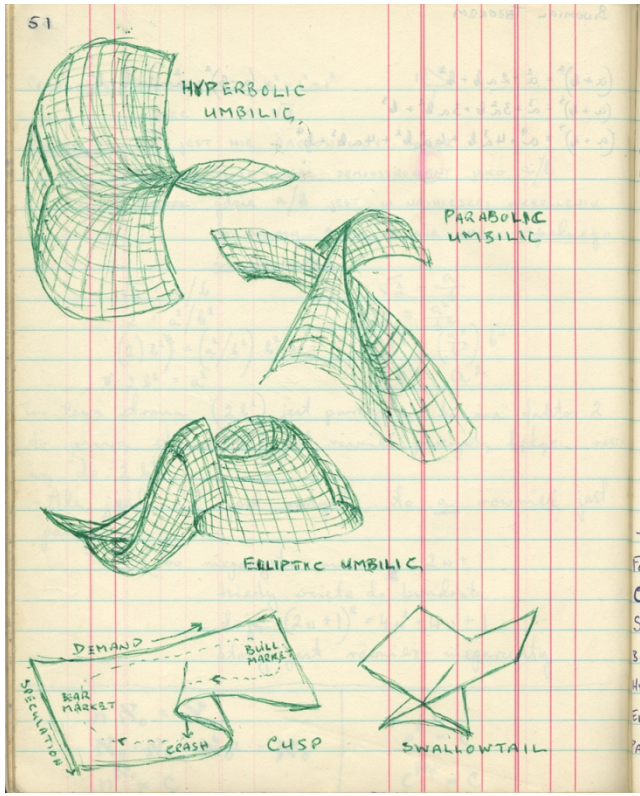
THEORETICAL FRAMEWORK ESTABLISHING CONECTION OF ARROWS OF TIME IN ELECTRODYNAMICS AND THERMODYNAMICS TO THE EXPANSION OF THE UNIVERSE.

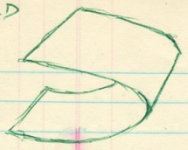
FIGURE 2.

TO UNDERSTAND THIS CONNECTION, LET US TAKE AN EXAMPLE – THAT OF ALTERNATING CURRENT CIRCUIT. SUCH A CIRCUIT RADIATES WAVES OUTWARDS. A SIMPLIFIED SITUATION IS SHOWN ABOVE, WHERE THE SOURCE OF THE WAVE IS AT POINT A AND THE WAVES ARE SPHERES WITH A AS CENTRE. IF WE TAKE $t=0$ TO INDICATE THE TIME WHEN THE WAVE STARTED OUTWARDS FROM A. AFTER ONE SECOND ($t=1$) IT WILL BE IN THE FORM OF A SPHERE OF RADIUS ONE LIGHT-SECOND. AT $t=2$ IT HAS RADIUS TWO LIGHT-SECONDS AND SO ON. A WAVE OF THIS TYPE IS CALLED THE RETARDED WAVE, SINCE IT REACHES A POINT AWAY FROM THE CHARGE AT A LATER INSTANT. THE TIME REVERSED VERSION OF THE RETARDED WAVE IS CLEAR, WHERE THE WAVE GOES OUT FROM A AT $t=0$, BUT REACHES A POINT AWAY FROM A AT AN EARLIER INSTANT. ALTHERWAY WE MAY SAY THAT THE

17 WAVE IS CONVERGING ON A. SUCH A WAVE IS CALLED THE ADVANCED WAVE.

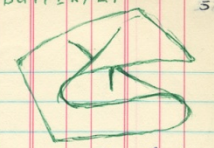
NOW, MAXWELL'S EQUATIONS, WHICH GIVE US THE FUNDAMENTAL LAWS OF ELECTRICITY AND MAGNETISM, TELS US THAT ADVANCED AS WELL AS RETARDED WAVES ARE THEORETICALLY POSSIBLE. NATURE, HOWEWER, SEEMS TO REJECT THE ADVANCED WAVES ALTOGETHER. WHY? IT IS POSSIBLE TO ANSWER THIS QUESTION WITHOUT INTRODUCING SOME EXTRA POSTULATE, BUT WHICH BRINGS IN COSMOLOGY. THIS PICTURE, KNOWN AS THE ACTION AT DISTANCE, IS IN FACT OLDER THEN MAXWELL'S THEORY. IN MAXWELL'S THEORY, TWO ELECTRIC CHARGES INFLUENCE EACH OTHER VIA THE MEDIUM OF A FIELD. WHEN ONE CHARGE IS SET IN MOTION IT DISTURBS THE FIELD AROUND IT. THIS DISTURBANCE TRAVELS OUTWARDS (VIA RETARDED WAVES) AND EVENTUALLY REACHES THE OTHER CHARGE WHICH THEN RESPONDS TO IT. IN THE ACTION AT A DISTANCE PICTURE THE TWO CHARGES INTERACT DIRECTLY. IN FIG. 2 THERE ARE TWO CHARGES a AND b MOVING IN SPACE AND TIME. THE INFLUENCE OF CHARGE a FROM POINT A TRAVELS WITH THE SPEED OF LIGHT AND REACHES CHARGE b AT POINT B.





FOLD

BUTTERFLY



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BY
RENÉ THOM, PROFESSOR OF MATHEMATIC AT PARIS INSTITUTE FOR HIGHER SC. STUDIES

CATASTROPHE THEORY BELONGS TO TOPOLOGY AS DEALS WITH PHENOMENA NOT ONLY NUMERICALLY BUT ALSO VISUALLY. DISCONTINUOUS EVENTS CAN BE REPRESENTED BY CERTAIN GEOMETRICAL SHAPES. FOR EXAMPLE, A TOPOLOGIST INTERESTED IN FORECASTING THE BEHAVIOR OF THE STOCK MARKET NOT ONLY WOULD RESORT TO STANDARD STATISTICAL ANALYSIS BUT WOULD ALSO EXPRESS SUCH IMPORTANT ECONOMIC VARIABLES AS "SPECULATION" AND "DEMAND" AS FACTORS IN CONSTANT MOTION ON A GEOMETRICAL SURFACE: A MARKET CRASH IS REPRESENTED BY A SUDDEN DROP FROM THE UPPER SURFACE TO THE LOWER ONE.

IN SITUATIONS INVOLVING THREE DIMENSIONS OF SPACE AND ONE OF TIME, THE NUMBER OF ELEMENTARY CATASTROPHES IS SEVEN.

FOLD CATASTROPHE - CAN BE USE TO EXPLAIN THE REFRACTION OF LIGHT BY RAINDROP TO FORM RAINBOW

CUSP: TO STUDY SUCH EVENTS AS TRANSITION FROM FLIGHT TO FIGHT, LOVE TO HATE.

SWALLOWTAIL: USED TO PROVIDE INSIGHTS ON NATURE OF CELL DIVISION IN EMBRYOS.

BUTTERFLY: USED TO PREDICT CERTAIN KINDS OF BEHAVIOR PATTERNS IN NERVOUS DISORDERS

HYPERBOLIC UMBILIC: IN ANALYZING THE COLAPSE OF BRIDGES AND DEVELOPMENT OF SONAR DEVICES.

ELIPTIC UMBILIC: PROVIDES MODEL FOR FLOW OF FLUIDS

PARABOLIC UMBILIC: SERVES AS A MODEL FOR SOLVING PROBLEMS IN THE FIELD OF LINGUISTICS.

APPENDIX 3 COLOUR HARMONY VARIATIONS, REFERENCE GUIDE

Based on Johannes Itten's 12 hue colour circle.