THE ROLE OF THE MUSICAL INTELLIGENCE

IN

WHOLE BRAIN EDUCATION

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ABSTRACT

This study was prompted by the recent increase in academic and public interest in neuromusical brain research, which provides information about how the brain processes music. It is the task of neural science to explain how the individual units of the brain are used to control behaviour, and how the functioning of these units is influenced by an individual's specific environment and relationships with other people. However, the concept of neuromusical research is relatively new to music education.

In any learning experience, brain processing (of information) is not an end in itself. The skill of 'thinking' is dependent on the whole integrated mind/body system, with skills being a manifestation of conscious physical responses that demonstrate knowledge acquisition.

Howard Gardner's 'Theory of Multiple Intelligences' lists the **musical intelligence** as one of eight autonomous intelligences: linguistic, logic-mathematical, spatial, bodily-kinesthetic, musical, intrapersonal, interpersonal, and environmental. All of these intelligences can be developed to a reasonably high level.

This thesis uses David Elliott's praxial philosophy as a conceptual basis. Elliott's four meanings of music education: education **in** music, **by** music, **for** music, and **by means of** music, have been selected to determine the parameters for an 'inclusive' understanding of **musical intelligence**. Scientific research findings, brain based data, and behavioural results with educational implications have been used to define what is meant by the musical intelligence, and its role in whole brain learning. Whole brain learning (also referred to as 'accelerated' learning or 'super' learning) is examined in the framework of IQ (intellectual quotient/intelligence), EQ (emotional intelligence), and SQ (spiritual intelligence).

It is important to note that the brain imposes certain constraints on the learning ability of individuals, but that there are also numerous benefits to be derived from an awareness of brain functions pertaining to education in general and music education in particular. These constraints and benefits are an important feature of whole brain learning, with the musical intelligence playing a vital role.

Keywords:

musical intelligence	neuromusical research	memory
whole brain education	brain based/dominance/profiles	music education
IQ, EQ, SQ	evolutionary psychology	therapeutic music

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CHAPTER 1

Research outline

1.1 Personal motivation

The personal motivation for this study originated at a five-day course/workshop arranged by the South African National Department of Education:

Whole brain learning to achieve outcomes-based education

led by Launa Jean Ellison (Director of Whole Brain Learning Consortium, USA), held at Laudium (near Pretoria) in July 1996. The focus of the course was on the practical implementation of Howard Gardner's "Theory of Multiple Intelligences" which at that stage consisted of seven intelligences: linguistic, logic-mathematical, spatial, bodily-kinesthetic, musical, intrapersonal, and interpersonal, with an eighth 'environmental' intelligence that has since been included. Although the musical intelligence was acknowledged, it received very little attention during the course, whereas the other intelligences were dealt with extensively. This was largely due to the fact that the leader and other participants had little or no knowledge about music education, and were ignorant about the possibilities of 'education by means of music'.

1.2 Introduction

One of the remaining challenges to science, is to understand the biological basis of consciousness and the mental processes by which people perceive, act, learn, and remember. The central tenet of modern neural science is that **all behaviour is a reflection of brain function**. The action of the brain underlies not only relatively simple motor behaviours such as walking, breathing and smiling, but also more elaborate affective and cognitive behaviours such as feeling, thinking, learning, and composing a symphony (Kandel et al 1991:2,6).

It is the task of neural science to explain how the individual units of the brain (neurons and glial cells) are used to control behaviour, and how the functioning of these units is influenced by an individual's specific environment and relationships with other people (Kandel et al 1991:6). In any learning experience, brain processing of information is not an end in itself. According to Hannaford (1995:86,87), the skill of 'thinking' is dependent on the whole integrated mind/body system, with skills being a manifestation of conscious physical responses that demonstrate knowledge acquisition. With respect to the values of music and music education, in the context of his praxial philosophy of music education, David Elliott describes *music-making* as "essentially a matter of procedural knowledge, or non-verbal *knowing-in-action*" and music-listening as an 'internal' form of practical *knowing-in-action*.

Since the response to the incessant flow and interchange of information in the brain is to translate thought into action, or in some way to transform brain activity into muscular activity, the study uses the praxial philosophy as a conceptual basis. Elliott's four meanings of music education emphasise the praxial aspect of music teaching and learning, and have been selected to determine the parameters for an 'inclusive' understanding of **musical intelligence**.

The interdisciplinary nature of this study requires an understanding of social and behavioural sciences (such as psychology, education, and specifically, music education), as well as information from the neurological field and applied sciences, and aspects of neuro-psychological analysis. Certain core concepts, ie. whole brain education, the 'triune' brain, a new dimension to psychology, memory, neuroscientific and neuromusical research, brain development and education, musical intelligence, and educational applications of brain function, that are critical to the study, are presented in the following framework with brief explanations.

1.2.1 Whole brain education

Whole brain education is based on a scientific understanding of the brain mechanisms, processes, and malfunctions that affect the successful completion of complex learning tasks, with the underlying mechanisms that govern learning concerns, such as emotion, interest, attention, thinking, memory, and skill development. Whole brain learning strategies adapt instruction to various learning styles, using multiple intelligences to set goals, rather than manipulating the learner's environment to achieve a desired behaviour. This study approaches whole brain education in part, from a multiple intelligence perspective that focuses on the development of **all** eight intelligences, and in part from the perspective that all these intelligences are actually variations of the basic IQ, EQ, and SQ with their neural arrangements.

It is therefore important to understand how the brain is specialised, both physically and mentally, thereby opening up a whole new dimension of intellectual and creative functioning. With respect to **functions of the brain**, it is helpful to view the organ not as a mysterious object, but rather as a 'generator of electricity' for its own purposes. This electrical activity creates an electro-magnetic field, and the overall electrical activity can be mechanically recorded as **brain-wave patterns**.

The different brain-wave patterns reflect different states of consciousness, which should be harnessed for effective education.

Biological research has indicated that there are physical differences in the structure of the male and female brain, with hormones programming the brain differently in the early stages of fetal development. This leads to differences in behaviour, emotion, aggression, skill, aptitude, and ambition. Until recently, **behavioural differences between the sexes** have been explained away by social conditioning: the expectations of parents, whose own attitudes reflect the expectations of society. In present times, however, there is far too much new biological evidence for the sociological evidence to prevail: there is now a framework within which an understanding can begin of ***why*** we are '**who-we-are**'.

By identifying learning styles, personality traits, and kinds of intelligence that help students learn through their **strengths**, it is possible for all students to develop their full potential, and in this way, to benefit their entire culture.

1.2.2 The 'triune' brain

There are several theories to explain the way the brain operates, but for the purposes of this study, the functional model of the **triune** brain has been selected to explain some of the brain's complex functions in relatively simple terms.

The brain is not only divided into two hemispheres, but can also be considered in terms of a 'three-in-one' grouping referred to as the **triune** brain, reflecting the evolution of the brain:

- the reptilian brain/brain stem is situated at the base of the skull, and is the brain element humans share with lower life forms. It controls instinctual, involuntary responses;
- the limbic system, which folds around the brain stem, is similar to that found in other mammals. It controls emotional responses and the beginning of memory;
- the neo-cortex, which wraps around the limbic system (including the brain stem), is the complex 'new brain' controlling rational thought.

1.2.3 A new dimension to psychology

According to Zohar & Marshall (2000:6) Western psychology can, at present, be described as being based on two processes, originally referred to by Freud as the **id** (which Sternberg (1998:565) interprets as irrational, immediate gratification of urges) and the **ego** (which is based on reality):

- a **primary process** that is associated with human instincts, the body, emotions and the unconscious
- a **secondary process** that is associated with the ego, the conscious and the rational mind.

They further claim that neither reason nor the emotions can appeal to anything beyond themselves. With recent access to information on spiritual intelligence **based on scientific evidence**, a viable third process that unifies and integrates material arising from the other two processes has become possible. Each of these three different kinds of thinking can be linked to one of **three basic neural systems**. In other words, when all three processes are utilised for the purposes of education, they form a vital component of **whole brain education**:

- the intellectual intelligence (IQ)
- the emotional intelligence (EQ)
- the spiritual intelligence (SQ).

An understanding of the **triune brain** (see 2.10.2 and 4.5)**,** as well as **IQ, EQ, and SQ** (see 3.3) is essential to the concept of '**whole brain** education' (see 4.1.2).

1.2.4 Memory

Without memory there can be no learning. Once it is understood how the brain's memory works, it becomes possible to tap its vast and largely unused potential. In the last decade or so, research has provided a new understanding of how the brain works, and how facts can be rapidly stored (short term) or deeply fixed in the memory (long term), and then recalled.

The natural memory is **context** dependent. It may be based on movement, music, intense sensory experiences (sights, sounds, smells, taste, touch), relationships and position in time and space. For effective learning, therefore, the limbic system must be involved. Information dependent on **content** is an unnatural memory which requires rehearsal, is resistant to change, lacks meaning, and is linked to extrinsic motivation (Jensen 1995a:204-206). When, on the other hand, the brain engages the emotions purposely and productively, learning is made personally compelling, deeply felt, and real. In this way, adding music or other sensory stimulation to a learning situation increases the retention of learning.

1.2.5 The significance of neuroscientific and neuromusical research

A significant aspect of brain research is, that from scientific findings, it is possible to deduce certain general principles and laws which can explain what is known, and predict what is yet unknown. Specific instances of brain function can therefore be considered **individual cases** of **universal laws**. With the recent developments in the cognitive sciences, modern educators have a responsibility to educate themselves about the development, organisation, and operation of the brain, to be able to:

- comprehend the growing scientific and professional writing in this field (the physical brain and brain functions)
- discuss, develop, and evaluate proposed educational applications
- effectively teach students about brain mechanisms and processes (what pupils/students should know about the brain), to optimise their own learning, and appreciate the different learning styles of others.

Neuromusical research is still in its early stages, but is providing valuable information about how the brain processes musical information, and how music stimulates spatial-temporal reasoning.

1.2.6 Brain development and education

The brain follows a natural pattern of development, and there is an order in which learning is programmed to take place (critical periods). For example, the mechanical aspects of the auditory system are in place at birth, and the auditory pathways continue to develop until seven to ten years, with certain critical periods for auditory development (Wolfe & Brandt 1998:12).

Until recently, educators have not had the means to comprehend internal brain processes, and have had to focus on knowable external objects or events in the environment (stimulus) and the behaviour (response) that resulted from unknowable cognitive processes. In this way, educators became a profession of behaviourists who learned how to manipulate the student’s environment to achieve the desired behaviour.

With a reasonable measure of accuracy, teachers are able to predict what will occur in a classroom, but generally do not know **why** it occurred. This partial knowledge that focuses only on **outward behaviour** can lead to inappropriate, generalised conclusions, which educators have come to accept as **a limitation to the teaching profession**. This limitation was legitimate for its time and also necessary, before advancing to the next stage based on **scientific understanding of the brain and its functions** (Sylwester 1995: 2-5).

Since it is only **through** the brain that humans can perceive and learn about what is **outside** the brain, it is vital to realise that what humans know about anything depends upon **what** the human brain can do, and **how** the brain does it all. The two issues of **brain capability** and **brain function** can therefore be considered of paramount importance in education.

The order in which the parts of the brain develop provides a map for parents and/or practioners who wish to provide the right kind of stimulation during each period of growth. Forced learning could result in the use of lower systems of the brain, since the higher ones that **should** do the work have not yet developed. The habit of using inferior brain areas for higher-level tasks can cause many learning problems.

1.2.7 Musical intelligence

This study investigates **the role of the 'musical intelligence'** as one of the eight intelligences or ways of knowing, included in Howard Gardner's 'Theory of Multiple Intelligences' (Gardner 1993), and in particular, the **human element** which must necessarily be involved in the education/development of the musical intelligence.

The focus of music education is not to educate a 'musician': its prime function should be to **educate a human being**. As music educators, it is therefore necessary to be interested and knowledgeable in the **total** education of the individual. The competencies of conceiving, composing, reading, performing, perceiving, and comprehending music are all brain capabilities. To understand how and why music is a powerful force, musical competence must be understood in terms of brain function and the neural substrates involved (Weinberger 1998).

It is important to note that Gardner's view of the intelligences emphasises **cognition.** The theory of multiple intelligences has evolved in practice to focus more on **metacognition**, which is an awareness of one's mental processes, rather than focusing on the full range of emotional abilities and the complexities of spiritual intelligence.

The term 'musical intelligence' remains ill-defined for many music educators. Music education, which focuses on the development of the musical intelligence, has in the past preferred to explore what is understood and felt from knowing about, and making predictions about **the actual substance and structure of music itself**. However, music education is focusing increasingly on the 'human element' and how educators can enhance real music experiences for their students by engaging both **cognitive** and **affective** responses.

It appears that this two-dimensional approach of reason and emotions is not sufficient to explain the full complexity of human intelligence. A third dimension, the **spiritual intelligence**, reflects the need for 'meaning' in a given context, posing the question 'why?' and provides the foundation for the effective functioning of both the intellect and the emotions.

1.2.8 Educational applications of brain function

The educational applications based on current scientific understanding of the brain and its processes have in many cases already been introduced by good teachers, who have somehow intuitively always 'known'. However, by teaching to behavioural objectives, educators are ignoring other functions of the brain and other aspects of memory and learning. Teaching in the traditional way, dependent on content and the textbook, is demanding but not very sophisticated. Teaching "to the human brain", based on a **real** understanding of how the brain works, elevates teaching into a new, challenging field, requiring the finest minds and intellects (Caine & Caine 1991: vii - ix).

Sperry (1985:19) maintains that brains can "no longer be assumed to be qualitatively similar at birth, with equal potentiality". Different mental disciplines use qualitatively different forms of cognitive processing that require different patterns of neural circuitry, the basic cerebral requirements for which are largely **pre-wired**. The potentialities of the two hemispheres of the same brain, with respect to verbal and spatial functions, are already at birth found to be qualitatively different. This indicates that on the educational front there is a need for educational tests and policy measures which can selectively identify, accommodate, and serve the differentially specialised forms of intellectual potential (Sperry 1985:18,19). Similar views are supported by Nicholson (1998) and Rushton (2000).

In South Africa, since the first democratic elections in 1994, the new government is ensuring that education is embarking on a course of major transformation, affecting educational structures as well as information presented to learners, and music educators cannot afford to remain professionally uninformed or uninvolved in this 'historic revolution'. Without scientifically informed educational leadership, educators can expect to have other (uninformed) people making decisions for them.

1.3 Problem statement

The main problem addressed in this study is formulated by the question:

What is the musical intelligence, and its role in whole brain education?

This necessitates considering the following sub-problems:

- What is understood by the concept **musical intelligence**?
- Whether music education can be used to facilitate the development of the musical intelligence in the context of whole brain education?
- Whether the development of the musical intelligence facilitates optimal brain function?
- Whether the amount of natural science in the professional preparation of music educators, at both pre-service and in-service levels, can be increased sufficiently to enable them to make use of educationally significant new developments in brain theory and research?

1.4 Aim of the study

The aim of the study is to contribute to a comprehensive definition of **musical intelligence** by examining at least four different meanings of music education in the context of whole brain learning. There is particular emphasis on the 'human element' involved, as well as the relationship between the development of the musical intelligence and other kinds of learning.

1.5 Notes to the reader

A number of issues concerning this study need to be clarified. They are presented in no particular order:

- A word of caution is necessary with respect to the interpretation of neuroresearch findings and their application to education in general, and music education in particular. It should be noted that similar research projects have on occasion produced contradictory results. Because of the complexity of the brain, neuroresearch results are usually difficult to interpret and there is a tendency for educators to simplify information, often to the point of inaccuracy. Many concepts such as the 'dual brain', 'triune brain', 'brain profiles' and 'brain gym' are, for example, foreign to the disciplines of neuroanatomy and neurophysiology. They can best be described as 'working models' of the different ways the brain processes information or activities. These brain based models have proven effective for educational purposes, and have therefore been included and investigated in this study.

- The 'dual brain' theory, in particular, was challenged two decades ago. Although many interpretations of relevant scientific research are contradictory, it provides a simplistic, functional metaphor for understanding how the brain processes information.
- A part of the 'hindbrain' is the *medulla oblongata*. As there are at least three medulla's in the human body, the references used for this study refer to the *medulla* in labelled figures, and to the *medulla oblongata* in the text to avoid any confusion.
- The study concerns the total spectrum of life-long learning, **from fetus to adult**. The words used to refer to the human element: fetus, child, learner, student, individual, people or humans, have been used as judiciously as possible, depending on their context.
- Although a broad selection of books and articles listed in the References was reviewed for their relevance to this study, much of the information did not have an adequate or acceptable neuroresearch base to support it, was not **essentially brain based,** or pertinent to the concept of **whole brain** education. For this reason, certain sections of the study are based on relatively few specific sources. **Scientifically based** literature on the spiritual intelligence is particularly scarce, and has therefore been limited to Zohar & Marshall (2000).
- By virtue of the fact that many of the original neuroresearch sources are not accessible to those on the 'outside' of the research institutions involved, it has not always been possible to quote a **primary** source of information. The assurance is given, however, that as far as possible primary sources were always traced.
- Due to the interdisciplinary nature of this study, literature on both neuroscientific and music education issues has been consulted. It is possible that some of the scientific research findings may prove politically contentious to some readers, but any political implications are beyond the scope of this thesis.
- To a large extent, the disciplines of neuroanatomy, neurophysiology and neurology function autonomously, making it unusually difficult to trace accurate scientific information relevant to the study of whole brain education. This observation was substantiated by Prof. Altenmüller in an interview (June 2001).
- Many concepts, ideas, and results have been presented several times in the study, in different contexts (for example, from a physical/functional/educational point of view)s.
- In instances where a number of items is listed, a comma has been inserted between the second last item and the word "and" which precedes the last item, to prevent ambiguity.

1.6 Research methodology

To define what is meant by the concept **musical intelligence** more clearly, and to examine its role in whole brain education, a literature study was conducted on:

- the physical brain (anatomy and physiology)
- selected brain functions (emotional intelligence, spiritual intelligence, memory, brain dominance, brain waves, genetic 'pre-wiring')
- a framework to facilitate whole brain education (hemispheric differences, the 'triune' brain, neuro-linguistic programming, sensory modes, mind-body link, multiple intelligences, social challenges)
- the role and development of the musical intelligence (four different meanings of music education).

- **Seminars** were attended, with presentations on:
  - Brain anatomy (practical dissection of the brain)
  - Brain physiology
  - Brain dominance.

- **Seminar-workshops** were attended on:
  - Whole brain education
  - Neuro-linguistic programming for musicians
  - Brain dominance profiles.

- **Interviews** were conducted with:
  - Mr. S.W. Liebenberg
  - Prof. George Odam
  - Prof. Eckhardt Altenmüller
  - Prof. Niels Galley.

- Limited, informal **self-experimentation** with the information accumulated for this study, was performed on music education groups and individual learners, over a period of five years, weekly, with approximately twelve groups (c. 250 children) that the author teaches.

1.7 Glossary of terms

The following glossary serves as clarification for:

- abbreviations of technical terms
- selected scientific concepts
- measurements of sound
- terms used in the context of 'music for therapeutic purposes'
- terms in connection with brain based learning.

1.7.1 Abbreviations of technical terms

CAT	computerised axial tomography
CD	compact disc
CPS	cycles/second: measurement of wave frequencies
BEAM	brain electrical activity mapping
BESA	brain electric source analysis (used in conjunction with MRI)
EEG	electro-encephalogram
ELF	extremely low frequency (of magnetic or electric fields)
MEG	magneto-encephalography
MRI	magnetic resonance imaging
NGF	nerve growth factor
NLP	neuro-linguistic programming
PET	positron emission tomography
RAS	reticular activating system
SQUID	super-conducting quantum interference device.

1.7.2 Selected scientific concepts

BIOFEEDBACK: a branch of the field known as EEG (see below). By broad definition, the term biofeedback refers to the process in which subtle information on how a person's body and brain are operating is amplified and shown back to that person.

CAT SCAN (computerised axial tomography): the cat scan uses multiple x-rays to produce clear cross-sectional views of anatomical structures, by showing dark shadows for denser elements and lighter shades for soft tissue.

CHEMICAL ANALYSIS: a useful, non-invasive way of studying the brain metabolism is to analyse chemicals involved in brain cell function. These chemicals can be found in various body fluids such as blood serum, urine, or saliva.

EEG (electro-encephalogram): detects and records brain waves from the surface of the skull and has yielded insight into normal brain development. This easily performed technique is not invasive and is appropriate for research involving young children. In EEG studies, the brain's electrical activity is recorded from the surface of the skull, using either paste-on electrodes or electrodes sewn into a cap. The EEG equipment detects small amounts of electrical energy which are then reflected graphically as brain waves. The frequency and intensity (or amplitude) of these brain waves indicate areas of the brain that are active.

fMRI: see MRI.

GLIAL CELLS: two classes of cells are found in the nervous system, namely *neurons* (nerve cells) and *glial* ('support' cells). Glial cells help to regulate the brain's immune system and to metabolise two of the main neurotransmitters in the cerebral cortex. The process of *myelination* is said to have taken place, when glial cells form an insulating layer (myelin) around certain nerve fibres, which assists in increasing the speed and accuracy of neural messages.

MRI (magnetic resonance imaging): one of the techniques used for diagnostic purposes, which has yielded new insights into how the normal brain develops and functions. MRI produces detailed images of any internal body part, focusing on soft tissue. The functional MRI (fMRI) provides information about changes in the volume, flow, or oxygenation of blood that occurs as a person undertakes a task.

PET (positron emission tomography): another technique used for diagnostic purposes. PET technology enables scientists to visualise fine details of the brain. It also determines the levels of activity that are occurring in the various regions of the brain.

QUANTUM MUSICHANICS (a term used by Charles Eagle for "Quantum physics for musicians", 1991:52): according to Eagle's Theory of Musichanics

- music is energy, and energy is music
- people make music, but music also makes them

- music matters, because music is matter.

ULTRASOUND: high resolution ultrasound measuring devices and recordings can be used by scientists to study and document the brain development of a fetus.

1.7.3 Measurements of sound

Cycles/Herz (Hz)	measurement unit of sound frequency
Decibels (dB)	measurement unit of sound intensity.

1.7.4 Music for therapeutic purposes

Baroque	The music is steady and structured. **Slow** Baroque music is used to impart a sense of order and predictability. Compositions by Bach, Handel, Vivaldi, Corelli and Telemann are often used.
Classical music	For some people, this has the somewhat deterrent meaning of 'art music' or high-brow music, as distinct from 'popular music' or music for entertainment. However, the term refers to music of a specific historical period, which has a clarity and elegance that promotes concentration, memory and spatial perception. Compositions of Haydn and Mozart are frequently used.
New Age music	A controversial term, used in many different ways. In the context of therapy it usually refers to music created to aid in healing, meditation, or worship.
Popular music	"Popular" music refers not only to 'pop' music, but also to all those pieces that remain firm listening favourites and depend on instant gratification for popularity.
Rock music	Rock music is particularly difficult to define. Conceived in the 1950's, it could be described as a kind of music with simple tunes, a very strong beat, the use of blues forms, using electric guitars, electric bass guitars, electric keyboards, and/or vocal lyrics (in which "voices from

the margins of society can still be heard out loud"), with a reliance on electronic amplification for performance (Encyclopaedia Britannica 2001).

1.7.5 Terms in brain based learning

Candida albicans	A fungal yeast infection releasing many toxins (including alcohol), affecting the frontal lobes of the brain (Hannaford 1995:154)
Cones	Light receptor cells of the retina of the eye that need bright light for stimulation
Disaffection	Social discontent
IQ	Intellectual intelligence/(intelligence quotient)
EQ	Emotional intelligence
MI	Multiple intelligences
SQ	Spiritual intelligence
Lateral dominance	An individual's preference for processing information analytically or globally
Musics	A term used by David Elliott for "music of different cultures"
Neuromusical research	'Musicological' brain research
Rods	Light receptor cells of the retina of the eye, best stimulated under dim light conditions
Whole brain learning	Sometimes referred to as 'superlearning', 'accelerated learning', 'optimal learning' or 'integrative learning'. This type of learning makes use of techniques that promote rapid learning, and involves both brain hemispheres.

CHAPTER 2

The physical brain

2.1 Introduction

"The central tenet of modern neural science is that all behaviour is a reflection of brain function" (Kandel et al 1991:6). To maximise the use of the brain in any task, it is necessary to have a basic knowledge of the anatomical structure and biological functions of the brain. This is essential to understanding some of the processes and devices the brain employs in the human experiences of thinking, feeling, and doing, all of which are initiated, controlled, and monitored by the brain. Current research areas include:

- How brain chemicals affect mood, personality, and behaviour (see 2.5.3)
- The role of nutrition in brain functioning (see 2.5.4)
- The connection between the mind/brain and the body (see 2.9) (Wolfe & Brandt 1998:13)
- The endocrine system (see 2.6.2).

2.2 How the brain is studied

The physical brain weighs about 1,5 kg and is by far the most remarkable organ in the human body, both architecturally and functionally. Because of the brain's complexity, most brain researchers/scholars focus their study on one of three levels. To understand these complex systems/levels, Sylwester (1995: 7) refers to Klivington's computer analogy that suggests three legitimate levels for understanding the development and operation of complex systems:

- the **top level** is software: the ability to write programmes
- the **intermediate level** is logic circuitry/electrical hardware of information processing
- the **bottom level** is the solid-state physics of semi-conductors in the component transistors.

In the same way that a computer programmer, a circuit designer or a solid state physicist each claim to know how a computer works (without knowing much of what the other two specialists know), so too can a **philosopher**, a **psychologist**, or a **neuroscientist** each understand how the brain works, but at three different levels (Sylwester 1995: 8).

2.2.1 The acquisition of neuroscientific information

Neuroscientists usually focus on the workings of small units such as individual cells, or small systems of cells within more complex systems. In this respect, the research perspective is that to understand the **system**, it is essential to understand the basic **units** of the system. To discover more about the brain, scientists have had to provide solid information on the normal and abnormal actions of a single neuron (see 2.5), the synchronised action of networks of neurons, as well as the factors that trigger neuronal activity. This search for useful information has included:

- **the study of the brains and behaviours of animals with simple neural systems**
  The complexity and general inaccessibility of the human brain limits its use in the study of basic neural functions. However, the basic neural functions are the same in all animals, with the result that animals with simple nervous systems have been selected for the purpose of studying single neurons, as well as certain invertebrates, which have fewer, but much **larger** neurons than humans.

- **the study of people and primates with and without brain damage or mental illness**
  Because of obvious experimental limitations, researchers have focused their studies on 'available' research subjects such as brain-damaged or mentally ill subjects. They would identify the nature and location of the brain's malfunction and compare the subject's behaviour with that of people without brain-damage, in an attempt to link the behavioural malfunction to that section of the brain that was malfunctioning. The procedure of cutting the *corpus callosum* (the connecting fibre between the left and right hemisphere of the brain) to reduce the continuous epileptic seizures suffered by certain patients, has provided researchers with a rich source of experimental data, leading to *split-brain* research with which present day educators are often reasonably familiar (Sylwester 1995:10,11).

- **the development of brain-imaging technologies**
  Brain-imaging machines process vast amounts of electrochemical data and so take researchers well beyond observable behaviour, black and white X-rays, EEG reports, and into the world of three-dimensional colour TV graphics with high spatial and temporal resolution.
  The focus of current brain-imaging technology is on:
  - **the chemical composition of cells and neurotransmitters**
    The CAT scan (computerised axial tomography) and MRI (magnetic resonance imaging)

are used to create three-dimensional images of anatomical structures, in this way locating features and malfunctions. The CAT scan uses multiple X-rays to produce clear cross-sectional views, by showing dark shadows for denser elements and lighter shades for soft tissue. The MRI focuses on soft tissue and provides the **reverse** image: it responds to the chemical differences in the composition of various brain and body tissues, providing a clear image of the chemical composition of the brain.

- **the electrical transmission of information along neuronal fibres and the magnetic fields that brain activity generates**
  The EEG (electro-encephalogram), which has been in use for more than half a century now, reports patterns in the electrical transmission of information within an active brain. An active human brain can generate an easily measured 10 watts. This electrical neural activity creates the brain waves that EEG instruments measure. The procedure is non-invasive, but has not been particularly accurate. Major technological advances in this field have been SQUID (super-conducting quantum interference device) and the BEAM machine (brain electrical activity mapping).
- **the magnetic activity associated with the electrical activity that the brain generates**
  The MEG (magneto-encephalography) is an improvement on the EEG. It measures the magnetic activity associated with the electrical activity generated by the brain (Zohar & Marshall 2000:73).
- **the distribution of blood flow through the brain as it replenishes energy used in electrochemical activity**
  PET (positron emission tomography) uses radioactive materials to monitor the unequally distributed patterns of the approximately 750ml of blood that flows through the brain every minute. It can trace sequential changes in brain energy use, as various parts of the brain are activated. PET research has provided advanced knowledge of how and where the brain processes events. Because PET scans are invasive, they are not often used on children who do not have a medical problem.

Brain imaging machines are costly and their use in the USA and other countries has so far been limited to medical research and diagnosis facilities, and university science and psychology departments. Over time, computer technology tends to become cheaper and more accessible. Researchers in certain university education departments have started using electrical imaging technologies, a facility which will no doubt be extended to many more universities in the future, for educational research projects (Sylwester 1995:12-14).

2.2.2 A broader research approach

A broader research approach is used by researchers/scholars when focusing on complex cognitive mechanisms/functions/behaviours, such as movement, language, and abstract analysis. Without the necessary research technology to monitor cell activity, these researchers/scholars have had to infer brain activity from external behaviour and brain malfunctions. Some of the fields using this broader approach are: cognitive psychology, linguistics, physical anthropology, philosophy, and artificial intelligence.

Of particular interest for this study, is the research being done at the Music Intelligence Neural Development Institute (M.I.N.D.) in California. The core of their scientific research is the "Trion Model of Higher Brain Function", with the focus on the cortical areas involved in spatial-temporal reasoning, and how this affects, or is affected by music, mathematics and science, and chess (M.I.N.D. Institute 2001).

2.3 The biology and structure of the brain

Maguire (1990:5) suggests that, to give the brain the attention it deserves requires appreciating why it is so extraordinary. For this purpose it is necessary briefly to consider the major parts, and then in more detail some of the brain's intricate assortment of parts and how they are organised, in particular those that impact on human development and learning.

2.3.1 Development process

For decades it has been recognised that all vertebrates share the same basic development stages from which the primitive brain emerges. Students of brain development can now view what once appeared to be a hopelessly complicated series of events, as a definable, sequential, and functionally determined process.

The neural tube is derived from the outer layer of the embryo. From the sheet of cells that lines this outer layer, a pear-shaped neural plate emerges, which gradually thickens and folds over onto itself. The end of the tube "towards the head" starts closing at about day 24 of gestation, followed by the end "towards the tail" two days later. The conversion of the neural plate to neural tube is called "neurulation".

The primitive neural tube quickly folds into the intact central nervous system, and in the early stages is composed of **three vesicles**: forebrain, midbrain, and hindbrain (with medulla and cerebellum) (Nelson & Bloom 1997:977-979). With greater differentiation, the forebrain gives rise to **two additional vesicles**:

- ***telencephalon*** - which becomes the cerebrum/cortex and cerebral hemispheres
- ***diencephalon*** - which becomes the thalamus and hypothalamus.

These vesicles are illustrated in the following figure from Kandel et al. (1991:298):

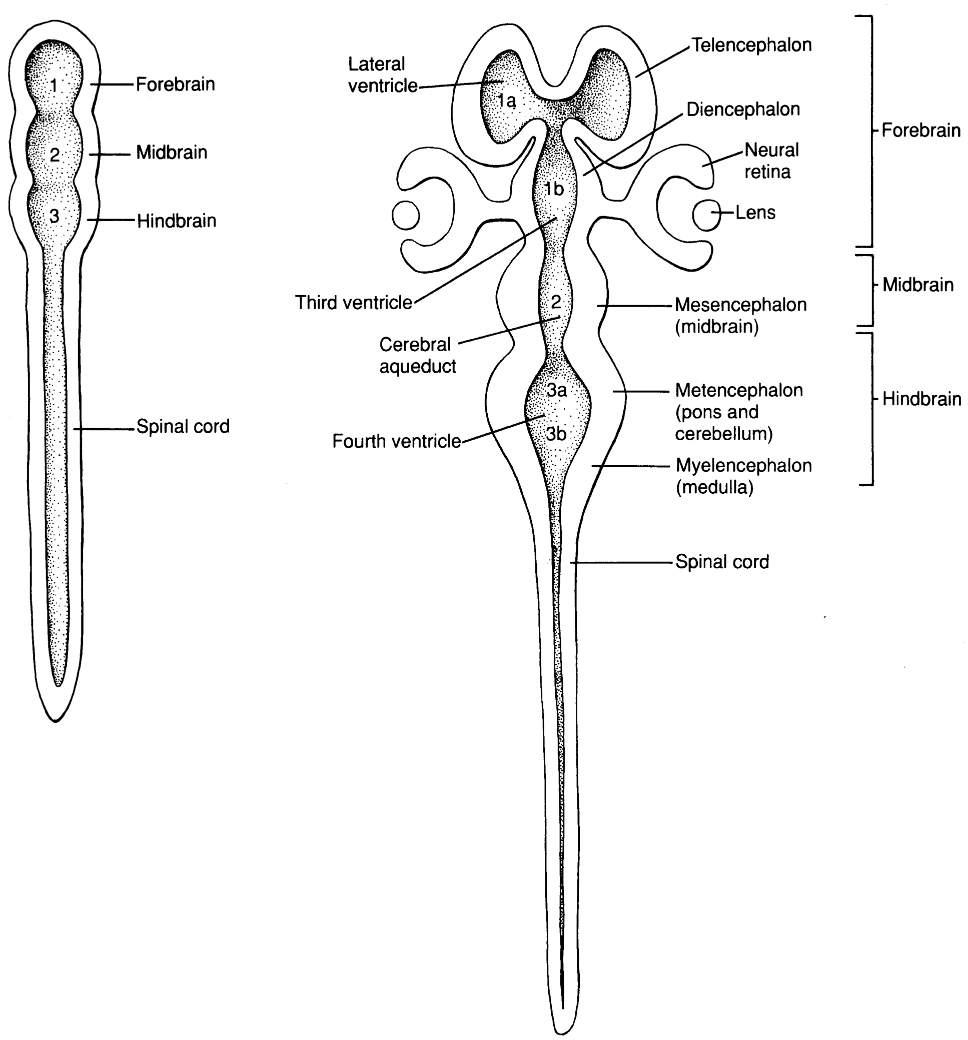


Figure 2-1

Development of the neural tube

Over the course of embryonic and fetal neural development, the brain becomes more highly specialised. The locations and relative positions of the hindbrain, midbrain, and forebrain change from conception to full term.

2.3.2 'Major' parts of the brain

When a brain is preserved in a jar containing formaldehyde, what is mainly visible is the *cerebrum.* This structure is often referred to as "the brain". The *cerebrum* forms the largest part of the brain, and is split into two prominent structures: the left and right *cerebral hemispheres* joined by a bridge of nerve fibres, the *corpus callosum*. Covering these two hemispheres is a thin layer of rumpled grey matter called the *cortex.* The brain and the spinal cord are surrounded by *cerebrospinal fluid* and protected by membranes called the *meninges*. The meninges and cerebrospinal fluid act as a 'shock absorber' system to protect the nervous system from the full force of bumps, twists, and turns of the body (Bloom, Lazerson & Hofstadter 1985:49).

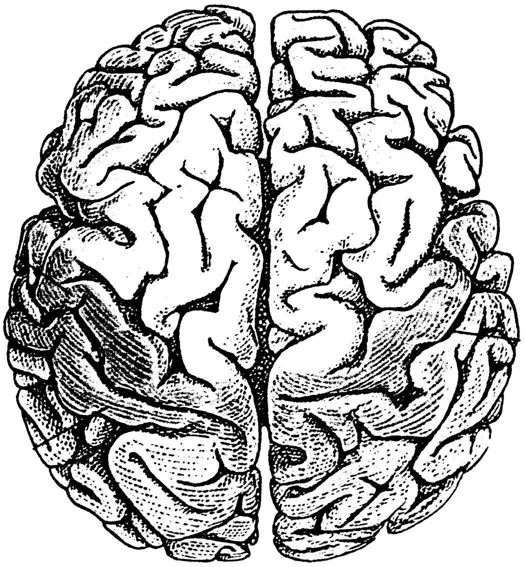


Figure 2-2

The hemispheres of the cerebral cortex

(viewed from behind and above) (Bloom et al. 1985:22)

2.4 The three large composite structures and their functions

The brain can be divided into three major regions, each with **distinct structures** and **functions**:

- The **hindbrain** is farthest back, near the back of the neck.
- The **midbrain** is located between the forebrain and the hindbrain.
- The **forebrain** is the farthest forward, toward what becomes the face.

The remainder of the *neural tube* becomes the spinal cord.

Sternberg (1998:84) explains that these labels do not correspond exactly to their locations in either an adult's or a child's head, because the terms originate from the front-to-back physical arrangement of these parts in a developing embryo's nervous system, which develops from the neural tube. Figure 2-3 shows the changing locations and relationships of the hindbrain, midbrain, and forebrain over the course of development of the brain.

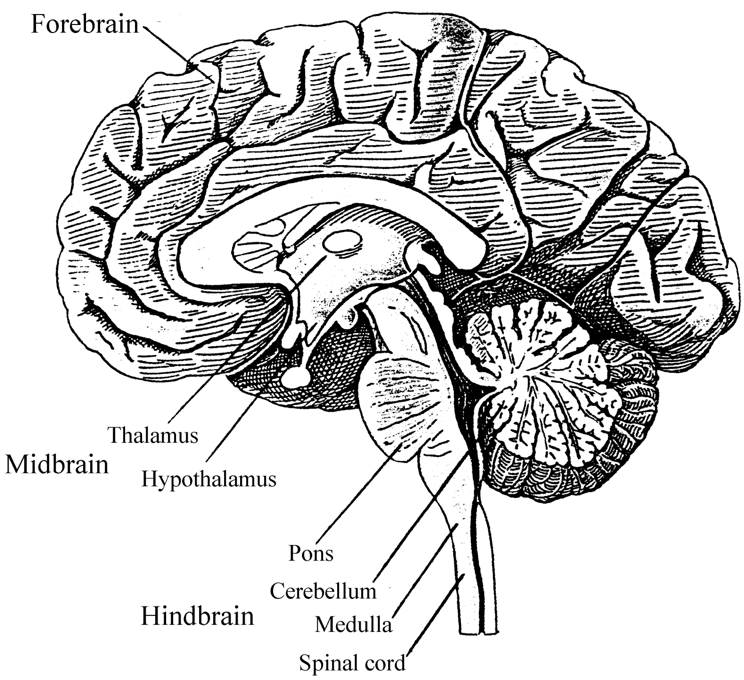


Figure 2-3

Hindbrain, Midbrain and Forebrain

(adapted from Bloom et al 1985:23)

2.4.1 The hindbrain

The most important parts of the hindbrain are the *pons* (bridge), the *cerebellum*, and the *medulla oblongata.*

- The **pons** contains a portion of the reticular activating system, and, in the brainstem, serves as a kind of 'relay station', providing the major routes by which the forebrain sends and receives signals to and from the spinal cord and the peripheral nervous system.
- The **cerebellum** lying directly behind the brain stem/reptilian brain, controls bodily co-ordination, balance, and muscle tone. It stores the basic repertoire of learned motor responses that the cortex may 'request'. It is concerned primarily with our body movement through space, helping to assume postures and maintain muscle co-ordination. It also contains a memory bank for simple learned motor responses, such as pulling one's finger away from a flame.
- The **medulla oblongata** is an elongated interior structure of the brain situated at the point where the spinal cord enters the skull. It contains the cardio-vascular and respiratory centres for the automatic control of heartbeat and respiration respectively, and controls blood pressure and the reflex responses of swallowing, coughing, and sneezing. The medulla oblongata is part of the reticular activating system (RAS): a midbrain structure that extends into the hindbrain (Sternberg 1998:84).

2.4.2 The midbrain

The midbrain has the following parts:

- **Superior colliculi** which are involved in vision (especially visual reflexes)
- **Inferior colliculi** which are involved in hearing
  (In mammals, the visual and auditory control of information is mostly taken over by the forebrain, but in non-mammals the midbrain is the main source of control for visual and auditory information.)
- **Substantia nigra** and **red nucleus** which are important in the regulation of motor functions
- **Reticular activating system**. One of the most indispensable functions of the midbrain is the reticular activating system (RAS), a network of neurons essential in the regulation of consciousness, as well as vital functions such as heart rate and breathing. RAS extends into the hindbrain, and includes the medulla and pons. Together the midbrain and hindbrain form the brainstem, which connects the brain to the spinal cord and is situated at the top of the spine. In evolutionary terms, the brainstem (sometimes referred to as the 'reptilian brain') is

the 'oldest' part of the brain, and is virtually identical to the brain of a reptile. Physicians are able to make a determination of 'brain death' based on the function of the brainstem.

2.4.3 The forebrain

The forebrain is situated toward the top and front of the brain, and comprises four parts:

- The **cerebral cortex** is a two-millimetre deep, outer layer of the cerebral hemispheres (see 2.3.2). In human beings the cerebral cortex is highly convoluted, containing many folds that increase the surface area of the cortex. The cortex enables us to co-ordinate thoughts and actions, to plan, to perceive visual and sound patterns, to use language: basically "to think" (Sternberg 1998:88,89).

- The **limbic system** comprises three central interconnected cerebral structures:
  - the *hippocampus* (named for its seahorse-like shape), which plays an important part in memory formation
  - the *amygdala* (named for its nutlike shape) plays a role in anger and aggression
  - the *septum pellucidum* (named for the wall it forms between the anterior part of the two lateral ventricles), which is involved in anger and fear.

  The **limbic system** is important to emotion, motivation, and learning. Fish and reptiles, that have relatively undeveloped limbic systems, respond to the environment almost exclusively by instinct. Mammals, in particular humans, have more developed limbic systems, which seem to help restrain instinctive responses and rather adapt behaviour to a changing environment.

- The **thalamus** is a two-lobed structure, approximately in the centre of the brain at eye-level, and just below the cortex. Specific *thalamic* fields serve as 'relay stations' for almost all incoming sensory information, to the appropriate region of the cortex. The thalamus is also involved in the control of sleep and waking.

- The **hypothalamus** is situated at the base of the forebrain, beneath the thalamus. Specific *hypothalamic* fields serve as 'relay stations' for the internal regulatory systems, such as water balance in the tissues and bloodstream. It is sometimes viewed as part of the limbic system, regulating behaviour related to species survival: fighting, fleeing, mating, and feeding. The hypothalamus also plays an important part in the *endocrine system* where it controls sexual behaviour (see 2.6.2).

The above information on the three major regions of the brain and certain of their major structures with their functions, is summarised in the following table (adapted from Sternberg 1998:87).

Table 2-1

Regions, Major structures, and Functions

REGION OF THE BRAIN	MAJOR STRUCTURES WITHIN THE REGIONS	FUNCTIONS OF THE STRUCTURES
Hindbrain	**Pons** (also contains part of the RAS)	Involved in consciousness (sleep/ arousal); bridges neural transmissions from one part of the brain to another; involved with facial nerves
	Cerebellum	Essential to balance, co-ordination and muscle tone
	Medulla oblongata	Juncture at which nerves cross from one side of the body to opposite side of the brain; involved in cardio-respiratory function, digestion, and swallowing
Midbrain	**Superior colliculi**	Involved in vision (especially visual reflexes)
	Inferior colliculi	Involved in hearing
	Substantia nigra, red nucleus	Important in controlling movement
	Reticular activating system (also extends to the hindbrain)	Important in controlling consciousness (sleep/arousal), attention, cardio-respiratory function and movement
Forebrain	**Cerebral cortex** (outer layer of the cerebral hemispheres)	Receiving and processing sensory information, thinking, other cognitive processing, and planning and sending motor information
	Limbic system	Learning, emotions, and motivation
	Hippocampus	Learning and memory
	Amygdala	Anger and aggression
	Septum pellucidum	Anger and fear
	Thalamus	Primary relay station for information coming into the brain; transmits information to the correct regions of the cerebral cortex
	Hypothalamus (sometimes viewed as part of the limbic system)	Controls the endocrine system, the autonomic nervous system; regulates internal temperature and behaviour related to species survival; plays a role in controlling consciousness (see RAS); involved in emotions, sexual response, pleasure, pain, and stress reactions

The location of the structures and functions of the three large composite regions of the brain, is illustrated in the following figure:

Figure 2-4

Distinct structures and functions of the brain within the three major regions

(Sternberg 1998:86)

2.4.4 Lobes of the cerebral hemispheres and cortex

One way of viewing the cerebral *cortex*, together with some of the smaller structures beneath it, is to divide it into four lobes. These lobes are not distinct units, but rather arbitrary anatomical regions, named for the bones of the skull which lie over them.

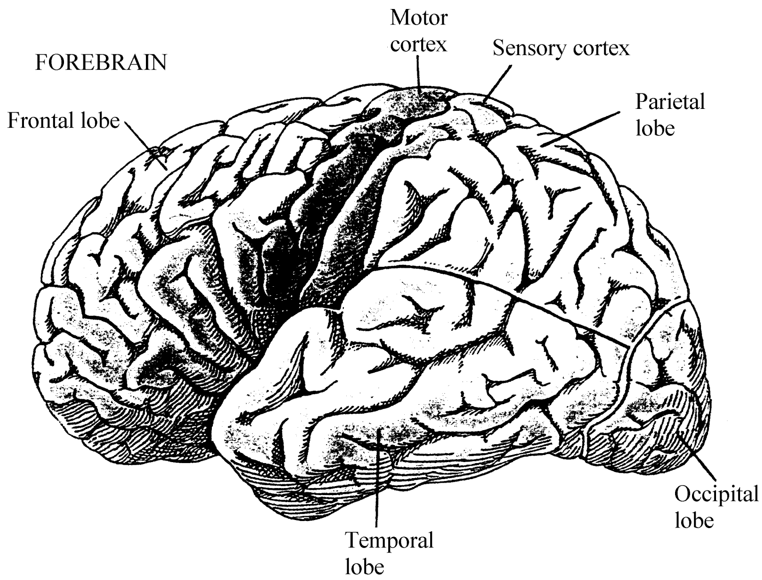


Figure 2-5

The lobes of the cerebral cortex

(adapted from Bloom et al 1985:23)

The lobes and their functions are:

frontal lobe having to do with **higher thought processes**, decision-making, problem-solving, and will

parietal lobe having to do with the processing of **sensations in the skin and muscles** of the body

occipital lobe having to do with **visual processing**

temporal lobe having to do with **auditory processing**, learning, memory, and language.

2.5 Structural components

The main operational unit of the brain is the microscopic nerve cell, or *neuron,* of which there are approximately 100 billion in the average brain, all linked together in a highly sensitive network.

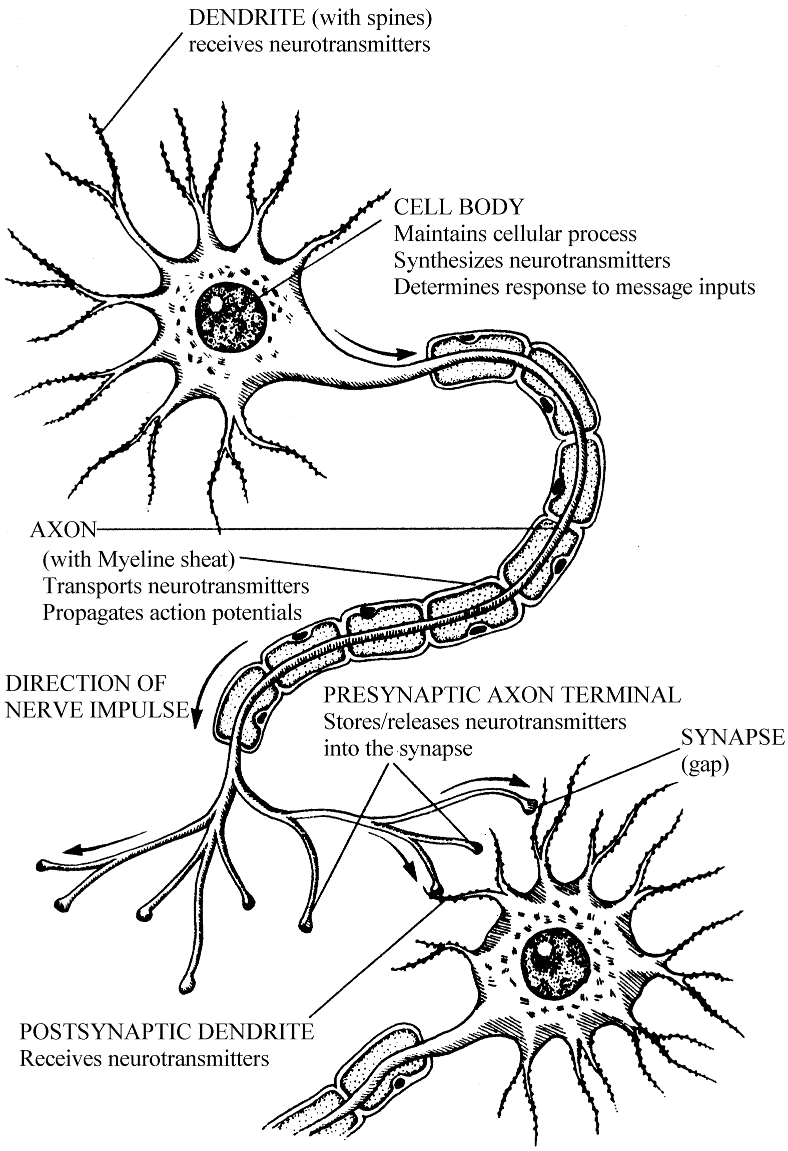


Figure 2-6

Sketch of a neuron

(Sylwester 1995:31)

There are **three** types of neurons serving three different functions:
sensory neurons
motor neurons and
*inter*neurons.

- **Sensory neurons** receive information from the environment and connect with *receptor cells* that detect changes in the sensory organs (such as the skin, ears, tongue, eyes, nose, muscles, joints, and internal organs). Sensory neurons carry information away from the sensory receptor cells to the brain/spinal cord.

- **Motor neurons** carry information in the opposite direction: away from the brain/spinal cord to the body parts that are supposed to respond to the information.

- **Interneurons** serve as *intermediaries* between the sensory and motor neurons. They **receive** signals from sensory neurons or other interneurons, and **send** signals to motor neurons or other interneurons.

2.5.1 Parts of the neuron

According to Sternberg (1998:101), the shape of a neuron is determined by its function. Neurons vary in their structure, but almost all neurons have four basic parts:
soma (cell body)
dendrites
axon and
terminal buttons.

- The **soma** contains the nucleus, which is responsible for the life and reproductive functions of the neuron.

- The **dendrites** are parts of the neuron at the end of the soma. A typical neural cell body contains many short, fingerlike, tubular extensions called dendrites, which receive information from other neurons. Dendrites contain many receptors: protein molecules that extend through the dendrite's membrane, to receive the chemical message carried by another neuron's neurotransmitter molecules. During memory formation, spines may develop on dendrites, increasing the number of receptors and therefore the amount of neurotransmitter information that can enter the neuron at one time (Sylwester 1995:30).

- The **axon** is a long, thin tube that can divide and branch at its terminus. One kind of axon is *myelinated* (surrounded by a myelin sheath that is formed by *glial* cells), which protects the axon from electro-chemical interference and speeds up the conduction of information along the axon. The second kind of axon has no myelin sheath at all: these axons are smaller and shorter than the myelinated axons, and conduction is much slower. Because the myelin layer on the axons is white, the term white matter is often used to describe large areas of brain tissue consisting mainly of **myelinated** axons. The **myelin sheath** facilitates the speedy conduction of information.

- The **terminal buttons/knobs** (small knobbly structures) are found at the ends of the branches of an axon, where the neuron stores its neurotransmitters in little packets called vesicles (see 2.3.1), until they are released (Sylwester 1995:33). The terminal buttons do not directly touch the dendrites of the next neuron. A very small gap, the **synapse**, exists between the terminal buttons of one neuron's axon and the dendrites/soma of the next neuron. To pass on information, the terminal buttons release a chemical 'messenger'/neurotransmitter across the synaptic gap to the receptor dendrites/soma of the next neuron.

2.5.2 Conduction of information within/between neurons

There are basically two kinds of neuronal communication:
intraneuronal (within neurons) and
interneuronal (between neurons).

- **Intraneuronal** communication within the neuron is *electro-chemical*, involving chemicals having positive or negative electrical charges. Each neuron contains electrically charged chemical particles called *ions*.

- In **interneuronal** communication, when one neuron is stimulated by another, the following process takes place:
  - ➢ an electrical impulse from the terminal buttons of another neuron travels through the branchlike *dendrites* and down the long trunklike *axon* to the *nucleus*
  - ➢ the impulse directs the nucleus to release appropriate chemicals called *neurotransmitters* or *neurochemicals*

➢ these *neurotransmitters* flow into the 'gap' (called the *synapse*), between one neuron and its neighbour

➢ the receptors on the neighbouring neuron's dendrites now become activated.

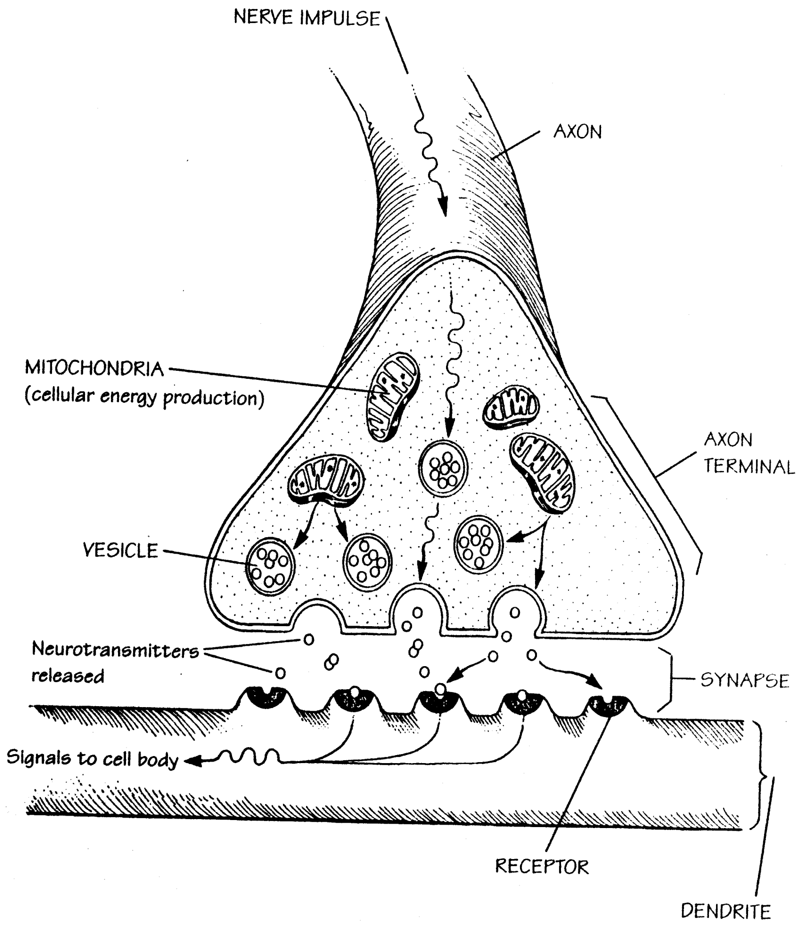


Figure 2-7

Synapse/Dendrite connection

(Sylwester 1995:34)

In this unique electrochemical process, one neuron communicates with another and vast systems of neurons process individual brain activities (Maguire 1990:7).

2.5.3 Neurotransmitters/brain chemicals

Neurotransmitters are the "lubricants" that allow connections to be made between brain cells. Mental activity is a bio-chemical flow of synaptic energy through the brain: just *thinking* of certain things can trigger a physical response. More than fifty **neurotransmitters** have been identified by scientists. They carry out their communicative functions at the *synapse,* which is a very narrow gap that separates the *axon terminal* of a presynaptic neuron from the *dendrite receptor* of a postsynaptic neuron.

Neurotransmitters can be chemically classified into three types:

- **Amino acids**, such as glutamic acid
- **Mono-amines**, such as dopamine, serotonin, and norepinephrine
- **Peptides**, such as endorphin, and vasopressin - composed of chains of 2 to 39 amino acids. (Shifts in the body/brain levels of these molecules allocate the emotional energy: what to do, when to do it, and how much energy to expend.) Cortisol and endorphins are two examples of peptides that can affect behaviour in educational settings, especially with respect to stress.

Oxygen is as essential for learning as it is for life: although the brain makes up only one fiftieth of the body's weight, it uses up one fifth of the body's oxygen. **Water** plays a crucial role in assisting oxygen distribution to the brain (Hannaford 1995:146).

According to Ostrander et al (1994:186), food can "lift your intelligence, enhance your memory, and fuel your learning power". **What one eats, dictates the levels of specific neurotransmitters and must necessarily influence brain-function.**

Certain substances in ordinary edibles can affect the way one feels, thinks, and behaves:

- The **sugar** in certain foods (notably sweets) enters the bloodstream quickly, stimulating the production of *serotonin,* a chemical transmitter in the brain. Serotonin has a relaxing effect, and at least temporarily provides a better frame of mind to cope with life’s daily challenges.

- Two of the most important brain nutrients are the amino acids *tyrosine* and *tryptophan*. The brain metabolises *tyrosine* which is present in **high protein** foods, into two different neurotransmitters: *norepinephrine* and *dopamine.* These neurotransmitters:
  - ➢ sharpen the awareness
  - ➢ increase the attention span
  - ➢ help the brain to perform rational functions more effectively.

On the negative side, it is possible that a person can become so agitated, that he/she cannot handle opposition or setbacks.

- *Tryptophan,* the amino acid present in high-carbohydrate foods, stimulates the production of *serotonin* which can:
  - have a calming effect
  - raise the pain and discomfort threshold by raising the level of endorphins
  - assist in conquering insomnia.

According to Rose (1991:5,6), nutrition is vital during the formation of brain cells, and tryptophan is especially important for brain biochemistry, with human milk having twice as much of this amino acid as cow's milk. However, combining proteins and carbohydrates can be counterproductive, sometimes inhibiting the production of serotonin altogether (Maguire 1990:41). **In societies where mothers are undernourished, children may have up to fifty percent fewer neurons than their counterparts in more affluent societies.** It should be remembered that a healthy diet in infancy is **crucial for the process of myelination**, which facilitates the speedy conduction of information (Sternberg 1998:102).

Maguire (1990:116,117) reports on certain experiments that were conducted over a period of eight months in the USA (1981), on a group of retarded children, and in Britain (1988), on school children of average intelligence, to ascertain whether inadequate nutrition affects brain function, or more specifically, whether certain dietary supplements enhance brain function. The scores of the intelligence tests at the end of the eight-month period indicate that there is a definite improvement in brain function with certain dietary supplements, in particular **protein**, **vitamin**, and **mineral** supplements.

2.6 Gender differences in brain development

According to Maguire (1990: 12) and Moir & Jessel (1992:5,128), brain researchers in the 1970's and 1980's managed to identify some significant physical distinctions between the brain structures, priorities, and strategies, in men and in women. Until recently, behavioural differences between the sexes were attributed to social conditioning, with little attention given to the **biological** view based on the interplay of specific hormones on the male or female brain, which is specifically pre-wired to react with them. To reduce gender differences to only those of reproduction is "a denial not only of the scientific truth, but of the very essence of our humanity, be it male or female" (Moir & Jessel 1992:128).

The biological and neurosciences offer an explanation for the way in which men and women come to be different. This has presented sociologists with the problem arising from the confusion on the issue of **sex** and **equality**. Concerning **sex**, **diversity is a biological fact**, whereas **equality is a political, ethical and social precept**. Recent decades have been witness to two contradictory processes:

- the development of scientific research into the differences between the sexes
- the political denial that such differences exist.

These two intellectual undercurrents are in direct opposition to one another, with political pressure being applied in many instances to prevent 'politically sensitive' scientific research information from being publicised.

2.6.1 Normal genetic sex determination

Our 'identity blueprints' are formed by forty-six chromosomes, half of which are contributed by the mother, and half by the father. The first forty-four pair up, forming pairs of chromosomes which determine our eventual bodily features such as hair colour, eye colour, etc. The last pairs of chromosomes are different:

- the mother contributes an X-shaped chromosome to the egg
- the father contributes either another X-shaped chromosome (in which case the 'outcome' will normally be the formation of a girl baby), or a Y-shaped chromosome (in which case, normally a baby boy will be formed).

However, **the genes alone do not guarantee the sex of a child**: hormones play a crucial role in sex determination.

2.6.2 The endocrine system and hormonal sex determination

The endocrine system (endocrine means *secreting* or *releasing inside*) operates by means of glands, which are groups of cells that secrete chemical substances, and is controlled by the *hypothalamus*. Endocrine glands release their chemical products directly into the bloodstream. These chemical substances which operate within a communications network, are **hormones**. The *pituitary gland*, which is controlled by the hypothalamus, is of central importance in the endocrine system and is, in turn, in control of many other endocrine glands (see 2.6.5). The endocrine system provides a means of activating responses in the body via hormones in the bloodstream (Sternberg 1998:107-111).

Moir & Jessel (1992:22-24) maintain that the intervention, or lack of intervention, by certain male *hormones* constitutes the other crucial factor responsible for determining the sex of the child. If a *female fetus* (genetically XX) is exposed to *male hormones*, the baby is born looking like a normal **male**. If a *male fetus* is deprived of *male hormones*, the baby is born looking like a normal **female**.

In the first weeks, the tiny fetus is neither noticeably male or female. At around six weeks, the sexual identity is finally determined:

- when the male fetus (genetically XY) develops special cells which produce the male hormones (the main hormone being *testosterone*), stimulating the development of embryonic male genitalia
- when the female fetus (genetically XX) produces no significant amount of male hormone, and results in a female embryo.

In the same way that the six-week-old fetus was not recognisable as male or female, so the embryonic brain, too, takes approximately a further two weeks to acquire a specific sexual identity. **The natural template of the brain appears to be female**, and in normal girls it will develop naturally along female lines.

In the case of an embryonic male fetus, the process is different. In the same way that the sex of the male fetus is determined by the intervention of male hormones, so **radical** intervention by the male hormones is necessary to change the 'female brain structure' into a male pattern. The male embryo has to be exposed to a large 'dose' of male hormones at the critical time when the brain starts to develop. Of importance for the male embryo is the fact that when the sex of the fetus is determined, the formation of the sexual 'equipment' is crucial for the production of male hormones, which in turn determine the sex of the unformed brain.

2.6.3 Deviations in fetal brain developments

It is possible that:

- a male *fetus* may have enough male *hormones* to bring about the development of male *sex organs*

- as the male *sex organs* start developing, they may **not** produce enough additional male *hormones* to 'push' the **brain** into the *male pattern*.

In this case the baby will be born with a **female brain** in a **male body**. Similarly, if a female foetus is exposed to male hormone, the baby could be born with a male brain in a female body.

From 2.6.1 and 2.6.2, it is clear that **there is a 'critical interplay' between the hormones and the unformed brain**. However, once the brain sex has been determined in its male or female structure (at the critical time of embryonic development), the **later** intervention of hormones from the opposite sex has no effect. Evidence does suggest that **brain-sexing is a matter of degree**: the more male hormone the foetus is exposed to at the critical time of brain development, the more the adult will be male in behaviour.

Although the organisation of the brain into a male or female neural network is permanent and can only be modified by altering the hormones at the critical stage of embryonic development, the difference of brain sex does not show fully until the hormones of puberty become effective (Moir & Jessel 1992: 180,181).

2.6.4 Physical differences in brain structure

The following differences between the sexes are noticeable:
In the part of the brain controlling sexual behaviour, the **hypothalamus**, the pattern of cells and structure of the male and female hypothalamus are distinct and different.

- The **cerebral cortex** (see 2.3.2) is measurably thicker on the right side in males, and on the left side in females.
- The **corpus callosum** (see 2.3.2) or network of fibres connecting the left hemisphere with the right hemisphere, is proportionately larger in a female brain than in a male brain.

2.6.5 Changes in the female adolescent

In girls, around the age of eight, the level of female hormone begins to rise, the body becomes more 'rounded', and at the age of about thirteen, the menstrual cycle begins. The hormonal flow is regulated by the *hypothalamus* (see 2.4.3) which 'instructs' the pituitary gland to open and close the valve for sex hormones. This 'hypothalamus-pituitary command system' does not always function successfully, leading to wide fluctuations of hormone concentrations in women, which result in considerable fluctuations in behaviour. In severe cases of drastic fluctuations, women can be left incapacitated. The extent to which these mind-altering chemicals (hormones) can affect women, can be briefly explained as follows:

- In the first half of the menstrual cycle, *oestrogen* (the hormone which promotes the growth of the egg) alone is present, and reaches its peak when ovulation occurs, after which its level temporarily declines. Oestrogen promotes brain cells to become more active and alert, heightening the senses and promoting a sense of well-being.
- After ovulation, *progesterone* is produced in the place where the egg grew. Progesterone is essentially there to promote a successful pregnancy. It has an inhibitory/calming effect: the brain becomes more 'sluggish', which can lead to tiredness and depression, or, the calming effect can help stabilise the emotions.
- After ovulation, the levels of both the *oestrogen* and *progesterone* rise slowly until they reach another peak together. About four or five days before menstruation **both these levels drop dramatically**, sometimes resulting in **severe withdrawal symptoms**, due to:
  - ➢ much less progesterone to calm the mood
  - ➢ much less oestrogen to promote a feeling of well-being.

Moir & Jessel (1992:74) document the following warning:

> The psychological changes that occur during this phase of the menstrual cycle can have serious consequences for a susceptible woman and also for society at large, and should not be considered merely a 'minor nuisance'.

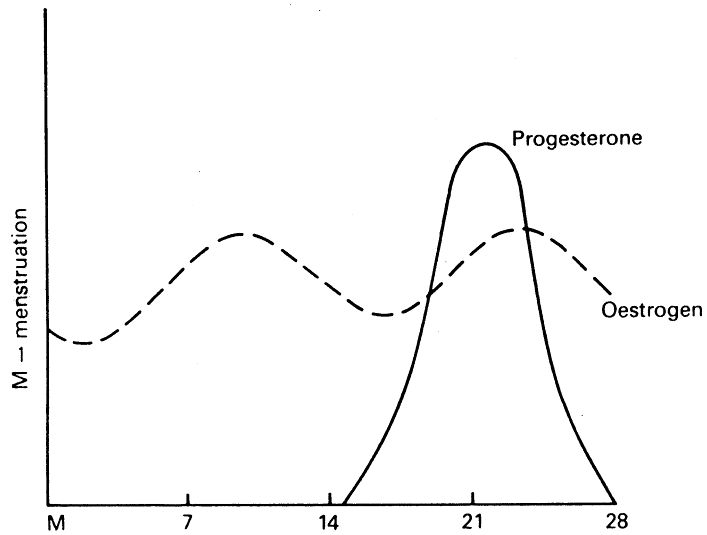


Figure 2-8

Changes in oestrogen and progesterone levels during a menstrual cycle

(Moir & Jessel 1992:72)

2.6.6 Changes in the male adolescent

Hormones are 'mind-chemicals' which act on the brain, instructing it to effect body changes, creating a great deal of psychological trauma for developing girls and boys. The physical changes during puberty alter the psyche, and the biochemistry alters behaviour, perceptions, emotions, and abilities.

In the case of boys, the male hormone levels increase about two years later than girls. The principal hormone involved is *testosterone*, an anabolic steroid that helps to build up the body, giving males the advantage of physiological superiority. The hormonal flow is also regulated by the *hypothalamus*, which strives to keep the hormone levels fairly constant.

The manifestation of aggression, dominance, and assertiveness in males has a biochemical origin. According to Moir & Jessel (1992:79,80), the evidence is now incontrovertible. The male brain pattern is 'tuned' for potential aggression, with male hormones, acting on a predisposed male brain network, being the root of male aggression. During puberty, the level of testosterone increases dramatically, having an effect on aggression that surpasses its influence on the more obvious forms of sexuality. (The authors consider it no coincidence that the age group with the highest crime rate is from thirteen to seventeen years.)

What is crucial, however, is the effect of testosterone on a brain structure **that is pre-wired to react with it**. A normal woman will not become as aggressive as a man when injected with doses of testosterone, as her brain is not 'programmed' to react to the chemical.

2.6.7 The effect of social conditioning

Men and women are different, and the society in which they grow up does affect them, essentially **by reinforcing their natural differences**. Many cases have been recorded which show that social conditioning cannot determine the sexual mind-set. The "happy consensus" that irrespective of gender, people are what society expects them to be, as well as the belief that people can, to a large extent, take control of their destinies, is in direct contrast to the fact that sexual differences are **a product of biology and cannot be altered**.

In all men and women, the brain has been pre-wired in a specific way that affects behaviour, long before the influence of society's values or teenager hormones have an effect.

For centuries, doctors observed that women recover more quickly than men from most forms of brain damage. It now appears that the right and left hemispheres in women's brains are more closely interconnected, so that one hemisphere can more easily compensate for damage to the other. The stronger corpus callosum link in the female brain could explain "women's intuition", because it is better able to integrate all the nuances and details of a particular situation. The more "compartmentalised" male brain might be better able to focus with precision on a limited number of relevant details, and give them apparent superiority in mechanics and maths.

2.6.8 The effect of sex hormones on the brain

Maguire (1990:14) refers to research done at the University of Western Ontario, where women were found to perform better on tasks involving **verbal skill** or **muscle co-ordination** when their oestrogen level was *high*. Alternatively, they performed better on tasks involving **spatial relationships** when their oestrogen level was *low*. In conjunction with other research findings, the indications are that sex-specific hormones do have an effect on the brain's transmission system.

According to research done by Pease & Pease (1999:119,175,187-208), hormones programme the brain before birth, with testosterone hormones inhibiting left-brain growth in boys, but generally providing them with greater right-brain spatial abilities. With respect to visuo-spatial (mathematical and scientific) ability, the sex difference becomes more pronounced with age. Male hormones enhance the visuo-spatial skills and female hormones depress them (Moir & Jessel 1992:89).

The full differences between the male and female brain are made manifest at puberty: differences in behaviour, emotion, ambition, aggression, skill, and aptitude. It would appear that popularity is more important for school-age girls than success or achievement: a bias that is reinforced by social conditioning. Biology cautions against a strongly feminine role (concern with people, morality, and relationships) in a traditionally male preserve (concern with things, theories and power), as the potential for mutual misunderstanding is great.

2.6.9 Differences in brain development

The physical development of the brain is largely complete by the age of five. There are, however, well-established intervals of development at ages of approximately 6 to 8, 10 to 12, and 14 to 16 years, which could be used to the child's advantage if educational stimuli could be timed to coincide with these natural periods of development. Furthermore, the brain development of girls at age 11 is approximately twice that of boys of the same age, but at age 15 something like the converse would be more accurate (Rose 1991:9).

The main gender differences in brain development have been compiled in Table 2-2 below:

Table 2-2

Gender differences in brain development

DESCRIPTION	MALE	FEMALE
Physical sex determination of embryo Genetic – at conception Hormonal intervention at critical stage c. 6 weeks after conception	Physical sex of embryo is determined by an X-chromosome from the mother and a Y-chromosome from the father Outcome: a male embryo Insufficient intervention to embryo by male hormones Outcome: sex of embryo could be altered to female	Physical sex of embryo is determined by an X-chromosome from the mother and an X-chromosome from the father Outcome: a female embryo High level of intervention to embryo by male hormones Outcome: sex of embryo could be altered to male
Brain sex determination of embryo (Brain template of all embryos is **female)** Hormonal intervention at critical stage c. 8 weeks after conception	Insufficient intervention by male hormones Outcome: brain template remains female	High level of intervention by male hormones Outcome: brain template becomes male
Brain structure	Cerebral cortex thicker on right side	Cerebral cortex thicker on left side
Testosterone / Oestrogen	Testosterone inhibits left hemisphere growth and verbal skills Improves right hemisphere spatial activities An excess leads to aggression	High levels of oestrogen lead to improved verbal skills and muscle co-ordination Low levels lead to improved spatial relationships
Brain development at c.11years	Approximately half that of girls	Approximately twice that of boys
Brain development at c.15 years	Approximately twice that of girls	Approximately half that of boys

2.7 Neural oscillations and brain wave patterns

According to Zohar & Marshall (2000: 71), there are oscillations and waves of all sorts and frequencies in the brain, as demonstrated by EEG printouts and brain-wave patterns. The brain's overall electrical activity, or the rate of neuron firing, can be mechanically recorded as a brain wave pattern. All the various neural oscillations are known to be associated with electrical fields in the brain, which in turn are generated by many dendrites oscillating 'in concert', without actually firing. These oscillations differ from the action potentials that move rapidly along the neural axon: they provide another way by which the brain can communicate with itself.

2.7.1 Brain wave patterns

Maguire (1990:7) states that the brain's overall electrical activity, or the rate of neuron firing, can be mechanically recorded as a brain wave pattern. The brain produces **four** main frequencies, with the different brain wave patterns reflecting different levels of consciousness:

- **Delta** waves, the slowest waves of all, represent **sleep**. These slow-firing brain wave pulses are found in deep, dreamless sleep.

- **Theta** waves represent **drowsiness** or ***deep reverie***. The theta pulse is faster than the delta, and is generally accepted as an unconscious 'sleep' state, but can also be associated with meditation and reverie. The connection of the theta pulse to deep creative thought and dreaming is still being researched.

- **Alpha** waves are relatively slow and indicate a **relaxed/reflective, meditative state**. Alpha waves are not as slow as theta, and are produced when we relax, daydream, or use our imagination. Accelerated learning techniques make extensive use of these waves in the learning process.

- Relatively rapid **Beta** waves are associated with normal **arousal**: alert/working. This is the fastest brain rhythm, and this state of the conscious mind is predominant when we are busy talking, moving, and being active. When left and right brain hemispheres are producing similar brain-wave patterns, a 'rhythmic synchronisation' occurs. "This hemispheric integration develops a co-ordination of rhythms that sets the stage for accelerated listening and learning" (Brewer & Campbell 1991:103-105). Especially valuable as integrating tools in synchronisation are music, movement, and art.

Figure 2-9

Brain wave patterns

(Maguire 1990:7)

The following table from Zohar & Marshall (2000:72) includes the relatively fast c.40 Hz (Gamma waves) and c.200 Hz waves which are not used for educational purposes, and indicates:

- the brain wave state
- the wave frequency in cycles per second (CPS) or Herz
- the characteristics of the states of consciousness.

Table 2-3

Brain wave rhythms

BRAIN WAVE STATE	WAVE FREQUENCY (Hz or CPS)	CHARACTERISTICS and/or WHAT THEY MEAN
	c. 200 Hz	Recently discovered in hippocampus: function as yet unknown
GAMMA	c. 40 Hz	Conscious brain, either awake or during dreaming sleep. Credited with perceptual feature binding.
BETA	13-30 Hz	Logical thought processing; analysis; alert; active: concentrated mental work. **Observed in adults**
ALPHA	7 – 13 Hz	Relaxation; daydreaming; connection to subconscious; creative imagination; inspiration; high suggestibility; information synthesis; fact assimilation; integrated learning state – a state of relaxed alertness. **Observed in adults or children 7 – 14 years**
THETA	3.5 – 7Hz	Unconscious sleep state; deep meditation/reverie, deep creative thought/ dreamimg. **Prevalent in children 3-6 years**
DELTA	0.5 to 3.5 Hz	Deep, dreamless sleep, or coma. **Also very prevalent in infants' brains**

Until very recently, it was not possible to discover more about the nature, function, or extent of neural oscillations, because of the limitations of the EEG machine, which was the only available technology for observing them. The electrical fields of the brain are very weak, and the brain itself and the skull act as a barrier between the electrical fields and the electrodes of the EEG, resulting in crude, limited readings.

2.7.2 Magneto-encephalography (MEG)

Whereas EEG measures electrical activity generated by the brain, MEG measures the associated magnetic activity, which is not affected by physical barriers. With the development of 'whole scalp' MEG's in the late 1990's, neuroscientists have been able to obtain a picture of neural oscillatory activity across the entire brain and deep within it. The brain has many complex oscillatory rhythms related to things like body movements, visual imagery, auditory commands and concentration (Zohar & Marshall 2000:73).

2.7.3 The significance of 40 Hz neural oscillations

According to MEG studies, the relatively fast 40 Hz oscillations are found all over the brain in different systems and at different levels. They cover the whole cortex, moving in waves from front to back. Both the local and more generalised oscillations go beyond the abilities of any single neuron (or localised group of neurons) in that they communicate and collate perceptual and intellectual processing across the whole brain: they place the activity of a single stimulated neuron in a larger, more meaningful context.

It would appear, according to research, that presence of consciousness in the brain is associated with the presence of 40 Hz neural oscillatory activity, which disappears when the brain is in coma or anaesthetised (Zohar & Marshall 2000:75). In the same way that

- linear/serial neural tracts enable rational, logical data-processing (IQ) to take place, and
- parallel neural networks allow preconscious and unconscious associative data processing (EQ), so the 40 Hz 'across-the-brain-oscillations' provide a means to bind experience together and place it in a frame of wider meaning (SQ) (see 3.2).

2.8 Perception

De Bono (1988:26) claims that it is the active nature of nerve networks that makes it possible for incoming information to organise itself into patterns, and that the formation and use of such patterns gives rise to **perception**. The brain is designed to form patterns, and then to use these patterns as often as possible.

A more recent view is that of Sternberg (1998:118): "Perception usually refers to the cognitive processes in the brain through which we interpret the messages our senses provide". It would appear that **genetic (biological) factors are far more important than cultural (non-biological) factors** in explaining sensory processes and structures, which affect our lives constantly. The senses provide individuals with sensations of sound, light, colour, taste, scent, pressure, temperature, balance, and motion.

2.8.1 Biological properties of the senses

The sensory organs are stimulated at specialised *receptor cells* to detect particular kinds of **energy**:

- mechanical
- electromagnetic
- chemical.

This energy, which is received from the environment, has to be converted into the **electro-chemical** form of energy that is meaningful to the nervous system. Each sense has its own set of specialised receptors for converting its own kind of stimulus energy, with respect to both the **intensity** and the **quality** of the stimulus.

2.8.2 Sensation

The five means by which humans sense the world are:

- vision (sight)
- audition (hearing)
- gustation (taste)
- olfaction (smell)
- somatic sensation (touch).

Most people rely on **vision** as their primary means of sensing the world around them. Of the non-visual senses, **hearing** is considered the most important.

One kind of sensing which seldom appears in such lists is that of the **sense of gravity**, which is used to monitor the movements of the head and body, and to orient the individual in space. The structure responsible for this is the *vestibular apparatus* in the ear. The importance of the *cochlear-vestibular* apparatus should not be underestimated. The ear is not limited to 'hearing'. Tomatis (1991:186) describes the ear as an 'energy-transmitter' that is made not only for hearing, but also plays a crucial role in energising **brain** and **body.**

2.9 The connection between mind/brain and body

On considering the interplay between brain and body, one very compelling theme emerges: **movement is essential to learning**.

- With movement within the womb, humans have their first sense of the world, and their first experience and knowledge of gravity
- With movement, humans build on these experiences to shape vision
- With movement, humans explore the form of their environment
- Movement makes it possible to interact with people and surrounding forces
- Every movement is a sensory motor 'event' which provides people with an understanding of the physical world, from which all understanding is derived
- Movement of the head aligns the sensory organs: eyes, ears, nose, and tongue
- Refined movements of the hands make it possible to touch and manipulate the world
- Movement makes it possible to pick up smells that trigger the memory of certain events
- Knowing how to sit, stand, walk, run, etc., is imprinted on the muscular memory structures of the body
- Movement of the face makes it possible to express joy, sadness, anger, and love, in the human quest to be understood
- Movement makes it possible to express thoughts and emotions in words and actions
- Through movement full brain activation occurs, opening the doors to learning in a natural way (Hannaford 1995:97).

For real learning (establishing meaningful connections for the learner) to be complete, there must be some output, such as physical or personal expression of thought. Learning involves developing skills that can be used to express knowledge. In the process of building these skills, body muscles are used to establish neuromuscular routes and their connections to cognitive routes. "Learning is not all in your head. The active, muscular expression of learning is an important ingredient of that learning" (Hannaford 1995:87).

2.9.1 Societal prejudice to bodily-kinesthetic intelligence

Due to the societal bias that human thinking is superior to the physical basis of thinking, the importance of physical achievements have been downgraded in the realms of work and school. The notion that physical activities are somehow less privileged or less special than those using language, logic, or relatively abstract symbol systems, has manifested itself in recent cultural tradition by a 'divorce' between mental and physical activities (Hannaford 1995:97).

Howard Gardner's "Theory of multiple intelligences" (MI theory) (see 4.9) recognises the importance of the bodily-kinesthetic intelligence, the musical intelligence, and the visual-spatial intelligence. These three intelligences have in the past not enjoyed the same level of esteem as, for example, those of the linguistic and logic-mathematical intelligences. MI theory has now elevated them to the ranks of the remaining five intelligences.

The intellectual skills used in the classrooms and in the workplace all make use of bodily-kinesthetic skills which require an intricate networking of thought, muscles and emotions: thinking and learning is anchored by movement (Hannaford 1995:87,98).

2.9.2 How movement anchors thought

According to Hannaford (1995:98), if a thought is to be remembered, an action must be used to anchor it: it must be materialised with words. The following are descriptions of thought 're-inforcement':

- **Writing**. In the process of writing, thought connections are made by the movement of the hand. It is not necessary for the person to read what is written, but the movement is necessary to build the neural network that will anchor the thought.
- **Talking**. Many people find that the process of talking anchors their thoughts. Talking is considered an important sensory-motor skill, involving facial, tongue, vocal, and eye muscles. Talking makes it possible to organise and elaborate thoughts.

Recent research has shown that the two areas involved with the control of muscle movement, the *basal ganglia* and the *cerebellum*, are also important in co-ordinating thought (Hannaford 1995:99).

2.9.3 The basis of the movement-thought link

As a young baby's repertoire of movements grows, each development places the sensory apparatus, especially the eyes, ears, mouth, hands, and nose, in an increasingly advantageous place for environmental input. The vestibular system is connected to the core muscles of the back and abdomen, which first work to lift the head, enabling the baby to respond actively to aural and visual input. As the neural networks to the core muscles mylenate from use, the baby is eventually able to sit, crawl, and walk.

The **cross-lateral movement involved in crawling is of special importance**, activating the development of the *corpus callosum*. It has been known for some years already, that children who miss the vital stage of crawling often exhibit learning difficulties later on (Hannaford 1995:129).

2.9.4 Vision and movement

The visual sense functions most effectively when the eyes are actively **moving**. When the eyes stop moving they no longer take in sensory information. In an active learning situation, the external eye muscles constantly move the eyes up and down, side to side, and all around. The internal muscles constrict or dilate the pupil for proper lighting, and the ciliary muscles of the lens broaden or lengthen the lens for near and far vision (Hannaford 1995:102).

Babies start following movements of the hands, feet, and other objects with their eyes, leading to the development of hand/eye and foot/eye co-ordination, that then allows the infant to move in response to objects in the environment. Three-dimensional and peripheral vision allow the greatest environmental learning and contribute to the development of a spatial awareness. When children enter school, they require foveal focus for 'up close', two-dimensional paperwork.

The transition from three-dimensional and peripheral to two-dimensional foveal focus is often abrupt, and in many cases unnatural. Children who have looked at books in the home, before entering school, have usually acquired a certain amount of foveal focus.

Thinking and learning are not all in the head. Neuroscientific research on the cochlear-vestibular system supports the notion that the **body** plays an integral part in all intellectual processes, from the earliest stages through to old age. The role of the body in the learning process is being dramatically clarified by scientific research, and according to Hannaford (1995:12), this knowledge will have a powerful effect on how children are raised and taught.

Thinking is a response to the physical world, and in studying the brain, thinking can only be understood in the context of a physical/action reality. Even abstract thinking can only be manifested through the use of muscles in the body, as in speaking, writing, making music, computing, etc. For this reason it is necessary to appreciate the importance of movement, in particular integrative movements that require balance and coordination, to assist nervous system development and functioning. **Movement** is an integral part of all mental processing: **thought is made manifest in action** (Hannaford 1995:103-107).

2.10 Brain organisation

There are several ways of looking at the brain physiologically. Traditionally, scientists have divided the brain's structures into three functional components: the forebrain, the midbrain, and the hindbrain. According to Herrmann (1989:31), the division is mainly arbitrary, having relatively little to do with facilitating our understanding.

2.10.1 Brain theories

The new biologically based brain theories focus on the developmental relationship between *a brain's ancestors* and *its current environment*: the controversial "nature versus nurture" issue (see 3.7.1). Education has tended to treat the **nurture** side as dominant, but this new information indicates that **nature plays a far more important role than previously believed**, and that the basic wiring patterns of the brain are genetically specified (Bloom, Lazerson & Hofstadter 1985:49). Nelson & Bloom (1997:980) claim that the environment matters little, if at all, to how the sensory and motor systems of the child develop. **It is the brain's ability to reorganise itself in response to new experience that makes it possible for humans to learn throughout their lives.**

As the general public become aware of these brain theories, some people may be disturbed by their evolutionary base, and educators will no doubt have to be prepared to comment on the new fundamental issues emanating from the thrust of these theories. Hence the necessity for educators to be informed about the work in brain theory, as its attraction moves from the scientific community into the educational community, and then into public awareness (Sylwester 1995: 14,15).

2.10.2 The triune brain theory

The triune brain theory was proposed by Dr. Paul MacLean of the Laboratory for Brain Evolution and Behaviour at the National Institute for Mental Health (USA) in 1978 (Sylwester 1995:39), and reflects the brain as three brains each superimposed over the 'earlier' in a pattern of brains-within-brains. In the evolutionary process each appears to have made some new starts and replicated older functions, making the functional divisions of these three areas not clearly definable. While the three brains overlap in the functions they perform, they differ in 'style' (Rose & Nicholl 1997:28).

This triune grouping of the **reptilian brain,** the **limbic/mammalian brain** and the **neocortex** can best be described as a **functional grouping**, rather than an anatomical one.

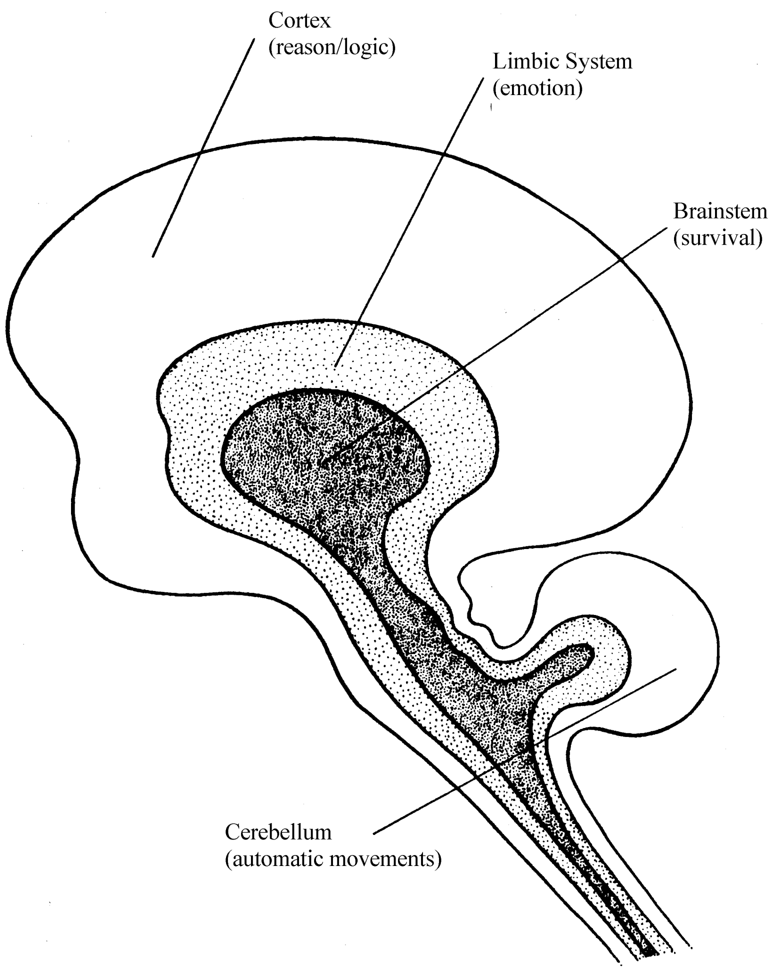


Figure 2-10

The triune brain grouping

(from Sylwester 1995:40)

- **The reptilian brain**
  The primitive reptilian brain is so-called because it strongly resembles the brain found in prehistoric reptiles, as well as in crocodiles and lizards today (Herrmann 1989:31). It controls and handles most sensory input and is connected to the higher-level functions. According to Fairbanks (1992:3), this portion of the brain evolved more than 500 million years ago.

- **The limbic/mammalian brain**

  The limbic, or mammalian brain, encircles the more primitive reptilian brain, and consists of the limbic system, which is an emotional controller. The limbic system is an interconnected group of structures perched on top of the brain stem, linked around the inside edges of the cortex (*limbus* in Latin means "border") and evolved between 200 and 300 million years ago (Fairbanks 1992:3). Because this system contains the mechanisms that make an organism warm-blooded, it is also known as the 'mammalian' brain. The key components of the limbic system are the cerebrum, the midbrain and the forebrain.

  The functions of the limbic system include:

  - Establishing emotional states and related behavioural drives (it is the processor of many of our *emotional reactions,* especially life-sustaining ones having to do with sex and aggression: fight or flight responses)
  - Linking the conscious, intellectual functions of the cerebral cortex with the unconscious and automatic functions of the brain stem
  - Facilitating memory storage and retrieval (it regulates emotional stability and the transfer of sensory input into memory)
  - Controlling *body temperature, blood pressure,* and *blood sugar* (it handles basic physical needs such as breathing, eating, and heart rate).

  The *amygdaloid body* (amygdala) appears to act as an interface between the limbic system, the cerebrum, and various sensory systems. The *hippocampus* (a folded area of the cortex) appears to be important in learning, especially in the storage and retrieval of new long-term memories (Martini 1998:464).

  The following comments on the function of the limbic system may be helpful in defining its functional role:

  - If one is stressed or fearful, the information may not be fully available to the neocortex. The human brain is downshifted to the more primitive areas of the brain, reverting to instinctual behaviour rather than rational judgement (Rose & Nicholl 1997:30).
  - The limbic system functions as the regulator of emotions and is also essential to memory. Memory of cognitive material can be heightened when structured within an emotional context or in such a way as to elicit an emotional response (Brewer & Campbell 1991:199,200).

Of significance is the fact that **the part of the brain that controls emotions, also controls health and memory** (Rose & Nicholl 1997:29). This implies that negative emotions could affect an individual's learning ability negatively.

- **The neocortex**
  Over the limbic system lies the neocortex. Although the neocortex is found in mammals such as the chimpanzee, dolphin, and whale, the brain of homo sapiens differs from those of these mammals by virtue of its size in relationship to both the brain and the body. It is this part of the brain that is the 'seat of intelligence' and enables humans to think, perceive, speak, and act as civilised beings, and is thought to have evolved about 50 million years ago.

According to Rose & Nicholl (1997:32), the brain is not primarily designed for thinking. The attributes that are considered most human, such as language, perception and intelligence, represent only a small portion of the brain's overall responsibilities to keep humans alive and functioning.

2.10.3 Reticular activating system (RAS)

Located at the top of the brainstem, the reticular formation integrates the type of incoming sensory information into a general level of attention. The average attention level is usually at its highest in the morning, dropping during the day and evening, and dipping below consciousness during periods of sleep. The term *reticular* means *net:* the reticular system acts as a chemical net that opens and closes to increase and decrease the information flow in and out of the brain (Sylwester 1995:43,44).

2.11 An overall view

One of the ultimate challenges in science is to understand the biological basis of consciousness, and how the mental processes of perception, movement, learning and remembering take place. It is important to know whether these processes are localised to specific regions of the brain, and to understand how the anatomy and physiology of a region relates to a specific function in perception, thought, or movement. To understand the regions of the brain and how they are specialised for different functions, it is necessary to have a basic knowledge of:

- the anatomy and physiology of the brain as a whole
- the properties of specific nerve cells and their interconnections
- the contribution of genes and the endocrine system
- the influence of the environment on the different functions of the brain.

Increased knowledge about the brain and brain behaviour, illustrates the importance of changed chemical 'settings' in the brain: a change in brain chemicals results in the stabilising of a different pattern/setting, which could possibly be associated with different modes of thinking (De Bono 1988:26-28).

Although the nervous system is complex, it is governed by a relatively simple set of functional, organisational and developmental principles. When taken together, these principles bring order and understanding to the myriad details of the physical brain.

CHAPTER 3

Brain based functions with educational implications

3.1 Introduction

The brain follows a natural pattern of development, and there is an order in which learning takes place. The order in which the parts of the brain develop, provides a map for parents and/or practitioners who wish to make use of the best kind of stimulation during each growth period. Forced learning could therefore result in the use of lower systems of the brain, since the higher ones that **should** be doing the work have not yet developed. There are indications that 'habit' of using inferior brain areas for higher-level tasks could lead to many learning problems.

In the past, the mechanisms that govern significant learning concerns such as emotion, interest, attention, thinking, memory, skill development, and the effects of stress, were not understood by educators. They focused on objects or events in the environment (stimulus) and behaviour (response). During the middle decades of the 20^{th} century, psychology's overemphasis on cognition in the realm of emotion can, to a certain extent, be ascribed to the domination of academic psychology by behaviourists such as B.F. Skinner (USA). He maintained that only behaviour that could be seen objectively from the outside, could be studied with scientific accuracy, effectively ruling emotions out-of-bounds for science. The past eighty years of research on intelligence have been (mis)guided by the scientific vision of an 'emotionally flat mental life'. This vision is gradually changing as psychologists recognise the essential role of **feeling** in thinking.

The single most important contribution education can make to the development of a child, is to help him/her toward a field where his/her talents are best-suited, and where he/she will be satisfied and competent. Gardner recognised the limits of the old way of thinking about intelligence. His "Theory of multiple intelligences" (see 4.9) reflects a multi-dimensional view of thinking and knowing, emphasising cognition, and developing in practice to focus more on 'metacognition', an awareness of one's mental processes, rather than on the full range of emotional abilities. According to Goleman (1996:40), there is ample room in Gardner's description of the personal intelligences, for insight into the play and management of emotions. However, **the role**

of *feeling* in these intelligences is not pursued in any detail, the focus being more on cognition *about* feeling.

By utilising the whole-brain approach, which recognises the inseparability of cognition and emotion, it becomes possible to engage learners in meaningful emotional processes. By empowering them to manage their own emotions, they can become **self-motivated**: a powerful strategy for learning.

Without memory there can be no learning. Once it is understood how the brain's memory works, it becomes possible to tap that vast and largely unused potential. Research indicates that the *hippocampus* is involved in the memory of 'dry' facts, whereas the *amygdala* is involved in the memory of 'emotionally charged' facts (Goleman 1996:20,21). The fact that some learners seem to forget a great deal of what they have been taught, may be ascribed to reliance on a singular memory system, instead of utilising multiple memory systems for better retrieval (Jensen 1995a:204,205).

An understanding of learning styles can greatly assist in the planning of education and training programmes. Educators and psychologists have developed a number of systems that identify and generalise diversity in order to better understand and make use of the general classification ('typing') of human nature and learning styles. Examples of these learning systems are: Bernice McCarthy's 4MAT-system (McCarthy 1990), Accelerated Learning, and systems based on Howard Gardner's Multiple Intelligences.

The neurophysiologist, Dr. Carla Hannaford, claims that the lateral dominance of eyes, ears, and hands in relationship to the dominant brain hemisphere, greatly influences the way that information is processed by the brain, and consequently the kinds of learning activities that are 'preferred' by an individual. Understanding a learner's brain, body, and nervous system makes it possible to have constructive insights into individuals, rather than giving them labels which will confine and limit their view of themselves and their potential. Hannaford (1997:9,10) recommends the use of a learning styles assessment system called 'Dominance Profiles'.

Many learners are being incorrectly labelled "attention disordered", when in fact they are simply kinesthetic learners (see 3.6). Children who are diagnosed as ADD (attention deficit disorder) or ADHD (attention deficit hyperactivity disorder) have a neurological disorder, and normally experience emotional and learning difficulties. From a thorough understanding of ADHD, brain waves, and neurotherapy treatment, comes a change in the way the child's behaviour is viewed.

To facilitate optimal brain function in education, it is necessary to make use of a **multi-sensory, brain-compatible** approach to learning: a holistic **whole-brain** approach. For this purpose, it is appropriate to examine in more detail the influence on learning of:

- Emotional intelligence
- Spiritual intelligence
- Memory and recall
- Brain profiles/dominance
- Brain waves/neurotherapy
- Evolutionary psychology.

3.2 Emotional intelligence

Goleman (1996:4) suggests that the name **Homo sapiens,** the thinking species, is misleading, in view of the fact that when it comes to shaping decisions and actions, feeling is at least **as** important, if not more important than thought: "Intelligence can come to nothing when the emotions hold sway" (Goleman 1996:4). To fully understand what is meant by emotional intelligence, it is necessary to define and examine the meaning of **emotion**.

According to Sternberg (1998:553), **emotion** can be described as the predisposition to respond experientially, physiologically, and behaviourally to certain external and internal variables. Emotion and motivation are very closely linked, often making it difficult to distinguish between them. Although motivation and emotion are similar in many ways, they also differ in several important ways, as illustrated in Table 3-1:

Table 3-1

Some differences between motivation and emotion

(Sternberg 1998:541)

MOTIVATION	EMOTIONS
Stimulus generally unobserved	Stimulus often apparent
Often cyclical (e.g., recurring hunger)	Not normally cyclical
Energise, direct, and sustain activity	May interfere with everyday activity
Responses are goal-directed	Responses are inner-directed
Experienced as desires to attain something	Experienced as feelings
Active	Passive

Emotions can be either pre-programmed (genetic) or acquired (learned), and can manifest in a variety of ways. The five most widely recognised and well-researched emotions, most often regarded as 'basic' to all humans are:

- happiness
- fear
- anger
- sadness
- disgust.

Sternberg (1998:542) adapted Plutchik's (1980:164) 'Emotion wheel', which posits **eight** basic emotions occurring in four pairs, with various shadings/relationships of emotions, and is charted in Figure 3-1:

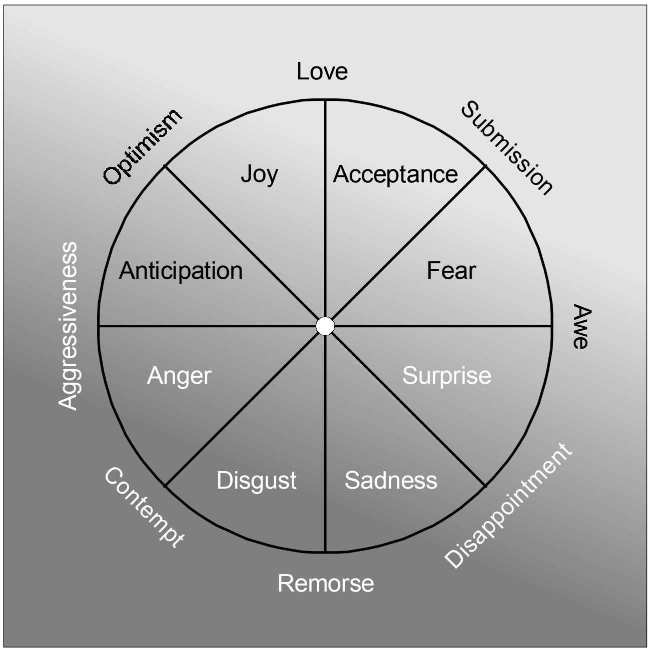


Figure 3-1

Plutchik's 'Emotion wheel'

(Sternberg 1998:542)

Sternberg (1998:544) indicates that the question of whether any emotions are truly 'basic' remains an open one. From an evolutionary perspective, emotions have two aspects that are both essential to human survival:

- a **physiological aspect** **-** there is a distinctive physical reaction in each emotion
- a **cognitive aspect** - the interpretation of the feelings experienced.

The expression of emotion enables people to communicate feelings, regulates how others respond to them, facilitates social interaction, and encourages pro-social behaviour. The similarity of facial expressions across cultures is an example of the communicative function of emotion. The high level of agreement across cultures suggests that facial expressions for emotions may be an innate part of the human physiological make-up. There are indications that 'creating' a facial expression produces particular changes in psycho-physiological reaction, but it remains unclear as to whether these changes are the same as experiencing the emotion itself, or whether they merely affect the intensity of the emotion.

Emotional intelligence is involved in the control and regulation of emotions. The following abilities are ascribed to emotional intelligence:

- to perceive accurately, appraise, and express emotion
- to access and/or generate feelings that are involved in generating thought
- to understand emotion and emotional knowledge
- to regulate emotions for the purpose of promoting emotional and intellectual growth.

Goleman (1996:193.194) maintains that during the first three or four years of a child's life, the brain grows to about two thirds of its full size, and "evolves in complexity at a greater rate than it ever will again". Key kinds of learning take place more readily during this period than later in life, with **emotional learning** being one of the most important. A child's readiness for school depends on the most basic of all knowledge: **how** to learn. The following seven key ingredients of this crucial capacity are all related to **emotional** intelligence:

- **Confidence**: a sense of control and mastery of one's body, behaviour, and the world
- **Curiosity**: the sense that finding out about things is positive and leads to pleasure
- **Intentionality**: related to a sense of competence, of being effective
- **Self-control:** a sense of inner control (controlling one's own actions in age-appropriate ways)
- **Relatedness**: the sense of being understood by, and understanding others
- **Capacity to communicate**: a sense of trust in others and of pleasure in engaging with others, including adults
- **Co-operativeness**: the ability to balance one's own needs with those of others in group activities.

3.2.1 Emotions and intelligence

Taking a broader perspective of intelligence, the new line of enquiry leads to how crucial emotional intelligence is in terms of learning and leading a successful life. Emotional intelligence can be expanded into five main domains:

- Knowing one's emotions: self-awareness, leading to the recognition of a feeling 'as it happens'
- Managing emotions: handling feelings so that they are appropriate
- Motivating oneself: the ability to marshal emotions in the service of a goal is essential for paying attention, for self-motivation and mastery, and for creativity
- Recognising emotions in others: empathy, or the ability to tune in to the subtle social signals that indicate the needs and wants of others

- Handling relationships: to a large extent this entails skill in managing the emotions of others.

People differ in their abilities in each of these domains, with the underlying basis for our level of ability being **neural**. The brain is, however, constantly learning and remarkably plastic, making it possible to remedy lapses in emotional skills. Cognition and emotional intelligence are not opposing competencies, but rather separate ones that complement one another, both adding separately to a person's qualities (Goleman 1996:40-45).

3.2.2 Emotional intelligence as a meta-ability

According to Goleman (1996:82,83), there is ample evidence that emotional skills such as impulse control and accurately reading a social situation **can** be learned. In early childhood, the challenge between impulse and restraint, desire and self-control, gratification and delay, offers a reading of the trajectory that the child will most probably take through life.

At the root of all emotional self-control is the fundamental skill of resisting impulse because, by their very nature, all emotions lead to one or another impulse to act. Goal-directed, self-imposed delay of gratification can be described as the essence of emotional self-regulation, and underscores the role of emotional intelligence as a *meta*-ability, being able to determine how well or how poorly people are able to use their other mental capacities (see 6.3.3).

3.2.3 The power of hope, optimism, and self-efficacy

Hope plays a powerful role in life, and according to Goleman (1996:87) can be defined as "believing you have the will and the way to accomplish your goals, whatever they may be". From the perspective of emotional intelligence, hope means that:

- one will not take a defeatist attitude
- one will not become depressed in the face of difficult challenges/setbacks
- one will not give in to overwhelming anxiety (Goleman 1996:86,87).

Optimism, like hope, means that despite frustrations and setbacks, there is a strong expectation that, in general, things will turn out all right in life. With respect to emotional intelligence, a realistic optimism is an attitude that offers a buffer to people against falling into apathy, hopelessness, and depression when faced with difficulties. Optimism can be explained in terms of how people accept their successes and failures: optimistic people see a failure as being due to something that can be changed, so that they experience success the next time round.

Hope and optimism provide a powerful means of predicting academic success. In the face of failure and frustration, reasonable talent is not sufficient to lead to success, but rather the ability and capacity to keep going in spite of defeat.

Goleman (1996:89,90) suggests that although a positive or negative outlook may well be ascribed to inborn temperament, it can be tempered by experience and optimism and hope can be **learned**. The belief that one has mastery over the events of one's life and can meet the challenges as they arise, is referred to by psychologists as 'self-efficacy'. The sense of self-efficacy can be strengthened by developing any kind of competency, making a person more willing to take risks and seek out more demanding challenges: an attitude that makes people more likely to make the best use of whatever skills they may have, or to develop these skills further. People's beliefs about their abilities have a profound effect on those abilities. Those who have a sense of self-efficacy overcome failures, approach problems in terms of how to handle them, rather than concentrating on what can go wrong.

3.2.4 Flow as the neurobiology of excellence

'Flow' can be described as emotional intelligence at its best, presenting the 'ultimate' in harnessing the emotions in the service of performance and learning. It is a state that most people experience from time to time, where they are so self-absorbed in the task at hand that they lose all self-consciousness and are unconcerned about thoughts of success or failure, with the sheer pleasure of the act itself providing the motivation. The quality of attention in flow is relaxed yet highly focused, with the compelling, highly motivating feeling of mild ecstasy "induced by nothing more than intense concentration" (Goleman 1996:92).

When people are focused on activities that effortlessly capture and hold their attention, there is a **lessening** of cortical arousal, due mainly to the fact that flow occurs only within reach of the summit of ability, where skills are well rehearsed and **neural circuits are most efficient**. In flow or optimal performance, the state of cortical efficiency requires a bare minimum of mental energy. One can enter the state of flow by:

- intentionally focusing a sharp attention to the task at hand, with the focus taking on a force of its own, making the task seemingly effortless
- engaging in a task one is skilled at, at a level that slightly taxes the ability, in the delicate zone between boredom and anxiety.

To achieve a state of optimal performance it is crucial to match musical challenges with the level of musicianship. The interaction between musical **challenge** and musicianship/musical **ability**, with the outcomes of frustration, self-enjoyment, or boredom (Elliott 1994:24), can be represented graphically:

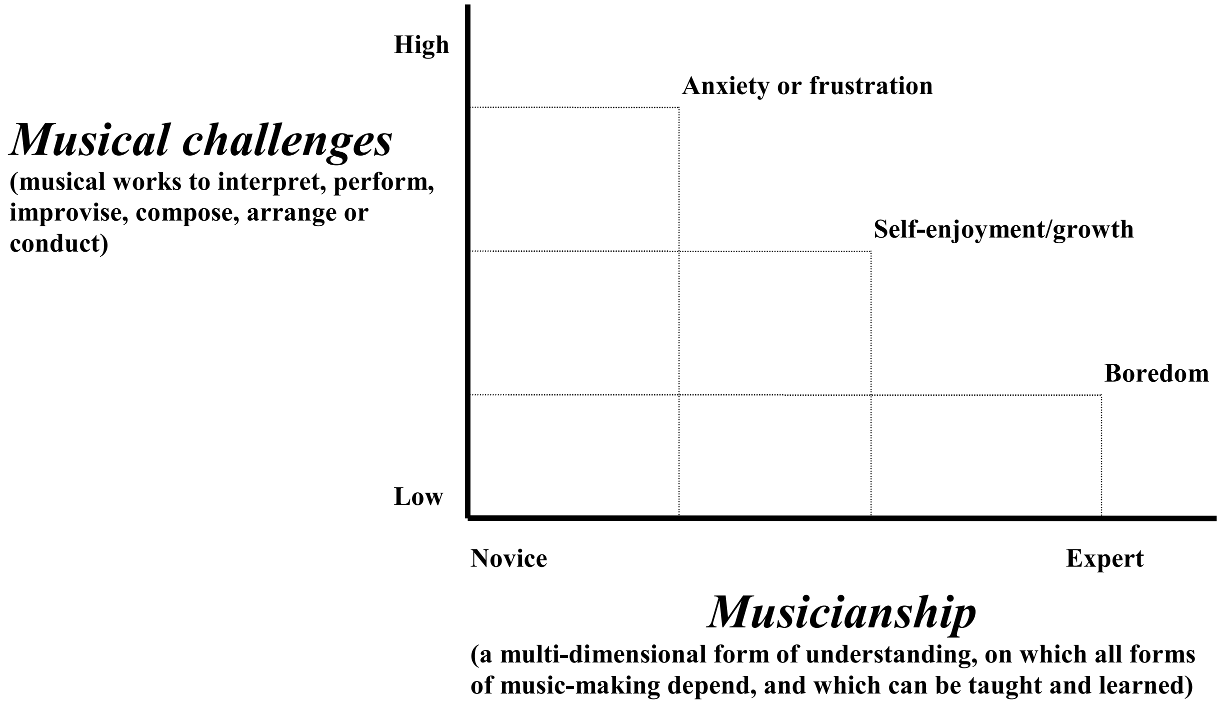


Figure 3-2

Matching musical challenges with the level of musical ability

Goleman (1996:93) claims that "just as flow is a prerequisite for mastery in a craft, profession, or art, so too with learning". Students who get into flow as they study are more successful, quite apart from their potential as measured by achievement tests. High achievers found that studying provided them with a pleasing, absorbing challenge of flow for about 40 percent of the time they devoted to it. For low achievers, study produced flow for only about 16 percent of the study time, with demands outreaching their abilities and providing anxiety. They experienced more flow in socialising than in studying.

3.2.5 Learning and flow

'Teaching models' based on Gardner's Theory of Multiple Intelligences (see 4.9) have been put into practice in many schools in the U.S.A. (for example Project Zero in Boston and those schools affiliated to the Whole Brain Learning Centre. See also "*Teaching and learning through MI*" by Linda Campbell, and "*Multiple Intelligences in the classroom*" by Thomas Armstrong), all employing the strategy revolving around identifying a child's natural competencies, playing to the strengths, and trying to remedy the weaknesses. A child will enter flow more easily in a domain where he/she has a natural ability.

By knowing a child's brain dominance profile (see 3.5.4), a teacher can 'fine-tune' the way information is presented to the child, from a remedial level to a highly advanced level, in a way that is most likely to provide an optimal challenge, and make learning a pleasurable experience. When children gain mastery of a skill in a natural way, they will be enabled to gain flow from learning and be motivated to take on challenges in new areas. Once the child learns that pursuing a particular field becomes a source of the 'joy of flow', and since it takes pushing the limits of one's ability to sustain flow, that becomes a prime motivator for improvement: it makes the child happy.

Pursuing flow through learning is a more humane, natural, and productive way of harnessing emotions in the service of education. The ability to channel emotions towards a productive end is a masterly skill. The power of emotion to guide effective effort is reflected by:

- controlling impulse and putting off gratification
- regulating one's moods to facilitate rather than impede thinking
- motivating oneself to persist and try again in the face of setbacks
- finding ways to enter flow and so perform more effectively (Goleman 1996:94,95).

3.2.6 The social aspect of emotional intelligence

There are four separate abilities that can be considered components of 'interpersonal intelligence' as defined by Gardner (see 4.9.1):

- **Organising groups**
  The essential skill of a leader which involves initiating and co-ordinating the efforts of a network of people
- **Negotiating solutions**
  The skill of the mediator preventing or resolving conflicts
- **Personal connection**
  Empathy and connecting with others: responding fittingly to people's feelings, concerns, and relationships. Empathetic children with the ability of personal connection are usually good team players, are adept at reading emotions from facial expressions, and are generally well-liked by their classmates

- **Social analysis**
  The ability to detect and have insights about people's feelings, motives, and concerns. Knowing how others feel can lead to an easy intimacy or sense of rapport, especially important for counsellors and therapists.

Those who are adept in social intelligence (the social analysis part of interpersonal intelligence) can connect with people smoothly, are able to read their reactions and feelings with proficiency, are able to lead and organise, as well as handle any disputes that arise during the course of human interaction. Those who have these interpersonal abilities are also adept at monitoring their own expression of emotion, but they need emotional integrity/discernment, if they are to avoid becoming shallow, anchorless 'socialites'.

3.2.7 Social incompetence

Social incompetence or *dyssemia*, (from the Greek *dys-* for "difficulty" and *semes* for "signal") amounts to a learning disability with respect to non-verbal messages. This could be caused by:

- a poor sense of personal space
- a poor interpretation or use of body language
- the misinterpretation or misuse of facial expressions, such as failing to make eye-contact
- a poor sense of prosody, the emotional quality of speech: speaking too shrilly or flatly (Goleman 1996:120,121).

Children who are unable to read or express emotions well, constantly feel frustrated. Socially they become isolated and academically they also suffer. In the classroom a socially awkward child is as likely to misread or misrespond to a teacher, as to another child. The resulting anxiety can interfere with ability to learn effectively. Tests on children's non-verbal sensitivity have confirmed that those who misread emotional cues tend to do poorly in school compared to their academic potential as reflected in IQ tests.

It is possible for children to **learn** the most elementary lessons of social interaction, such as:

- speaking directly to others when spoken to
- **initiating** social contact and not always waiting for others
- carrying on a conversation rather than replying with yes or no, or other one-word replies
- expressing gratitude to others
- waiting until one is served something
- thanking others, or saying "please" to share.

In this way, children can develop social skill in the fine art of emotional influence. The emotional state of a learner is at least as important as the intellectual-cognitive content of the educator's presentation. Jensen (1995b:36,40) suggests that learners be given time to first de-stress, after which their emotions could be positively engaged with amusing activities to make the learning enjoyable. Engagement of emotions leads to learners 'knowing that they know it'. As self-confidence increases, so does the intrinsic motivation for learning.

3.2.8 The effect of criticism

The crucial art of 'feedback' or criticism is one of the most important tasks of giving people the information they need to keep their efforts 'on track' and create an awareness of what is expected of them. How criticism is given and received has a profound effect on the motivation, energy, and confidence of those performing tasks. Harsh criticism can demoralise those who receive it, creating antagonism and lack of co-operation.

An artful critique focuses on what a person has done and can do, holding out hope of doing better, and suggesting the beginning of a plan to do so. The following suggestions with respect to the art of the critique may be helpful:

- **Be specific** about the nature of the problem
- **Offer a solution** about how to take care of the problem
- **Be present.** Critiques are most effective when given face to face, and in private, providing the recipient with an opportunity for a response or clarification
- **Be sensitive** to what the impact of the critique will be to the person at the receiving end (Goleman 1996:152-154).

Jensen (1995b:41,42) encourages educators to actively utilise emotions as "an ally and powerful strategy for learning".

3.3 Spiritual intelligence

Early in the twentieth century psychologists devised tests for measuring human intellectual or rational intelligence, which became known as an individual's *intelligence quotient* (IQ). In the mid-1990's, Daniel Goleman claimed that feelings were at least as important, if not more important, than thought. He pointed out that the emotional intelligence (EQ) is a basic requirement for effective use of IQ. At the end of the century, certain scientific data indicate that a third intelligence exists: the spiritual intelligence (SQ), which, according to Zohar & Marshall (2000:3) completes the full picture of human intelligence.

They argue that all human, possibly infinite intelligences can be linked to one of three basic neural systems in the brain, and that the multiple intelligences (see 4.9.1) Gardner describes can be considered variations of the basic IQ, EQ and SQ with their associated neural arrangements.

3.3.1 Scientific evidence of SQ

Although SQ is an ability as old as humanity, Zohar & Marshall (2000:11) claim to be the first to fully develop the concept of a spiritual intelligence. Academics have found the spiritual aspects of intelligence difficult to study, as existing science is poorly equipped to study that which cannot be measured objectively.

There is, however, a great deal of **scientific evidence** for SQ in recent neurological, psychological and anthropological studies of human intelligence, as well as in studies of human thinking and linguistic processes (Zohar & Marshall 2000:11). Scans taken with positron emission topography for the purposes of neuro-psychological and neurological research have revealed a particular location among the neural connections in the temporal lobe of the brain, which responds to spiritual or religious stimuli, and is referred to by the authors as the 'God-spot'. In the past, such temporal lobe activity has been linked to mystical visions of epileptics and people taking certain drugs, but research has now proved that this activity is also found in normal people.

According to Deacon (1997:35), humans are unique in using the frontal lobe facility of language (which co-evolved with rapid development of the brain's frontal lobes) to deal with meaning. From an evolutionary perspective, Deacon's neurobiological research on language and symbolic representation indicates that "we have used SQ literally to grow our human brains . . . to become the people we are" (Zohar & Marshall 2000:13). In this way, SQ gives humans the potential for further growth and transformation, for further evolution of their human potential.

3.3.2 Neural organisation of the brain

In the past, only two forms of brain organisation were recognised:

- **Serial neural connections -** serially connected neural tracts form the basis of human IQ. They allow the brain to follow rules and to think rationally and logically

- **Neural networks - m**assive bundles of neurons connected in a haphazard way are the basis of EQ.

Both forms of neural organisation exist and have different abilities, but they **do not operate with meaning and cannot answer the question 'Why?'**. A third form of brain organisation, that is able to answer this question, has recently been identified and is based on:

- **Neural oscillations**

  Research by Wolf Singer on unifying neural oscillations, indicates a third kind of 'unitive' thinking and an accompanying third mode of intelligence (SQ) which can deal with questions of meaning (Zohar & Marshall 2000:12). The new MEG (magneto-encephalographic) technology has made whole-skull studies of the brain's oscillating electrical fields with their associated magnetic fields possible.

3.3.3 The crisis of meaning

Zohar & Marshall (2000:26-32) maintain that in the traditional culture of the West, all the meanings and values it preserved began to disintegrate as a result of the scientific revolution of the seventeenth century, with the accompanying rise of individualism and rationalism. The technology of the Industrial Revolution had many repercussions: people moved from the land into the cities; communities and families were disrupted; tradition and crafts were displaced, making reliance on habit and repetition virtually impossible.

With associative meanings and values uprooted, the notion that people have become isolated, passive victims of forces larger than themselves, as well as a helplessness to change their own lives, has become almost overwhelming. There is a tendency for people deprived of meaning in their lives, **to seek 'wholeness' by becoming obsessed with health** (see 5.8.4).

The threats of global extinction do, according to Zohar & Marshall (2000:31,32), have an effect on the way people think and behave. The more immediate concerns of "Live today, there may never be another tomorrow" have become commonplace as the time-frame for life shrinks and with it the context of meaning and value within which people live their lives. Reductionist scientific thinking has alienated Western religious traditions from magic and mystery, slowly rendering them less effective, with Western humanism "becoming a mixture of conceit and despair" and increasingly "spiritually dumb".

3.3.4 Understanding SQ

SQ makes people aware that they have existential problems and enables them to solve them, or at least find peace about them: it gives humans a 'deep' sense of what life's struggles are about. In chaos theory (Zohar & Marshall 2000:205-207), 'the edge' is the border between order and chaos, between knowing comfortably what life is about and being totally lost. It is the human SQ, the intuitive sense of meaning and value, which guides people at the edge.

The following examples provide a further understanding of SQ (Zohar & Marshall 2000:13-16):

- SQ can put people in touch with the spirit behind all great religions, but practising religion is not a pre-requisite for a high SQ
- SQ enables people to integrate intrapersonal and interpersonal skills: transcending the gap between self and others (EQ alone cannot bridge the gap)
- SQ is used to wrestle with problems of good and evil, problems of life and death, the origins of human suffering and despair
- SQ enables humans to grow beyond their immediate 'ego selves' and live life at a deeper level of meaning.

A highly developed SQ could be indicated by:

- a capacity to be spontaneously adaptive
- a high degree of self-awareness
- a capacity to face and use suffering
- a capacity to face and transcend pain
- the quality of being inspired by vision and values
- a reluctance to cause unnecessary harm
- a tendency to see things in a 'holistic' way
- a marked tendency to ask 'Why?' and 'What if?' questions, and to seek fundamental answers
- a facility for working against convention
- a capacity to inspire others (ibid).

The collective SQ of modern society appears to be low. To move beyond a spiritually dumb culture characterised by materialism, expediency, narrow self-centredness, lack of meaning and commitment, would require enough individuals raising their personal SQ to have an effect on the evolutionary process of a society. It is possible for individuals to raise their SQ by developing a tendency to ask *why,* to become more reflective, to take responsibility, to reach beyond themselves, to become more self-aware, to be more honest with themselves and more courageous.

3.4 Memory and recall

Why is it possible to remember some things and not others? Until recently, it was widely believed that the brain operated as a vast filing system and retained information in an orderly, logical, linear way, which resulted in education systems dominated by left-brain processes. The irony of this "left-brain dictatorship" is, according to Webb & Webb (1990:25), that the left hemisphere has very poor memory storage. It now appears that the left hemisphere excels at processing new input, quickly discarding the old, whereas the right hemisphere (which processes information in a non-verbal, sensual and emotional manner) is concerned with long-term memory. More recent research indicates that the temporal lobes and the **hippocampus** play a vitally important role in long-term memory (Jourdain 1997:166).

Alpha and **theta** brain waves play an important role in memory. The normal 'day-to-day' state of consciousness is characterised by **beta** waves, a fast wave pattern that is useful for facilitating cognitive activity, but which inhibits access to the deeper levels of the mind. These deeper levels, which are characterised by feelings of relaxation, concentrated alertness and well-being, are reached in the alpha and theta states. It is in these relaxed states that **super-memory**, as well as heightened powers of concentration and creativity can be achieved. **This quiet awareness is highly receptive to learning new information** (Webb & Webb 1990:23).

A prerequisite to understanding and enhancing the brain's memory capabilities is to be able to make effective use of brain-based, memory-building techniques or strategies. Jensen (1995a:203) explains that any system utilising two or more of the brain's natural memory processes is considered a complex, and therefore successful, learning strategy.

Certain dietary deficiencies have a marked influence on memory processing. A lack of protein in particular, has a negative impact on the ability of the sensory cells to convert stimuli into electrical cells in the brain. The **emotional** importance of what has been learned in critical periods determines its permanence, and, of particular importance for this study, **music acts as a prime 'carrier signal' using rhythms, patterns, contrasts and varying tonalities to encode new information** (Webb & Webb 1990:26).

3.4.1 Encoding, storage, and retrieval

Neurologically, the *hippocampus, amygdala,* and *cerebral cortex* are all involved in acquiring, storing, and recalling human memories. Neuromolecular research has revealed that in certain cases a neuron's electrical signal remained charged for days, and sometimes for weeks, generally referred to as 'short-term memory'. In the case of 'longer term memory', Jensen (1995b:94) explains that the body converts electrical traces into verifiable physical-chemical traces.

As a functional system, memory should be considered in terms of a **process**, rather than as having a specific location in the brain. Memory theorists often distinguish among three different memory stores: **sensory, short term and long term memory**. These stores are not distinct physiological structures, they should rather be considered hypothetical constructs embracing sets of processes. All three memory stores process information in a similar way: they **encode**, **store**, and **retrieve** it (Sternberg 1998:263,264).

- **Encoding** is the process by which a physical, sensory output is transformed into a representation that can be stored in memory
- **Storage** is the process of moving encoded information into a memory store, and maintaining the information
- **Retrieval** is the process of recovering stored information from a memory store, and moving this information into consciousness for use in active cognitive processing.

3.4.2 Types of memory

Memory is often conceived of as involving three different stores: sensory, short term and long term. Sternberg (1998:262-282) describes the following types of memory stores and how they enable someone to gain access to/retrieve information when needed.

- **The sensory store** is a memory store for information just sensed. It is the initial repository of much information that eventually enters the short-term and long-term stores, and includes **intense smells**, **tastes**, **feelings**, **pleasure**, **sights**, and **sound**. Sensory memory often lasts for years, and may or may not, need moderate review.

  - **Smell** and **taste** are singularly strong memory triggers, due to the fact that the locus for registering smell and taste is situated in very close proximity to the *hippocampus*. These are the only two senses that are not initially processed via the lower brain structures and the cortex (Maguire 1990:71). Contextual memory (primarily based on location and circumstances, or context) in particular, is enhanced by intensifying the sensory input of sights, sounds, smells, taste, and touch (Jensen 1995b:100).

- **The short term store** is responsible for the storage of information for only brief periods of time (from a few seconds to a number of minutes). It relies primarily on acoustic information as well as other forms, such as visual images.

  - To commit information to short-term memory, or to move information to long-term memory, the key strategy used is repeating the information over and over, a process known as **rehearsal**. According to Sternberg (1998: 266.267), rehearsal is a learned strategy that comes naturally to adults and older children. Younger children, in particular, lack **metamemory skills**: the understanding and control of one's own memory abilities.

  - The capacity of the short-term store is approximately five to nine items, an item being something simple such as a digit, or something more complex such as a word. Remembering more complex units of information, or **chunks** (a single grouping of a collection of separate items), effectively **increases the total amount of information that can be retained** (Sternberg 1998:269).

- **The long term store** is where memories that are kept for long periods of time, sometimes indefinitely, are stored. Information is transferred from the short-term store to the long-term store by **rehearsal** of information. It would appear that information in the long-term store is primarily *semantically* encoded (i.e. encoded by the meaning of words), as well as visually and acoustically.

3.4.3 Factors influencing storage and forgetting

There are many factors which affect the ability to store or to forget information, such as:

- the pace at which information is learned
- rehearsal strategies
- organisation of information
- retro-active and pro-active interference.

The effect of time and pace on learning:

The ability to store or to forget information is affected by many factors, and the pace at which information is processed. According to the **total-time hypothesis** (Sternberg 1998:275), the degree to which information can be stored in memory depends on the total amount of time spent studying the material in any one given session, rather than on the way in which the time is appropriated in the session. People tend to learn better when they acquire information via **distributed learning** (learning that is spaced across sessions over time), rather than via **massed learning** (learning that is concentrated together all at once). If the learning of subject matter is **distributed over time,** rather than **cramming it into a short period of time**, the learner will recall more.

Rose & Nicholl (1997:48) recommend that students should sleep at night, rather than study through the night, as it is during sleep that the brain appears to assimilate and file away new information and give it meaning. When the new information is presented with pictures and sound effects and has emotional involvement, it becomes easier and more fun to learn. **The brain is unavailable for new input during sleep as it is very busy replaying, registering and storing new information**, and is not sensitive to external perceptual stimuli (Zohar & Marshall 2000:75).

An explanation for this, is that the development of long-term memory requires the physical reconstruction of the synapses in the neural networks that have been affected. It is therefore necessary to shut down their activity during the reconstruction process, and this is effected by **sleep**. In this way, sleep enhances the creation, editing and erasing of memories (Sylwester 1995:98).

Rehearsal:

Rehearsal seems to facilitate the transfer of information from short-term to long-term storage. The **way** one rehearses the information influences how effectively one retains it. The effectiveness of the rehearsal can be greatly enhanced by 'elaborating' information. This can be done by organising the information.

Organisation of information into semantic and episodic memory:

Semantic and episodic memory are not necessarily two distinct systems, although they do appear to function in different ways.

- **Semantic memory** is the memory for facts that are not unique to a particular individual, and that are not recalled in any particular temporal context. Semantic memory operates on **concepts***,* to which various characteristics or other ideas may be attached/connected. The mental organisation of concepts, or memory processing, can be more readily understood by envisioning an organisational structure, referred to by psychologists as a *schema*
- **Episodic memory** is the memory of personally experienced events or episodes.

Retro-active and pro-active interference:

At least two kinds of interference play important roles in memory theory and research: retro-active interference and pro-active interference.

- **Retro-active interference** occurs when interfering information is presented **after** presentation of the information that is to be remembered: it interferes with our ability to remember information that was learned previously
- **Pro-active interference** occurs when interfering information is presented **before** rather than after presentation of information that is to be remembered.

3.4.4 Classification of memory

There are several different ways of classifying functional systems of memory and recall, and there is a critical *biologically based* difference between the two ways new information is dealt with. The brain sorts and stores information according to whether it is ***context*-based**, or ***content*-based.** Context-based ("episodic") memory is related to a particular location or circumstance and it has unlimited capacity, forms quickly, is easily updated, requires no practice, is effortless, and is used naturally by all people. Content-dependent memory could be based on movement, music, intense sensory experiences, sounds, puns, relationships, and position in time and space. Indications are that the best learning and recall can be ascribed to **multiple memory locations** and **systems**.

Table 3.2 serves to illustrate differences between semantic and episodic memory, and the influence of sensory experience according to Jensen (1995a:203-213, 1995b:94-106) and Sternberg (1998:275,276):

Table 3-2

Differences between semantic and episodic memory, and the influence of sensory experience

Memory classification	Semantic memory	Episodic memory
Jensen	Semantic or taxon memory: information embedded in **content**; usually learned through rote, or by following lists It is an unnatural memory which requires rehearsal, is resistant to change, isolated from context, has strict limits, lacks meaning, and often requires extrinsic motivation Short-term 'working' memory: <15 seconds, unless rehearsed. Limited by chunks (see 3.4.2) Semantic memory is NOT 'brain-compatible': information gathering and memory of content without a context is difficult for the brain.	Episodic memory: information embedded in **context**; stored with a particular location or circumstance It has unlimited storage capacity, forms quickly, is easily updated, requires no practice, is effortless, and is used naturally by everyone This natural context-dependent memory may be based on movement, music, intense sensory experiences, sounds, puns, relationships, and position in time and space Enhanced by intensified sensory inputs: smells, tastes, feelings, touch, pleasure, sights, or sounds It can last for years, may or may not need moderate review, and requires minimal intrinsic motivation.
Sternberg	Semantic memory is our general world knowledge It is the memory for facts that are not unique to the individual, and that are not recalled in any particular temporal context Semantic memory operates on **concepts** – ideas to which various characteristics may be attached, and to which various other ideas may be connected People mentally organise concepts in some way. Researchers have tried to represent the organisational structure of memory by a **schema** – a cognitive framework for organising associated concepts including information and ideas based on previous experiences.	Episodic memory is the memory of personally experienced events or episodes.

Content based (*semantic*) memory is related to learning that it is list-oriented and acquired through rote. It is an unnatural memory that requires rehearsal. It is resistant to change, isolated from context, has strict limits, lacks meaning, and is linked to extrinsic motivation.

3.4.5 Memory-building techniques

The most effective memory-building techniques are based on the principle of **association**. The more connections we deliberately create between new information and information that we are already familiar with, the better the brain can retain that new information and recall it at a later date.

Whatever the evolutionary logic may be, our senses of smell and taste (where taste is a dependent relative of our sense of smell) are **singularly strong memory triggers**, and are uniquely positioned to create and evoke memories. Smell and taste are the only senses which are not initially processed via the lower brain, but all first-time information is routed by the hippocampus, which is right next to the locus for registering smell and taste, to the memory system in the cerebral cortex. The perfume and food industries all capitalise on smell and taste being strong memory triggers. So, too, do the arts. According to Maguire (1990:71), the French novelist Marcel Proust attributes the inspiration for his masterpiece *Rememberance of things past* to the aroma and taste of madeleine tea cake, which carried him back to his boyhood in Cambray.

Several different functional systems for memory and recall have been identified and labelled:

- The *'Wiring'* model which consists of two types:
  - *fixed wiring* ('hard wiring' or encoded memory of certain physical responses for survival)
  - *malleable wiring* ('soft wiring' or created memory of names, places, etc.) (Jensen 1995b:94).

- The *Connectionist* model which identifies three factors:
  - multiple region-based processing (memory taking place in several places simultaneously)
  - efficiency and effectiveness trade-offs between fast and slow-connection changes in learning and memory
  - speeding up of acquisition via multiple levels of learning (Schneider 1993:184-192).

- *Episodic memory* involves the retention of interrelated times, places, and circumstances.

- *Semantic memory* involves the retention of individual facts and ideas.

  It is possible for an amnesiac to lose track of whole episodes of the past, and yet still to hold on to all their academic and professional knowledge: semantic memories (Maguire 1990:69).

- *Skill memories* are the task-performance memories, which are acquired by practice and eventually turn into virtual habits, such as memories to drive a car, play the piano, swim, and button our clothes. Skill memory is the most primitive form of memory, and least likely to be touched by amnesia or any other brain disorder.

- *Taxon* memories or *taxon* memory systems (the word "taxon" being derived from "taxonomies" or lists) consist of items that do not depend on a specific physical context.

- *Locale memory* is based on the fact that individuals are constantly creating and testing spatial maps that provide them with information about their surroundings. These maps are constructed within the locale memory system. It is clear that people continuously monitor a great deal of sensory information, much more than they can specifically attend to. Long-term memories of events and places are formed automatically, without deliberately attempting to memorise them.

3.4.6 The importance of the locale memory system in education

It is in the recognition and use of the power of our *locale memory,* that we begin to give credibility to the complex forms of instruction that are needed to upgrade education (Caine & Caine 1991:40,41). Some basic features of the locale memory are:

- Every human has a spatial memory system which is survival oriented, and with a virtually unlimited capacity
- Locale memories always exist in relationship to where individuals are in space, as well as what they are doing. They are records of ongoing events with a complex set of relationships among all the items
- Initial memory maps tend to form very quickly, and to 'last'
- Map formation is motivated by *novelty, curiosity*, and *expectation*
- Locale/spatial memory is enhanced through sensory acuity, or enhanced awareness of smell, taste, touch, sound, and so on
- Although maps for specific places are relatively instant, some larger more intricate maps may take a considerable time to form, being the consequence of many experiences that come together gradually.

3.4.7 Creating thematic maps

Caine & Caine (1991:44-49) point out that although it may not be intentional, a great deal of education is what may be described as 'route learning' and not 'map learning'. To understand and appreciate the value of creating thematic maps, it is necessary to briefly examine the differences between 'route learning' and 'map learning'.

Route learning is the teaching model that:

- emphasises the use of taxon systems
- underlies behavioural objectives and performance outcomes
- has a beginning, a middle, and an end that is prespecified
- lends itself readily to multiple choice and other common forms of testing
- predetermines every step, with learners often failing to see the relevance or need of the information
- encourages memorisation rather than thinking
- replaces curiosity with rewards and punishments (tests, grades etc.).

Map learning is a model that includes:

- inquiry learning
- critical thinking and analysis
- creative and group processes
- open-ended outcomes and learning which are personally meaningful and unique
- invoking the learner's personal curiosity
- engaging the senses and emotions.

Both routes and maps are needed in learning: routes are useful in the short term, as 'steps' along the way in building maps.

Locale memory includes mental maps of information which are referred to as *thematic maps* (Caine & Caine 1991:42). It would appear that our ability to form natural mental maps should be at the core of thematic teaching, with the use of stories, metaphors, celebrations, music, and imagery, all of which are powerful tools for brain-based learning.

The *locale* system registers a continuous 'story' of life events or mental/emotional maps that occur in 'relationship' and are continuously being updated, whereas the *taxon* memories consist of 'parts' (single words, specific behaviours, complex information that has been memorised) out of which the story is constructed. The locale system makes use of the contents of the taxon systems.

In this context, learning from significant experience could be defined as: **the storage of items that have so many connections, and are of such quality, that they can be accessed appropriately in unexpected contexts** (Caine & Caine 1991:43).

Without a better use of our locale memory system in learning, most teaching becomes meaningless and segmented. In cultures where taxon memory is especially emphasised and honoured, our definition of 'learning' can be seen as useless or confusing (Caine & Caine 1991:48).

3.5 The dominance factor

The brain cannot learn by itself; it needs information. Other parts of the body, in particular the eyes, ears, hands and feet are important contributors to learning, and supply the brain with the raw information it uses to learn about the world. People differ in the way they use the body's learning organs: some favour one **eye** over the other, one **ear** over the other, one **hand** over the other and one **foot** over the other. There is also a tendency to favour one brain hemisphere over the other (Hannaford 1997:17).

3.5.1 Hemispheric specialisation

The brain is composed of two distinct hemispheres connected in the middle by a bundle of nerve fibres called the *corpus callosum* (see 2.2.1). Each hemisphere develops and processes information in a specific way.

In simple terms, the *logic* hemisphere (usually on the left side) deals with details, language processing (alphabet, words, syntax, spelling) and linear analysis: it processes information from pieces to the whole in a linear manner, and prefers a step-by-step technique when learning a new skill.

The *gestalt/*global hemisphere (usually the right hemisphere) deals with images, movement, emotion, and intuition: it processes information from the whole to the pieces, in a contextual manner, and is often referred to as the 'creative' brain because of its spontaneous, curious nature (Hannaford 1997:18-21). She prefers to use the terms *logic* and *gestalt,* because some people are 'transposed': they process the logical functions with the right hemisphere and the gestalt functions with the left hemisphere.

Where there is good communication between the two hemispheres, the result is integrated thought. To achieve integrated thought, it is important to note that:

- the more both hemispheres are activated by use, the **more neural connections** form across the corpus callosum,
- the more connections, the **faster the processing** between the hemispheres becomes, and
- the faster the processing, the **more intelligently people are able to function**.

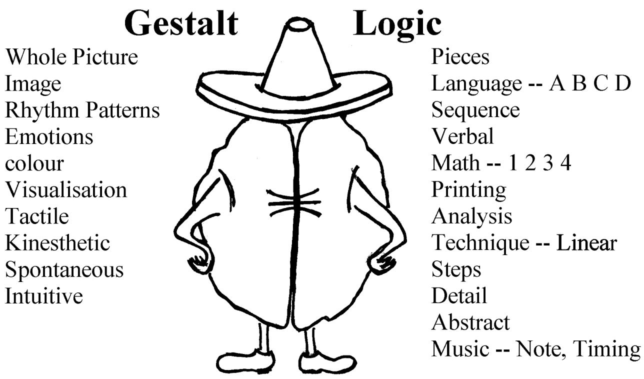


Figure 3-3

The brain's two hemispheres

(Adapted from Hannaford 1997:19)

There are many differences between the two brain hemispheres. The most important are listed in the Table 3-3 below (Hannaford 1997:20):

Table 3-3

Differences between the two brain hemispheres

LOGIC	GESTALT
Processes from pieces to whole	Processes from whole to pieces
Parts of language	Language comprehension
Syntax, semantics	Image, emotion, meaning
Letters, printing, spelling	Rhythm, dialect, application
Numbers	Estimation, application
Techniques (art, music, sport)	Flow and movement
Analysis, logic	Intuition, emotion
Looks for differences	Looks for similarities
Controls feelings	Free with feelings
Language oriented	Prefers drawing, manipulation
Planned, structured	Spontaneous, fluid
Sequential thinking	Simultaneous thinking
Future oriented	Now oriented
Time conscious	Less time sense
Structure oriented	People oriented
When under stress	**When under stress**
Tries harder; lots of effort	Loses the ability to reason well
Without results	Acts without thinking
Without comprehension	Feels overwhelmed
Without joy	Has trouble expressing
Without understanding	Cannot remember details
May appear mechanical, tense, insensitive	May appear emotional or spaced-out

3.5.2 Cross-lateral control

In addition to these differences in hemispheric specialisation, there is a further difference between the two hemispheres: they each control a different side of the body. The brain has a crossover pattern, with each side of the body communicating with the opposite brain hemisphere: **cross-lateral control**.

The individual prefers those sensory-motor functions that are facilitated by his/her particular pattern of lateral dominance. The senses and physical movements where the dominant eye, ear or hand is on the opposite side of the body from the dominant brain hemisphere communicate effectively with the brain even in times of stress. **In particular during times of new learning or stress, the non-dominant brain hemisphere tends to radically decrease its functioning, leaving the dominant hemisphere to continue primary functioning** (Hannaford 1997:22).

The state of decreased function in one hemisphere is referred to as a **unilateral state**. When both hemispheres are functioning together optimally, it is referred to as an **integrated state**. **This integrated state is the key to higher level reasoning and creativity** (ibid).

3.5.3 Learning preferences

Learners show preferences for using some senses over others. Some people learn better by hearing things, some prefer to see things, others prefer to handle things. People can exhibit a considerable number of learning preferences that are innate, and contribute to their unique learning styles. These learning styles are neither good nor bad, they merely reveal an individual's preferred way of processing information.

When taking in new information, or in times of stress, people have greater access to those senses that are directly linked to the **dominant brain hemisphere**. The sensory intake is facilitated when the dominant eye, ear, hand and foot are on the **opposite** side of the body from the dominant brain hemisphere. There is a tendency to rely more on these familiar ways to learn. This tendency to prefer one side to the other is called **lateral dominance**, and an individual's learning style depends on the particular way his/her learning organs are neurally linked (Hannaford 1997:16-18).

3.5.4 Dominance profiles

"Dominance Profiles" is a personal assessment technique that can help determine an individual's learning style, which can then be followed up with useful strategies that assist the learning process. The individual's lateral dominance is basically innate and influences the way his/her body and mind initially process information. As new skills and adaptive strategies for learning are acquired, it is possible to grow beyond the constraints of the basal profile. According to Hannaford (1997:15), however, **in times of new learning and stress in particular, the basal Dominance Profile will still influence the individual's behaviour throughout life.**

The profiles provide important clues about a learner's preferences at school, home, or at work. They serve as guide in the presentation of new information to particular learners, or where they should be seated in a classroom for maximum benefit of learning.

3.5.5 One-sided processing

During times of **new learning** and **stress**, there are certain limitations to accessing and processing information:

- only the eye, ear, hand and foot **opposite** the dominant hemisphere will be proficient at processing. This is referred to as an **able** profile.
- limited access to those senses and physical movement functions that are dominant on the **same** side of the body as the dominant brain hemisphere. This is referred to as a 'receptive' or 'expressive' **limited** profile.

The following **'Able' profile** (Fig.3-4) shows the unilateral state where the **gestalt hemisphere** is inhibited during stress. When the learning components (eye, ear, hand and foot) are on the **right** side of the body, but are controlled by the **left** brain hemisphere, there will be full sensory motor access. Such learners may experience difficulty understanding the 'big' picture and comprehending information.

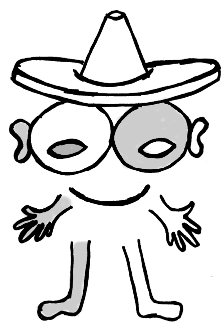


Figure 3-4
'Able' profile

In the event of **all** the learning components (eye, ear, hand, foot and brain hemisphere) being dominant on the **right** side of the body (a **limited profile**) (Figure 3-5), in times of new learning and stress, this individual will have difficulty in accessing most auditory and visual information, in moving gracefully, and in communicating. This kind of learner focuses on the **whole** picture, is unable to see the details, and requires 'quiet time alone' to process information (Hannaford 1997:22).

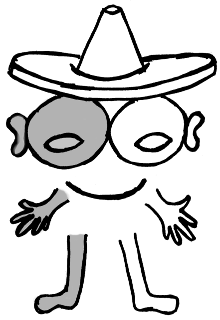


Figure 3-5
'Limited' profile

Both hemispheres need to work together for optimal learning. Although the left hemisphere is considered responsible for language, the comprehension functions of the gestalt hemisphere are required to gain full language function (Hannaford 1997:23).

3.5.6 Eye, ear, hand, and foot dominance

People can be limited in some senses (eye, ear, hand, or foot) and enabled in others. In times of new learning or stress, some people have full access to all the senses, whereas others are 'fully' limited in their access to the senses (Hannaford 1997:32).

- **Eye dominance**

  In an integrated state, primary vision is taken in through both eyes, which includes left and right eye fields. Only **four** percent of vision comes through the eyes as primary vision. The remaining **ninety-six** percent is manufactured in the brain using integrative information from the memory and the senses (Hannaford 1997:23).

  Logic dominant people whose **opposite** eye is dominant will process the details in their visual field, but miss the 'big picture'. Gestalt dominant people whose **opposite** eye is dominant will process the 'whole' picture, but miss the details. Figure 3-6 illustrates the difference in vision for these learners.

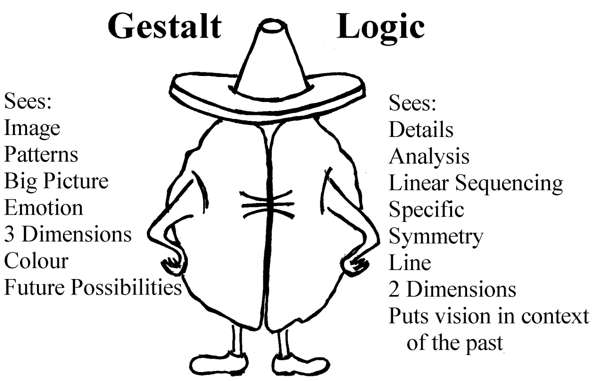


Figure 3-6

Differences in vision for Gestalt and Logic dominant learners

➢ In the **visually able** profile, learners have their dominant eye opposite their dominant brain hemisphere, and are able to access visual information even under stress. How the visual information is processed depends on the hemisphere with which the brain communicates.

Table 3-4

Visually able profiles

DIFFERENCES IN VISION FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Opposite eye** is dominant	Processes details in visual field, missing the big picture
Gestalt dominance	**Opposite eye** is dominant	Looks for whole picture, missing the details

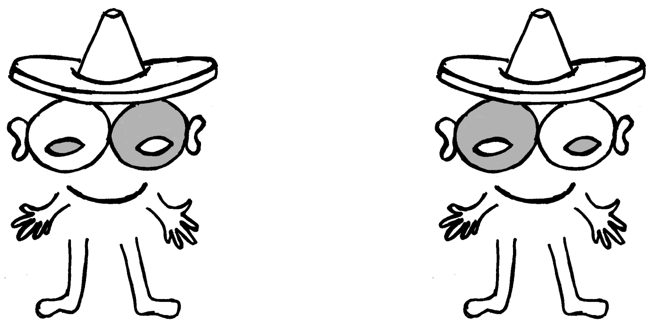


Figure 3-7

Visually able profiles

➢ In the **visually limited** profile, learners have the dominant eye on the *same* side as the dominant hemisphere, and visual access to information is decreased by stress.

Table 3-5

Visually limited profiles

DIFFERENCES IN VISION FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Same side eye** is dominant	May have difficulty remembering visual details under stress. As a verbal learner, the person must talk about what is being learned to anchor it
Gestalt dominance	**Same side eye** is dominant	At a great disadvantage under stress: cannot access the dominant hemisphere with sensory information and is therefore totally shut off

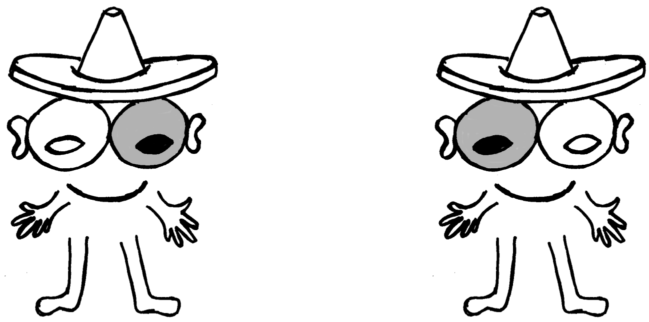


Figure 3-8

Visually limited profiles

A **visually limited** profile affects a person's ability to take in visual information. In stressful circumstances the eyes tend to move outward, relying on a broad, peripheral focus, making *foveal* focus (the close-up focus necessary for two-dimensional reading) difficult. The eyes usually track together as a 'team', with the dominant eye leading and the other eye following it. The left eye naturally tracks from right to left, and the left eye naturally tracks from left to right.

Learners with a left eye dominant pattern will initially be inclined to look at the right side of the page first, and then move to the left. **This could cause problems in reading languages that move from left to right, possibly reversing or transposing letters and/or numbers.**

- **Ear dominance**

The ears conduct auditory information to the brain, making it possible to hear and listen to sounds in the environment. In an integrated state, primary hearing is taken in through both ears. The sound is then interpreted in the brain, making use of memory and all the other senses, giving an auditory perception of the world.

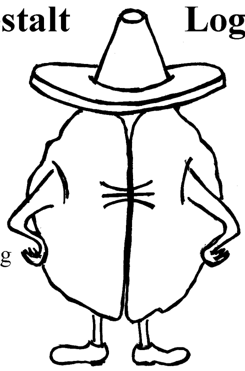


Figure 3-9

Differences in hearing for Gestalt and Logic dominant learners

- In the **auditory able** profile, the dominant ear is **opposite** the dominant brain hemisphere. The **temporal lobe** is the area of the brain that processes auditory information, and has strong neural links with the area that processes memory and emotion in the **limbic system**. Learners with an auditory preference often have good memories (Hannaford 1997:28).

Table 3-6

Auditory able profiles

DIFFERENCES IN HEARING FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Opposite ear** is dominant	Will listen for the details and linear progression of information. Individuals have good memories for numbers, formulas, spelling, and other detailed information
Gestalt dominance	**Opposite ear** is dominant	Will prefer to listen for the overview, metaphor, story, dialect and emotion of the information. Individuals have a good memory for faces, underlying meanings and emotions, and whole concepts

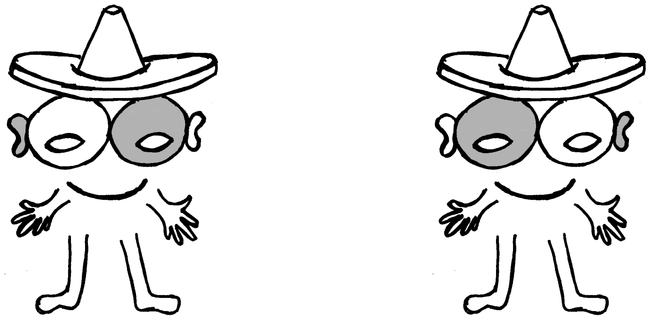


Figure 3-10

Auditory able profiles

- In an **auditory limited** profile, where the dominant ear is on the *same* side as the dominant hemisphere, auditory access is decreased during stress. According to Hannaford's research, **over half of all learners are auditory limited**, yet most teaching is verbal.

Table 3-7

Auditory limited profiles

DIFFERENCES IN HEARING FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Same side** ear is dominant	An inability to decipher fast sound components in ordinary language
Gestalt dominance	**Same side** ear is dominant	Not able to understand the tone and meaning behind words

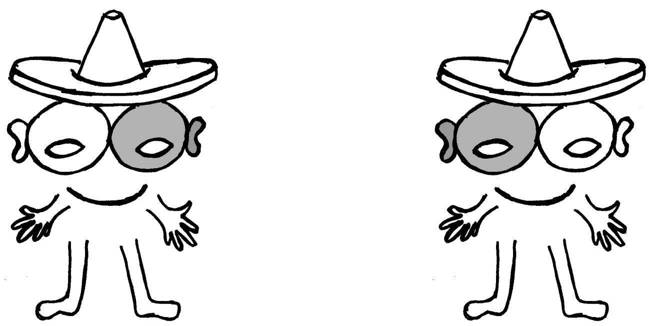


Figure 3-11

Auditory limited profiles

- **Hand dominance**

Hands are extensively involved in human communication, both in verbal and kinesthetic (bodily) expression. PET scans of the brain indicate that, when an individual is speaking, there is increased activity in those areas of the brain associated with hand movements (motor and sensory cortexes of the neo-cortex) (Hannaford 1997:28). The hands feed information to the brain through touch and movement, and are also a means of expressing learned knowledge through gesture and writing.

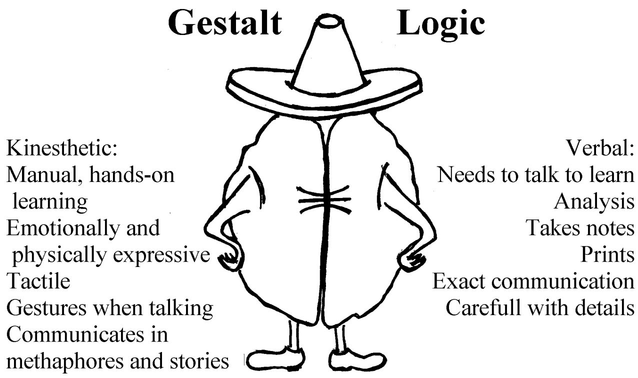


Figure 3-12

Differences for Gestalt and Logic access to the dominant hand

- In **verbally/kinesthetically able** people, patterns of dominance for brain hemispheres and hands have a marked influence on how the individual prefers to express him/herself (Hannaford 1997:28,29). Logic hemisphere dominant individuals with their dominant hand *opposite* their dominant logic hemisphere have a tendency to be **verbally** expressive, to *talk* about what is being learned, and what is 'on their mind'. Even under stress, they can communicate with words. When the dominant hand is *opposite* the gestalt hemisphere, the learner is **kinesthetically able** ('hands-on' learning).

Table 3-8

Verbally/kinesthetically able profiles

DIFFERENCES IN HANDEDNESS FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	Opposite side hand dominant	Verbally expressive; talk about what is being learned; can communicate with words even under stress
Gestalt dominance	Opposite side hand dominant	The learner is kinesthetically able, and can communicate kinesthetically even under stress

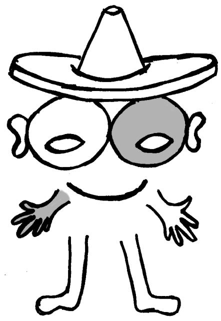


Figure 3-13

Verbally/kinesthetically able profiles

- In **verbally limited** individuals with dominant hands on the **same** side as the dominant brain hemisphere, **communication** will be **limited.**

Table 3-9

Verbally/kinesthetically limited profiles

DIFFERENCES IN HANDEDNESS FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Same side** hand dominant	Under stress they are verbally/kinesthetically limited
Gestalt dominance	**Same side** hand dominant	Limited kinesthetic/verbal expression under stress

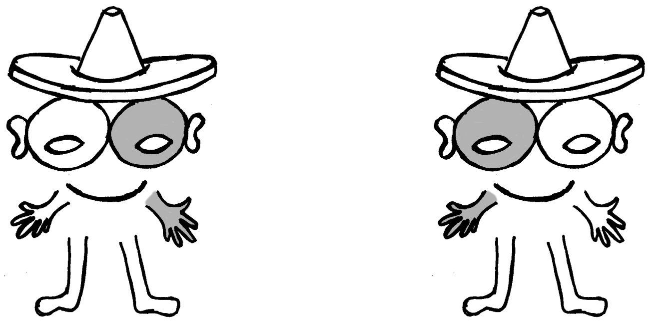


Figure 3-14

Verbally/kinesthetically limited profiles

Gestalt hemisphere dominant persons have a tendency to be kinesthetically expressive. **"All gestalt dominant learners welcome movement to anchor learning"** (Hannaford 1997:30).

- **Foot dominance**

  The feet are controlled by the opposite hemisphere, which co-ordinates and commands the **movement of the feet** in accordance with muscular intention and hemispheric processing.

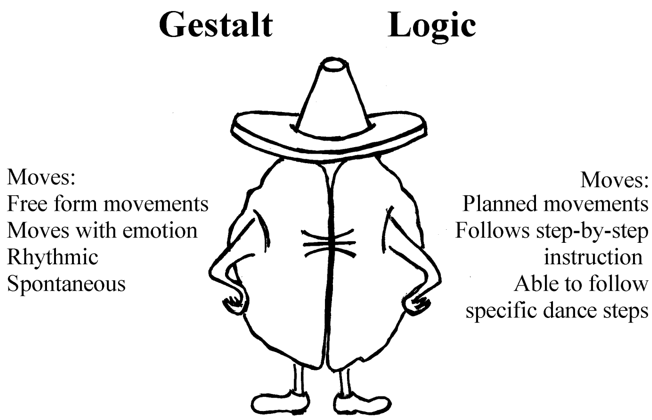


Figure 3-15

Movement of the feet

- In people who are **movement able**, the dominant foot is **opposite** the dominant brain hemisphere. A person with his/her dominant foot **opposite** the logic brain hemisphere will tend to make more planned movements.

Table 3-10

Movement able profiles

DIFFERENCES IN FOOTEDNESS FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Opposite side** foot dominant	Good at following step-by-step instructions in movement activities such as sports and dance – may lack spontaneity of movement
Gestalt dominance	**Opposite side** foot dominant	Movements will be more free-form and spontaneous. May have difficulty in following step-by-step instructions

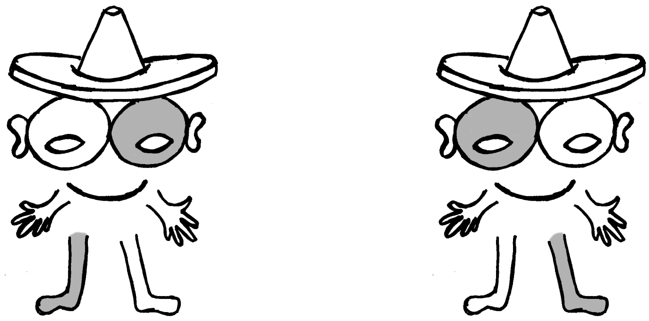


Figure 3-16

Movement able profiles

- In people who are **movement limited**, the dominant foot is on the same side as the dominant hemisphere, and the individual will have difficulty moving forward under stress.

Table 3-11

Movement limited profiles

DIFFERENCES IN FOOTEDNESS FOR LOGIC/ GESTALT DOMINANT LEARNERS		
Logic dominance	**Same side** foot dominant	Have difficulty moving forward under stress – a tendency to 'stop-in-their-tracks'
Gestalt dominance	**Same side** foot dominant	Unable to take immediate physical action when confronted by stressful circum-stances

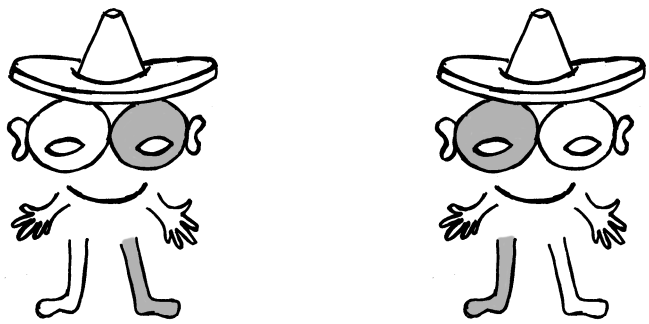


Figure 3-17

Movement limited profiles

Dominance profiles give information about all the components of learning: **eyes, ears, hands, feet and brain hemispheres**. It is possible for a person to be enabled in some senses and limited in others. It is also possible for some people to have **full access** to all their senses, while others are **fully limited** in their access to their senses during stress.

3.5.7 A summary of learning characteristics in a unilateral state

Table 3-12

'Able' in a unilateral state (decreased function in one hemisphere)

Dominant SENSE	Dominant HEMISPHERE	Learning Characteristic
Right eye	Left	Visually able
Left eye	Right	Visually able
Right ear	Left	Auditory able
Left ear	Right	Auditory able
Right hand	Left	Verbally able – kinesthetically limited
Left hand	Right	Kinesthetically able – verbally limited

Table 3-13

'Limited' in a unilateral state (decreased function in one hemisphere)

Dominant SENSE	Dominant HEMISPHERE	Learning Characteristic
Right eye	Right	Visually limited
Left eye	Left	Visually limited
Right ear	Right	Auditory limited
Left ear	Left	Auditory limited
Right hand	Right	Communication limited
Left hand	Left	Communication limited

3.5.8 Whole brain integration

"The optimal learning state is one of whole brain integration. In this state, both hemispheres are equally active all the time, thus accessing **all** sensory information and effectively communicating, moving and acting on the information" (Hannaford 1997:34).

It is possible to design or improve the environment to encourage whole brain learning by:

- making the setting as stimulating and stress-free as possible (stress increases unilateral functioning)
- offering learners a broad spectrum of multisensory opportunities such as visual presentations, auditory explanations, and tactile opportunities to touch/assemble/take apart models
- the opportunity to move frequently: to wake up the brain and anchor learning
- anchoring learning into the mind/body system with activities such as singing alone or in groups, self-created music and dance sessions, co-operative (non-competitive) physical education programmes, co-operative group solution finding and reflective time.

3.6 Brain waves and neurotherapy

A considerable number of learners that are labelled "attention disordered", are in fact kinesthetic learners, as opposed to visual, auditory, or tactile learners, that need to engage in gross motor (large-muscle) activity to learn best. However, children who are diagnosed as ADHD (attention deficit hyperactivity disorder) have a neurological disorder, and will experience difficulties that vary in relation to environmental demands and expectations.

According to Duff & Braithwaite (1999:2), the frontal lobes control the executive functions of the brain. In ADHD learners, behavioural problems arise because the cognitive functioning is impaired due to frontal lobe disregulation, affecting some cognitive functions. From a thorough understanding of ADHD comes a change in the way the child's behaviour is viewed.

3.6.1 Managing ADHD with medication

The use of psycho-stimulant medication to manage the symptoms of ADHD has become very popular over the past two decades. Stimulant medication is known to influence the action of neurotransmitters, primarily dopamine and norepinephrine. There are also indications that the medication may tend to temporarily affect the neural control networks in the brain, which use these neurotransmitters for control of arousal and attention levels, and ultimately for self-regulation of behaviour.

The dosage of this medication varies from individual to individual, but the effects of the medication can usually be observed about thirty minutes after taking the tablet, and they wear off again after four to six hours. Parents frequently report significantly improved behaviours, as well as improved relationships between the child and the rest of the family, and peers. Hyperactivity and aggression may be reduced, and consequently the **amount** of academic work that is completed may increase.

However, among those children that respond to the medication (one review reported that medication was **in**effective for twenty-five to forty percent of children with ADHD) and show an enormous improvement in behaviour, there is little or no improvement in their concentration, learning ability, and cognitive skills. In other tests involving medication there has been no evidence of any significant improvement in reading, athletic or game skills, proactive social skills, or learning and achievement (Duff & Braithwaite 1999:2).

3.6.2 The rationale for neurotherapy

By using Quantitative Electro-encephalography (QEEG), a technique which statistically analyses the frequency content of the EEG (electro-encephalograph) at various sites on the scalp, researchers have found patterns in the EEG of children with ADHD that are consistent with findings revealed by other neuro-imaging studies carried out over the past decade.

ADHD children tend to have an excess of slow (theta) brainwaves, and not enough fast (beta) brainwaves associated with information processing (Duff, Silberstein & Jarman 1999:1). Minor neurological dysfunctions involving the frontal lobes and the central cortex can result in specific learning difficulties. Neurofeedback enhancement of beta activity has been found successful in the remediation of learning difficulties, with indications that the benefits are **permanent** (Duff & Braithwaite 1999:1,6).

3.6.3 Neurotherapy treament for hyperactivity, attention, cognitive skills, and learning difficulties

According to Duff & Braithwaite (1999:3,4), recent advances in neurophysiology and neuroscience are beginning to provide a better understanding of the processes mediating attention and the scientific basis for neurotherapy. It is well established that ADHD is associated with certain neurological dysfunctions involving the frontal lobes and central cortex (it is not yet certain exactly which dysfunctions cause which symptoms). Researchers involved in developing techniques to enable ADHD children and adults to 'retrain' their brainwaves to reflect an increase of fast *beta* waves and a decrease in *theta* waves, have found EEG biofeedback (more recently called neurotherapy) to be particularly effective.

Neurotherapy treatment is non-intrusive and involves patients viewing a computer screen that displays their brainwave activity, obtained from EEG-sensors placed on the scalp. By using the visual and auditory feedback provided by the computer ('video-games'), patients learn how to reduce the slow *theta* waves and increase the fast *beta* waves. The process by which this happens is known as **operant conditioning**, and is the mechanism by which most activities in life (such as for example walking, driving or meditating) are learned.

As the theta/beta ratios reduce (after about twenty treatment sessions) and normalise (after about thirty to fifty sessions, depending on the severity of the symptoms), **hyperactivity** and **impulsivity** reduce or disappear, **attention span** and **concentration** increase, and **IQ** increases, as do measures of **cognitive skills**. In addition to these, most of the undesirable behaviours associated with ADHD also 'reduce' or disappear.

3.6.4 Effectiveness of the treatment

During neurotherapy, the patient learns to exercise neuromodulatory control over the networks responsible for mediating attentional processes. Neurofeedback is directly linked to changes in cortical functioning. As the brain learns to produce certain brainwaves, it acquires the ability to process information more normally. Once this ability has been acquired, it is used on a regular basis, and the skill is retained. According to Duff & Braithwaite (1999:4), research indicates that neurotherapy is effective in eighty percent of ADHD patients. There are no negative side-effects to the treatment, and after the 'retraining', the positive gains can be expected to be as permanent as any other acquired/learned skill.

3.7 Evolutionary psychology

Over the past several years, the discipline of evolutionary psychology has, according to Nicholson (1998:135), gathered both momentum and respect. Evolutionary psychology is based on a convergence of research and discoveries in the fields of genetics, neuropsychology, paleobiology, as well as other sciences, and indicates that although human beings inhabit a modern world of technology, they do so with the ingrained mentality of Stone Age hunter-gatherers: they are 'hardwired'.

3.7.1 Biogenetic identity

Evolutionary psychology provides a new and provocative way to think about human nature: it provides a challenging perspective that calls for further investigation. The discipline recognises that individual differences are caused by each person's unique genetic inheritance, as well as by personal experiences and culture. In the field of behavioural genetics, several genes thought to control human dispositions have been identified, including aspects of temperament and cognitive skills. In heritability studies comparing identical twins, it was found that social attitudes were 40 percent heredity, 60 percent environment. IQ was 70 percent heredity, 30 percent environment (Rushton 2000:60,61).

The **70% nature: 30% nurture** ratio has implications for education and music education, insofar as it indicates that there is a limit to how much the human mind can be remoulded, and that the environment does not play as important a role as educators have been led to believe (see 2.10.1). In shaping human nature, the biogenetic origin of cultural customs and norms is emphasised in comparison to the capacity of learning and language (Nicholson 1998:137,142).

3.7.2 Practical implications of evolutionary psychology

The thoughts and emotions that best served early human beings in their struggle for survival, were programmed into their psyches and continue to drive many aspects of human behaviour even today.

- **Emotions before reason**

  In the face of impending natural disasters, Stone Age people came to trust their instincts (or emotional radar) above all else. This reliance on instinct was vital for survival, and as it is for human beings even today, **emotions** are the first screen to all information received.

  People are often encouraged to use rational analysis or other logical devices when making choices, but evolutionary psychology suggests that emotions can never be fully suppressed. "Because of the primacy of emotions, people hear bad news first and loudest" (Nicholson 1998:138). Positive and negative messages cannot be balanced, as the negatives have by far the greater power and can erase any built-up credit of positive messages in one stroke.

  It is perhaps because of this primacy of emotions, that the most discouraging and potentially dangerous thing anyone in a position of authority can do, is to tell someone that they have failed. Negative messages have to be navigated with extreme sensitivity.

- **Loss aversion, except when threatened**

  Those human beings who survived the dangers of the Stone Age, would undoubtedly have tried to avoid loss. This would not have negated their curiosity about the world around them but the indications are that they would have waited until circumstances were safe enough, before cautiously exploring.

  Similar kinds of behaviour can be seen in children: when they feel secure they can be quite adventurous. However, in the face of danger, such behaviour evaporates. Loss aversion in life-threatening circumstances would no doubt have been met with resistance and furious fighting. Those who were willing to do anything to survive, would be those who lived to pass on the genes that encoded such determination to live.

  Thus it can be assumed that we are hardwired to avoid loss when comfortable and secure, but to defend ourselves desperately when directly threatened. On average, people tend to avoid risk except when threatened (Nicholson 1998:138,139).

It is therefore important that people in positions of authority frame challenges for others in ways that are non-threatening, but without encouraging complacency.

- **Confidence before realism**

  According to Nicholson (1998:140), those who survived the often terrifying conditions of the Stone Age, were surely those who **believed** they would survive. People who radiated confidence attracted allies and appeared more attractive as mates. They were those who had the best chances of passing on their genes.

  The legacy of this dynamic is, that human beings put confidence before realism and strive to shield themselves from any evidence that could undermine this façade of confidence. People are driven to feel good about themselves, but should be mindful that even with self-confidence, they are unable to control the world: confidence has to be separated from reality, something the mind cannot do instinctively.

- **Classification before calculus**

  To survive in the Stone Age, human beings developed prodigious capabilities of sorting and classifying information to systematise their vast and complex world. These capabilities were not limited to the natural environment (animal habits and plant life), but extended to making judicious alliances with other individuals. This in turn, required human beings to become hardwired to enable them to stereotype people, based on very small pieces of evidence, such as their appearance and a few readily apparent behaviours. Classification made life simpler as well as saving time and energy. Calculating (analysing options and discerning 'next steps') was not a feasible alternative to making rapid decisions based on classification.

The human tendency of 'classification before calculus' still remains in modern times. People naturally sort others into acceptable and unacceptable groups, winners or losers. This propensity to classify does not necessarily make it an acceptable practice. However, it does explain why some groups find it difficult to associate with others (Nicholson 1998:140).

3.7.3 The message of evolutionary psychology

It is possible to train people, to teach them about different ideas, and to exhort them to change their attitudes. Evolutionary psychology, however, asserts that the needs, drives, and biases of the Stone Age human beings still exist, and that there is a limit to how much the human mind can be remoulded.

It is reasonable to expect that even in modern times, when people have to make choices, the hidden agendas of emotion, loss aversion, overconfidence, categorical thinking, and social intuition will continue to prevail. Evolutionary psychology suggests the importance of having a clear view of our biased natures, making it possible for people to construct a mind-set to guard against their worst consequences.

According to Nicholson (1998:144), human beings organise socially, so the desire of human beings to obtain status in organisational settings can be ascribed to human nature. It is important to know that people respond positively to being rewarded by status recognition: **hierarchy will remain forever**.

3.7.4 Leadership

> The truth is that leaders are born, not made. They are not clones, but all of them share one special personality trait: a passion to lead (Nicholson 1998:146).

Studies conducted by behavioural geneticists indicate that people are born with set pre-dispositions that harden as they age into adulthood. Whereas it was previously assumed that shyness was induced by environmental factors and that a person could overcome shyness to the extent of becoming extrovert if they so wished, certain genes for detachment and novelty avoidance have been identified which, when combined, amount to shyness (Nicholson 1998:146). Similarly, it was believed that people who were highly emotional could be persuaded to become desensitised emotionally (Nicholson 1998:142).

Research, however, suggests that traits such as shyness and emotional sensitivity are inborn, and that in conjunction with each person's fundamental brain profile, people also come with inborn personalities. Although training and education can compensate for underlying dispositions, there is little point in trying to change the deep-rooted inclinations which form part of their biogenetic destiny.

There are many types of leadership situations, but the important criterion is whether a person has the personality profile to meet the demands of the situation. A baseline requirement for competent leadership is the motivation to lead. People who experience shyness and/or a high sensitivity to stress are usually reluctant to lead and are unable to flourish in leadership positions. According to Rushton (2000:81), the male hormone *testosterone* affects temperament, self-concept, sexuality, aggression, and altruism. It is therefore possible that it plays an important role in leadership motivation.

Evolutionary psychology therefore subscribes to the view that it is **nature**, rather than nurture, that makes people who they are, and that it is time to recognise 'what we are' and for each one to use this information to live in harmony with his/her hardwiring (Nicholson 1998:146,147). Heritability studies on identical twins who have been separated early in life (growing up in different homes) are similar both in physical traits and behavioural traits (see 3.7.1). These studies suggest that an individual's biogenetic identity plays a more crucial role in making them 'who they are', than previously thought. This biological reality has many scientific and everyday implications, in particular with respect to understanding how people cope with different environments. According to Rushton (2000:100), heredity plays a big role in development. As an individual ages, the more his/her genes, rather than childhood environments, gradually take control.

3.8 An overall view

The central tenet of modern neuroscience is that all behaviour is a reflection of brain function. The action of the brain is not restricted to relatively simple motor behaviours such as walking, breathing and smiling, but includes complex affective and cognitive behaviours such as feeling, learning, thinking and creating.

High resolution techniques that are now available make it possible to 'image' both the structural and the functional organisation of the human brain. The biochemical function of local neural circuits can be studied during perception, movement and thought, giving new insights into behaviour by seeing how it is represented in the functional architecture of the human brain (Kandel et al 1991:324).

For the purposes of this study, selected brain-based functions have been examined with a view to illustrating some of the strategies used by the human brain: those impacting on whole brain education in general and those affecting the development of the musical intelligence in particular.

CHAPTER 4

A framework to facilitate whole brain education

4.1 Introduction

Neuroscientific research challenges separation of teaching into the cognitive, affective and psychomotor domains. Brain based learning involves acknowledging the brain's mechanisms and processes for meaningful learning, and organising teaching accordingly: in other words, facilitating optimal brain functioning. Neuroscientific research has established and confirmed that multiple complex and concrete experiences are essential for meaningful learning and teaching. Brain based learning utilises the fact that the various disciplines relate to each other and share common information that is recognised and organised by the brain. As the learner constantly searches for connections on many levels, so the educator needs to "*orchestrate the experiences*" from which the learner extracts understanding: a major perceptual shift for most educators (Caine & Caine 1991 vii-5).

Education is the main way for enabling individuals and nations to meet the rapid changes that are taking place on the economic and social fronts, hopefully even to help young people build lives that have meaning and purpose in a very unpredictable future (Fairbanks 1992:1, Rose 1991:3). New approaches are needed to face the challenges created by rapid and long-term change. More effective and efficient training and learning are required for the fast acquisition of ever-increasing amounts of knowledge, which is becoming a necessity.

4.1.1 Education for 'creative' industries

In the past, companies focused on industry and manufacturing; more recently they have increasingly moved their focus to communications, information, entertainment, science and technology. The value of these new 'intellectual property' sectors depends more on their ability to generate new ideas than to manufacture commodities. These sectors have become a powerful element in many global economies, with a significant growth rate, generating new global markets and more new jobs than other sections of the economy. The 'creative industries' are described in Britain's National Advisory Committee for Creative and Cultural Education's (NACCCE's) report (1999:18,19) as a subset of the intellectual property sector, and include:

- architecture
- arts and antiques
- crafts
- design
- designer fashion
- film
- leisure software
- music
- performing arts
- publishing
- software and computer services
- television and radio.

The revolution in the creative industries has provided fields of significant opportunity for the creative abilities of young people, with a growing emphasis on freelance work, short contracts, self-employment, and entrepreneurial abilities. High-level skills are required in the world of global markets and competition, as well as the ability to adapt to change and new opportunities. Although it is essential to raise the standards of literacy and numeracy, as well as the standards of academic qualifications, employers are looking for more than academic ability (NACCCE 1999:19,20).

Employers and others are increasingly emphasising the need for qualities and aptitudes which **academic** qualifications have not been designed to produce, such as:

- powers of creativity
- powers of communication
- powers of empathy and adaptability
- social skills.

It is possible to develop high skills at high speed, by using systems that subscribe to the literal meaning of **education** (to "draw out from"), drawing out an individual's wealth of innate talent and vast store of knowledge. These systems benefit not only the individual's learning ability, but also his/her mental and physical health (Ostrander et al 1994:13). Systems such as "Enhanced Learning", "Integrated Learning" or "Accelerated Learning" (see 5.7) make use of a multi-sensory, brain-compatible approach to learning, describing the conditions for learning and the presentation of material. Many of the techniques used in holistic and whole brain approaches to learning have been in use for a number of years, although not in a consistent or deliberate way. Only recently has it become possible to understand **why** they work, and **how** best to use them (Fairbanks 1992:1).

4.1.2 Whole brain learning

Whole brain learning views the learner as an "interacting" whole, in which the role of the learner's multi-sensory 'input' channels (providing input to the brain) is recognised and deliberately stimulated. The two brain hemispheres, which process information differently, are balanced. To enhance the learner's compatibility with the various sensory processing modalities, the learner has to be 'prepared' and the learning materials presented in creative ways: the "learning state" has to be managed deliberately (Fairbanks 1992:1). Nine important aspects of recent research on the human brain which impact on learning and teaching, in no particular order, are:

- Brain based learning
- Constraints and Barriers
- Right and left brain
- The triune brain
- The sensory modes
- Neuro-linguistic programming and visualisation
- The mind-body link
- Multiple intelligences
- Spiritual intelligence.

4.2 Brain based learning

Over the past decade, phenomenal technological advances have enabled scientists to solve some of the complexities of the brain, using non-invasive brain imaging techniques such as magnetic resonance imagery (MRI) and positron-emission tomography (PET). Rose & Nicholl (1997:26) point out that development in the cognitive sciences has led to the emergence of theories using biological processes to explain the inner workings of the brain. They suggest that together with developments in genetics, there are indications that this century will be dominated by developments in the biological sciences.

The results of brain research have transformed ideas about learning. The discoveries in the fields of biology, physics, cognitive science, neurology and genetics, provide many indications of how people learn. It has become essential for education to address skills in the fields of communication, information technology, (transforming the way people think, how they communicate, how they work, and how they play), working with others, problem-solving, as well as improving the individual's learning and performance.

The way in which the brain functions is fundamental to understanding the learning process and for nurturing and developing **life-long learning**. A state of relaxed alertness, as characterised by alpha and high theta waves in conjunction with relaxed body rhythms, contributes to an important integrated learning state (Brewer & Campbell 1991:105).

Although **all** learning is brain based in some way, it is important to understand what is meant by the term "brain based learning":

- Brain based learning involves acknowledging how the brain functions for meaningful learning. Teaching should therefore be organised with those parameters in mind
- Brain based learning rests on the fact that various disciplines relate to each other, and share common information that the brain can recognise and organise
- Brain based teaching and learning requires a thorough understanding of how the brain functions. This, in turn, requires a framework to facilitate a more complex form of learning, which will integrate human behaviour and perception, emotions and physiology. Teaching in the traditional way, to behavioural objectives, dependent on content and textbook, is demanding but not very sophisticated. Other functions of the brain and other aspects of memory and learning are ignored (Caine & Caine 1991: vii- ix)
- For brain based learning and teaching, it is necessary to borrow from cognitive psychology, education, physiological responses to stress, and neurosciences (Caine & Caine 1991: viii).

The human brain has a phenomenal storage capacity. According to Lawlor & Handley (1996:4), individuals use less than ten percent of this capacity and probably more in the vicinity of one percent. This implies that there is an enormous amount of untapped potential which could be used for creative thinking, problem solving, and learning. In the field of education, if learning about the brain does not improve teaching, it remains at the level of mere information (Caine & Caine 1991:25).

4.3 Constraints and barriers

Without constraints the brain would have all the information it had ever processed available all the time, making it impossible to retrieve any **specific** information. Constraints can therefore be considered a crucial component of brain function (Persaud 2001:35).

The brain's natural function is to learn quickly and easily. There are, however, a number of factors which can negatively influence the brain's ability to learn easily, and which should not be ignored by educators. These are:

- environmental influence
- foveal vision
- limiting beliefs
- authority
- language.

It is necessary that teachers and learners become aware of certain 'barriers to learning', in an effort to overcome them and restore the natural function of the brain.

4.3.1 Environmental influence

Brains can no longer be considered as 'blank slates' or assumed to be qualitatively similar at birth (see 4.8.1). There are physical distinctions between the brain, its structures, priorities, and strategies in men and in women, with resulting behavioural differences. These can be attributed to the interplay of specific hormones on the male or female brain (whichever is specifically pre-wired to react to them), and can no longer be ignored (see 2.6).

A specific pre-wiring of the brain (a specific brain-profile) is necessary if the brain is to flourish in a particular environment, as set out in Table 4-1 below.

Table 4-1

Advantages and constraints of "pre-wiring"

PRE-WIRING	ENVIRONMENT	DEVELOPMENT
An individual with a specific pre-wired brain profile	An environment conducive to the development of this profile	Enhances development
	An environment **not** conducive to, or hostile to, the development of this profile	Restricts development

A specific environment can contain dual-plane messages (see 4.3.3). These messages contain considerable information and are the source of intuitive impressions that form either negative or positive attitudes. This implies that the learning environment can have an important influence on the subconscious attitude to learning. This environment could, for example, be positively influenced by creating an atmosphere of enjoyment with bright colours, pictures, flowers, music, chairs placed in a way to support communication. All these suggest a pleasant, relaxing experience, which could greatly contribute to overcoming certain attitudes which have become learning barriers (Lawlor & Handley 1996:87-89).

4.3.2 Foveal vision

Hannaford (1995:104,105) makes particular reference to her encounter with rural African children in South Africa. Without available books, they absorb a rich oral tradition and excellent three-dimensional and peripheral vision. Their eyes, however, on entering school at the age of five, have not yet developed the lens flexibility necessary for foveal vision (see 2.9.4 and 4.6.6). Many of these children perceive a blur when looking at a written page, and in spite of being highly motivated to learn as well as receiving strong family support, "experience humiliation and failure and 25.4% drop out in that first year of school. Due to unnatural expectations, stress, and lack of adequate time to develop foveal focus, South Africa has lost, and will continue to lose, a valuable resource in these children".

In addition to this, **seeing** and "lens resiliency" are intimately connected with movement. The fact that the eye ball is not completely shaped with collagen fibres until approximately age nine, is ignored in early schooling. Instead, restrictions such as instructing children not to move their bodies during class, or not to move their eyes beyond the blackboard or desk are the order of the day. This is often accompanied by long periods of reading, without relaxing the focus into the distance, possibly causing inflammation and the enlargement of the eyeball that can lead to *myopia* or near-sightedness. Myopia is showing an increase in incidence and is occurring at an earlier age than twenty years ago (Hannaford 1995:105).

Foveal focus over-dependence, staring, and lack of blinking can cause eyestrain. By encouraging the children to take breaks every 7-10 minutes, the eyes can re-establish three dimensional and peripheral vision in a natural, relaxed way. It should be noted that only by age seven or eight, when the "frontal eye field of the frontal lobes" matures, does the fine motor development of the eye muscles make it possible for accurate eye 'teaming', for two dimensional focus. Eye teaming occurs when the dominant eye tracks across a page of writing, and the non-dominant eye follows the movements exactly and blends the information, giving optimal **bi**nocular vision. Because of the nose between the two eyes, true binocular vision is not possible. This is why one eye takes the lead as the dominant eye, to guide the movement of both eyes (Hannaford 1995:106).

4.3.3 Limiting beliefs

The development of brain potential can be severely hampered by limiting beliefs emanating from the cultural norms of society, or of conditioning in early childhood (see 4.3.1). Although these barriers are very difficult to overcome on a conscious level, they can be reduced or eliminated at a subconscious level, through the use of body language, tone of voice and appropriate language (Lawlor & Handley 1996:5).

Lozanov (1978:203-250) developed *Suggestopedy* to demonstrate that the reserve powers of the brain, which lie in the subconscious, can be accessed by the use of suggestion. Because the mind contains certain emotional, logical, and ethical barriers that prevent suggestion from direct access to the subconscious, a more indirect route had to be found. According to Lawlor & Handley (1996:87), most people have been conditioned by their home or learning environment to believe that they have a limited memory, creativity and overall ability, a label which often becomes a self-fulfilling prophecy, which they accept as children and are unable to change.

It is known that a child can memorise considerably more information than an adult (the adult's memory and imagination weaken in inverse proportion to the growth of reasoning). Once a social norm has been established for the lack of importance of memory, as well as for the individual's limited capacity to memorise, this suggestive norm becomes a barrier which could be removed by the process of de-suggestion (Lawlor & Handley 1996:90). As these barriers can be a serious impediment to the learning process, the teacher/trainer/facilitator has to *de-suggest* the negative concepts embedded in the subconscious minds of the learners, and substitute them with positive beliefs through suggestion.

The process of *de-suggestion* can be promoted by the use of :

- **Double/dual-planeness.** This is a concept used by Lozanov to explain the influence of diverse stimuli, which are consciously or unconsciously emitted from or perceived by an individual. (Stimuli below the conscious level or plane, i.e. non-verbal communication, include facial expression, posture, gesture and tone-of-voice). This concept has been developed to a high degree in Neuro-Linguistic Programming (NLP) (see 4.7). Some principles of double-planeness which can be of use in the teaching/learning situation are:
  - **Sensory acuity**. The educator should be aware of the reaction of the learners to the message they are receiving. Effective communication can be measured by the response. The educator should keep on changing the form of communication until a favourable response (on the behavioural level) is received.
  - **Rapport**. The educator should build trust on a non-verbal level by 'pacing' (discreet mirroring of the learner's posture, movements and voice), and then 'leading' (by changing his/her behaviour so that the learner's behaviour follows).
  - **Eye movements and body language**. The educator should observe eye movements and body language of the learner, to become aware of mismatches in communication. It is possible that when the presentation of information does not suit the learning style (auditory, visual, and kinesthetic modes) of all the learners, it will be reflected in this manner. In addition to this, certain 'qualities' should be present in the teacher's communication with the learner.

- **Authority**. In this particular context, authority is necessary (without the educator being authoritarian) to create an atmosphere of confidence, and thereby the feeling that the information being conveyed is reliable, authentic, and worth learning. This can be achieved by the 'correct' use of the voice (by varying pitch, volume, and pace) and body. Lawlor & Handley (1996:88,89) recommend that educators/trainers/facilitators learn the basic skills of acting, as this would empower them, amongst many other benefits, to communicate effectively (in particular with right-brain dominant learners).

- **Language**. One of the NLP techniques suggests that all language used by the educator should be framed in **positive** terms (as opposed to negative terms), avoiding criticism and emphasising encouragement. Educators are often unaware of the powerful influence they exert by the way they use their voices and body language.
  - **Body language**. The proportion of body language (facial expression, gesture, posture etc.) used in communication is approximately fifty-five percent
  - **Voice**. Communication with the voice (tone, stress, pitch, pauses, use of silence etc.) is approximately thirty-eight percent
  - **Verbal content**. The verbal content of communication is about seven percent.

  Educators often focus on the verbal **content** of the lesson, while only a few think about the **way** they say it, or how to use their **bodies** (see 4.3.4) while they are saying it. It is possible that what they say may be understood, but not remembered because it has not penetrated the emotional barriers of the learners (Lawlor & Handley 1996:95).

4.3.4 The effect(s) of communication on memory

If learners receive information from a source that **lacks authority** or is connected to **a negative emotion**, they will tend to reject it on a subconscious level, thereby preventing it from being stored in the long-term memory. It is therefore of great importance that the educator consciously takes control of his/her body movements and voice, and uses them to convey a positive message of enthusiasm and cheerfulness.

- **Body-language**. Educators should be aware of the way they use their bodies, with respect to the effect this has on the learners, as well as on their own emotional state. Body posture can reflect and reinforce a pattern of either negative or positive thinking. This makes it necessary for the educator to take charge of his/her body, and consciously to direct its movements and posture to make 'good use' of the body. In addition to this, it should be noted that by crossing legs when we sit down, folding arms, or sitting with a curved spine, the natural balance of the body is being destroyed, which in turn contributes to a lack of 'centredness' and poise in the mind (Lawlor & Handley 1996:96).

- **The alpha state**. If learners are able to enter a state of relaxed awareness, the ability to memorise is considerably enhanced. In this state of relaxed awareness, the brain waves slow down to a frequency of about eight to twelve cycles per second: the **alpha** state (see 2.7.1). It is possible to induce this state by relaxation exercises, or playing slow movements from Baroque works. The alpha state can be highly beneficial on a therapeutic level: it can relax the body, calm the mind, overcome fatigue, and give fresh energy, and can be used by individuals to overcome stress.

By addressing the logical, critical barriers of individuals in advance, it is possible to overcome resistance to learning and foster a willingness to at least 'try' new activities.

4.4 Right and left brain

To access the vast potential of the human brain and make a meaningful contribution to education, it is necessary to understand the possibilities and the available processes. Learning styles and preferences were originally developed with a left/right brain theoretical foundation, based on early 'split-brain' research. Recent research has revealed that styles and preferences are immensely complex to understand, and that learning in the classroom has to be approached in a meaningful, challenging and relevant way, to cater for children of all types of learning styles and preferences (Caine & Caine 1991:34,35).

The anatomy of the brain stem and spinal cord is relatively simple compared to the complex anatomy of the cerebral hemispheres. The proliferation of neurons in the cerebral hemispheres is also much greater than in the other regions of the central nervous system. A clearer understanding of the relationship between the regional anatomy and localised functions of the brain is gradually emerging through the use of imaging techniques. With these techniques it is possible to map the activity of groups of neurons in the living brain **in a behavioural context** (Kandel et al 1991:308). As seen in 3.5.1, much of the human brain is divided into two hemispheres, a right and a left hemisphere, which appear to function in quite different fashions. The left hemisphere deals with information in a logical, analytical and linear way; the right hemisphere deals with patterns, 'wholes', tends to be imaginative and intuitive, and is attracted by colour, art, and music (Webb & Webb 1990:23).

Although each hemisphere is dominant in certain activities, **they are both together involved in almost all thinking**. When **words** (usually processed in the left hemisphere) are combined with **music** or **pictures** (usually processed in the right hemisphere), or when **words** are presented with

emotion, they are easier and faster to learn: **one of the tenets of whole brain learning** (Rose & Nicholl 1997:33-35).

Most people have a natural tendency to prefer thinking with one hemisphere rather than the other, and are described as being left or right brain dominant (Lawlor & Handley 1996:5). This tendency to prefer one side to the other is called lateral dominance (see 3.5.3), and in conjunction with an individual's natural preference for one hand/foot/eye/ear over the other, constitutes his/her basal profile (Hannaford 1997:17,18). In times of stress, or when taking in new information, people have greater access to those senses that are directly linked to the dominant brain hemisphere, and tend to rely more on these familiar ways to learn.

4.4.1 Optimal learning state

Studies in normal, brain-damaged, and other select populations, have been prompted by the discovery of complementary cognitive-mode asymmetries following commissurotomy/ disconnection of the hemispheres. One of the important outcomes in education and elsewhere, is an increased insight and appreciation for the importance of non-verbal forms and components of learning, intellect and communication. In addition to this, is an awareness of the discrimination against the non-verbal, non-mathematical half of the brain, which has its own perceptual-mechanical-spatial mode of apprehension and reasoning. It is imperative that better methods are devised to detect, measure, and develop the non-verbal components of intellect, *before their critical development periods have passed* (Sperry 1985:18).

Although each hemisphere can function, to a significant extent, independently of the other, Sperry (1985:21) points out that it is important to remember that the two hemispheres in the normal intact brain tend regularly to function bi-laterally as **an integrated dynamic entity**. Since the optimal learning state is one of **whole brain integration**, where both hemispheres are active all the time, **the learning environment should be designed to encourage whole brain learning**. This would require that the environment be stimulating, but, as stress increases unilateral brain functioning, also as stress-free as possible (Hannaford 1997:34).

When lessons are planned, educators should always keep their own brain dominance in mind. They should remain aware that all information they wish to put across to learners, should not be put across **only** in ways that suit their own brain preference, but in ways that make it easy for individuals with different brain dominances to learn (Lawlor & Handley 1996:105).

4.5 The "triune" brain

The so-called 'dual' and 'triune' brain groupings are not familiar to the disciplines of Neuro-anatomy and Neurophysiology, but are often used for educational purposes to make very complex scientific information accessible to teachers and learners.

As discussed in 2.10.2, the brain is not only divided into two hemispheres, but can also be considered in terms of a 'three-in-one' **functional** grouping. The following table briefly explains the three functional groupings, and is based on information by Rose & Nicholl (1997:28-32).

Table 4-2
Location and function of the three groupings of the triune brain

THE 'TRIUNE' BRAIN	LOCATION	FUNCTION(S)
Reptilian brain (brain stem)	At the base of the skull, emerging from the spinal column	Controls many basic functions: breathing, heart rate, fight-or-flight response
Limbic system (mammalian brain)	The central part of the brain that folds around the brain stem	Controls the emotions, hormones, thirst, hunger, sexuality, immune function. Important in long-term memory
Neo-cortex (the thinking brain)	Wraps around the limbic system, including the reptilian brain	The seat of intelligence: seeing, hearing, creating, thinking, talking, memory

The three parts of the brain reflect the evolution of the brain, from purely instinctual, involuntary responses to the acquisition of controlled emotional response and the beginning of memory, to the complexity of the 'new brain' or neo-cortex and rational thought (Rose 1991:17-19).

4.5.1 The role of the reptilian brain

The "reptilian" brain (brain stem) situated at the base of the skull is the brain element humans share with lower life forms (crocodiles, lizards, birds). It controls the basic functions which include breathing, pulse, fight-or-flight instincts (when threatened by danger) and territorial instincts (when threatened by "invasion-of-territory") (Rose & Nicholl 1997:28).

4.5.2 The role of the limbic system

The *limbus* (Latin: 'border' or 'collar') is the central part of the brain which wraps around the brain stem, and is referred to as the "limbic" system (this part of the brain is similar to that found in other mammals). The limbic system can be described as the 'emotional controller', as most of the emotional processing occurs there. The capacity to emotionally mark and remember experiences is important for the survival of a society. Without healthy emotional development of individuals, humans could not become adequately socialised and the values, rules, and wisdom of the society would be lost. The emotions of the limbic system are also responsible for the release of neuro-transmitters that can either strengthen or weaken the immune system (Hannaford 1995:53).

The limbic system provides the link between the reptilian brain and the neo-cortex. With respect to:

- **the link between the limbic system and the neo-cortex**, it is impossible to separate emotions from learning and other important activities of life. There are more neural connections going **from** the limbic system **to** the intellectual cortex than vice versa, from which can be deduced that **emotion is often a more powerful factor in influencing behaviour than is logical reasoning** (Rose & Nicholl 1997:29,51).

- **the link between the limbic system and the reptilian brain**, the emotional system acts like a 'switchboard', filtering incoming information from the senses to the neocortex. Emotionally-laden information which could pose a threat, does not move through to the 'higher' structures of the brain, but moves straight 'down', or is 'down-shifted' to the more primitive structures for an **instinctual reaction** rather than the use of **rational judgement**. Learning becomes inhibited when individuals feel threatened and stressed by the fear of failure, resulting in 'unthinking' reactions such as having their minds 'go blank'. This gives some indication on how important it is to learn to control one's state of mind: **how to recognise, acknowledge, and control emotions** (Rose & Nicholl 1997:30,52,53).

Hannaford (1995:53-56) describes the limbic system in the brain as consisting of five major structures:

- the **thalamus**
  The thalamus functions as a relay station for all the incoming senses, except smell. It relays motor impulses from the cerebral cortex through the brain stem to the muscles. It also interprets pain, temperature, light touch and pressure sensations, and plays a role in emotions and memory.
- the **hypothalamus**
  The hypothalamus controls the pituitary gland, normal body temperature, food intake, thirst, and the waking/sleeping states. It is also involved in aggression, rage, pain, and pleasure.

- the **basal ganglion**

  The basal ganglion connects the impulses between the cerebellum and the frontal lobe, helping to control body movements; facilitating fine muscle control of facial and eye muscles; motor-based memory (like learning to play the piano).
- the **amygdala**

  The amygdala has links to brain areas involved in cognitive and sensory processing, recognition of facial expressions and body language.
- the **hippocampus**

  The hippocampus makes use of sensory input coming in through the thalamus, and emotions coming in through the hypothalamus, to form short-term memory.

The intricate wiring of the limbic system indicates that in order to learn or remember something, there must be **sensory input**, a **personal emotional connection**, and **physical movement**. Emotions (how an individual feels about a situation) trigger specific neuro-transmitters, and the release of the neuro-transmitters they elicit, are intimately intertwined with cognitive function. Mental activity involves complicated physio-chemical activity (Rose 1991:20).

To the mind/body, every experience can be simply considered an 'event', and the way individuals choose to perceive a specific event, coloured by their emotions, will determine their response to it and their potential to learn from it. Those students who are highly motivated to learn, already possess an emotional commitment, and will learn because they enjoy it. Others, who have come to understand the 'personal survival' importance of education to achieve societal success will do well, because they approach learning with an emotional/survival commitment. Those who experience no emotional commitment to a particular educational curriculum and/or fail to appreciate its relevance to their lives, will not be motivated to learn.

4.5.3 Cerebral neocortex development: skills and needs

The neo-cortex controls the intellectual processes (Rose 1991:18). Developmental learning recognises that children grow and develop as a 'whole', and not one dimension at a time. In terms of brain development, neural networks linking the cortex to the brain stem and the limbic system grow continuously throughout life, with 'growth spurts' even at the age of about twenty-one, and again at approximately age thirty.

Considering the natural evolution of children's movement skills and needs, it is necessary for educators to synchronise the expectations and understanding of the child's development with the expectations and tasks they impose on them. Although the development of the cerebral neo-cortex is a continuous process, with each person naturally developing at his/her own pace, it is possible to delineate certain landmarks as illustrated in Table 4-3 (compiled from Hannaford 1995:82,83):

Table 4-3

Landmarks of cerebral neo-cortex development

AGE (approximate)	DEVELOPMENT
Conception – 15 months **Basic survival needs** – food, shelter, security, and safety **Sensory development** – starting with the vestibular system, then hearing, tactile, smell, taste, and seeing **Motor development** – moving from reflexes to core muscle activation, neck muscles, arms and legs, leading to rolling over, sitting, crawling, and walking	**Reptilian brain**
15 months – 4-and-a-half years Understanding of self/others, self/emotions, self/language Emotional exploration; language exploration/communication; social development; imagination; gross motor proficiency; memory development	**Limbic system/Relationship**
4-and-a-half - 7 years Whole picture processing/cognition Image/movement/rhythm/emotion/intuition Outer speech/integrative thought	**Gestalt (right) hemisphere elaboration**
7 – 9 years Detail and linear processing/cognition Refinement of elements of language Reading and writing skills development Technique development – music, art, sports, dance, manual training Linear math processing	**Logic (left) hemisphere elaboration**
8 years Fine motor development – skills refinement Inner speech – control of social behaviour Fine motor eye-teaming for tracking and foveal focus (two-dimensional focus)	**Frontal lobe elaboration**
9 – 12 years Whole brain processing	**Increased corpus callosum elaboration & myelination**
12 - 16 years Learning about body, self, others, community, and meaningful living through social consciousness	**Hormonal emphasis**
16 - 21 years Whole mind/body processing, social interaction, future planning and play with new ideas and possibilities	**Refining cognitive skills**

21+ Global/systems thinking High level formal reasoning Refinement of emotions Insight Refinement of fine motor skills	**Elaboration and refinement of the frontal lobes**

4.6 The sensory modes

The five senses usually delineated are those that take in information from outside the body: seeing, hearing, smelling, tasting and touching. However, the sensory input which provides information about gravity and motion, as well as the body's muscular movements and position in space, the **vestibular** system and **proprioception,** is essential to human development. Proprioception is the sensation from muscles, tendons, and the vestibular system, that enables the brain to determine movement and the position of the body and its parts in space (Hannaford 1995:39).

What people know, feel, learn, and think is determined by **how** they know, feel, learn, and think. How they do these things depends, in turn, on the sensory-motor systems through which the individual's experience of the world and him/herself is mediated. The human body can be described as a "fine-tuned sensory receptor for collecting information" (Hannaford 1995:29-33).

The sensory system starts developing within a couple of months after conception, in utero, with the vestibular system already visible in a two month old embryo (Hannaford 1995:35). Gravity is experienced through the vestibular system even before birth, with hearing, smell, taste and touch building on the gravitational sense, giving the first images of the environment.

4.6.1 Development of the vestibular system

An individual gathers information about the head's position relative to the ground from several small organs involved in vestibular sensation. The first sensory system to fully develop and myelinate by five months after conception, is the vestibular system. It controls the sense of **movement** and **balance**, and maintains **static** and **dynamic equilibrium**.

- **Static equilibrium** refers to the orientation of the body, in particular the head, relative to gravity, when standing still. Movement initiates sensory nerve impulses along the vestibular nerve to the brain. Nerve impulses proceed through nerve tracts to the cerebellum (see 2.4.1) where they are monitored and corrective adjustments in muscle activities are made, including eye-movements that originate in the cerebral cortex. In this way the muscles adjust to prevent loss of balance or equilibrium, and make it possible to maintain a stable bodily posture relative to the ground (Hannaford 1995:34).

- **Dynamic equilibrium** maintains the body position, in particular the head, in response to sudden movement. Three bony semi-circular canals of the inner ear, in which the *endolymph fluid* flows, lie at approximately right angles to each other, maintaining dynamic equilibrium by detecting imbalance in three planes. A slight alteration of fluid within the semi-circular canals has a direct effect on the muscles of the neck, trunk, limbs and musculature of the eye.

There is considerable activation of the head as the fetus moves in the amniotic fluid, as well as when the young child goes from crawling to walking to running. According to Hannaford (1995:35), the stimulation from these movements is crucial to brain processing.

The vestibular nuclei carry impulses from the semi-circular canals and cerebellum to the Reticular Activating System (RAS) (see 2.4.2) in the brain stem. Beginning in utero, the RAS alerts the neo-cortex, increasing its responsiveness to incoming sensory stimulus from the environment, and in this way making the individual ready to learn. The connection between the vestibular system and neo-cortex, as well as the eyes and core muscles, is highly important to the learning process. **When there is no movement to activate the vestibular system, it is not possible to take in information from the environment** (Hannaford 1995:35).

The vestibular system is already active in the fetus, but becomes particularly active as the child gains a sense of gravity and knowledge of the physical environment through movement. With every movement, the child stimulates the vestibular system, which in turn stimulates the brain for learning.

4.6.2 Development of the sense of hearing

At approximately twelve weeks, the fetus moves spontaneously, and is surrounded by the first patterns of sounds that will be absorbed by the nervous system: the mother's heartbeat, her breathing, digestion, and voice. With the use of fibre-optic cameras, it has been possible to monitor the movement(s) of a five-month old fetus in response to phonemes of language (various vibrations of sound as heard through the amniotic fluid). On hearing a specific phoneme, the fetus moved a specific muscle (the particular muscle moved varied in each fetus studied), but each time the same phoneme was sounded, the same muscle would move. Hannaford (1995:36) maintains that this early connection of a specific muscle response to sound suggests the importance of 'anchoring' sensory input with action/movement for learning to take place.

Once the amniotic fluid has dried out of the inner and outer ear canals of the newborn, the sense of hearing becomes one of the most accurate and important. For most people, the sense of hearing is at its best at birth, after which it starts deteriorating. It is important to protect the intricate hearing mechanism from damage from overly loud music, or exposure to constant sounds at the same vibration, not only for survival and active listening, but also to provide the alertness that comes with the higher vibrations which assist in the learning process.

The physical process of hearing takes place when sounds reach the ear and travel through the external ear canal. On reaching the middle ear, they cause the *tympanic membrane* (ear drum) to vibrate. This vibration is conveyed through the middle ear by a series of three small bones that ensure that the sound is efficiently transmitted to an opening in the fluid-filled cochlea of the inner ear. The changes in fluid pressure within the cochlea fluid initiate motion in a particular set of hair cells. Different regions of the cochlea respond selectively to different frequencies of sound, and individual hair cells at different points along the cochlea are tuned to different frequencies of vibration. The vibrations of the hair cells are transformed into electrical signals in the auditory nerve.

In the brain, the inputs from the two ears are combined by ascending pathways that cross the midline extensively. The pathways separate information about the timing and intensity of signals, and the information then ascends in parallel to the auditory cortex where the timing, frequency and intensity of the sound are mapped (Kandel et al 1991:481-498).

The cochlear-vestibular system of the brain is of vital importance (vestibular having to do with the body's position in space), suggesting that **the mind does not grow without movement**.

4.6.3 Development of the sense of smell

Smell is quite acute at birth and is strongly linked to memory, playing an important role in the baby's early learning and throughout life. The sensation of certain smells can:

- bring back a flood of memories
- be used to alert to danger
- act as a strong stimulant to the reptilian brain for displaying behaviours (grooming, preening).

4.6.4 Development of the sense of touch

Touch is a natural, integral part of life. The skin, which covers the entire body, is one of the primary organs for early environmental learning, and is replete with nerve sensors for:

- light touch
- heavy touch
- pressure
- heat
- cold
- pain
- proprioception (see 4.6.5 below).

The areas around the mouth and hands have more receptors for touch than any other areas of the body.

The act of being touched increases the production of a specific hormone in the brain, Nerve Growth Factor (NGF), which activates the greater nervous system and specifically 'nerve net development'. When touch is lacking, the nerve development may be slowed down to such an extent, that essential bodily function development may not occur, which could result in death. A programme where premature babies are exposed to constant touch, known as Kangaroo mother care (KMC), has greatly reduced the mortality rate: **touch** alone stimulates sensory-motor growth and nerve net development (Hannaford 1995:41).

When touch is combined with other senses, more of the brain is activated, stimulating the development of more complex nerve networks and increasing the learning potential. Inappropriate touching is rejected by society, which has led to people avoiding 'touching'. Hannaford (1995:42) suggests that, at a time when children and adults need 'touch' more than ever, it is time to relearn appropriate, supportive touch for its value in development and learning.

4.6.5 The proprioceptive system

Proprioception is the body's sense of itself in space, and is one of the body's most important ways of knowing. All the muscles of the body have proprioceptive receptors that are able to sense the degree of stretch in the muscle. These stretch receptors constantly provide information about the body's physical position, and the necessary feedback to make it possible to move and maintain balance.

As far as development is concerned, the proprioceptive system is closely tied to the vestibular system, which allows the balance that is necessary to move from an inert position. Successful movement requires secure balance, which in turn depends on a 'sophisticated' proprioceptive system constantly aligning every part of the body. In the process of reading, the system constantly provides feedback to the brain that readjusts the balance of the shoulder and neck muscles, so that the eyes remain level while reading. When stress interferes with the balanced activation of this system, there is a sensation of feeling 'un-centred', with a resulting loss of balance and physical sense of the body in space.

Movements for complex skills can be mentally imagined and 'rehearsed' through visualisation, which allows the brain to rehearse the neural pathways that control the relevant muscles, and in this way strengthen the brain network involved (Hannaford 1995:45).

4.6.6 Development of vision

Vision can be considered a very complex phenomenon, with less than ten percent of the process taking place in the eyes. The remaining approximately ninety percent of the process takes place in the brain from association with touch and proprioception. Touch is particularly important to vision: for the young child, touch is the major contribution to a full understanding of vision.

Much of vision is **learned**. People have to train themselves through books, movies and art, to see three dimensions in a two-dimensional format. Hannaford (1995:46) refers to tribal people she encountered in Africa and Australia, who have never experienced books, and are unable to 'see' an illusion of a three-dimensional scene on a two-dimensional page.

The eyes are designed to move and accommodate for light, as well as to provide as much sensory detail as possible: they must be actively moving for learning to take place. The *retina*, the sensory nerve layer at the back of the eye, contains two kinds of light receptor cells:

- *Rods*, that make up approximately ninety-five percent (so-called because of their shape): they are distributed around the periphery of the retina and are best-stimulated under dim light conditions
- *Cones*, that make up approximately five percent. They are grouped in a small area of the retina, the *fovea centralis*, and need bright light for stimulation.

The combination of rods and cones makes three dimensional as well as two-dimensional focus possible, and peripheral as well as **foveal** focus. However, considering the ratio of cones to rods, Hannaford (1995:48) considers it unlikely that people were designed to be engaged in foveal focus activities (such as reading, watching TV or computer screens) for long periods of time.

Throughout people's lives, there is a need for rich, sensory, hands-on learning. Experiences can be viewed as direct and real, involving senses, emotions, and movements, and engage the learner fully. As the goal of life-long learning is pursued, it should be remembered that learning **first** takes place through the senses, after which emotions and movement are added (Hannaford 1995:49).

According to Lawlor & Handley (1996:6), an important contribution to the theory of learning, made by neuro-linguistic programming (see 4.7), is that people learn and think with a preference for a particular sense, or combination of senses. Those that prefer to process information visually are **visual** learners; those that prefer to process auditory information are **auditory** learners; those that prefer some active physical involvement are **kinesthetic** learners.

An educator should always keep in mind the different learning preferences of students. For those with a preference for:

- **visual material**, the information should be written down or displayed visually, making use of transparencies, flip charts, or posters
- **auditory information**, back-up audio tapes for revision, the use of music and/or the way the voice is used, can facilitate a clearer understanding
- **physical activity**, it would be helpful to have some periods of physical activity, linked to the topic under discussion, to satisfy the needs of the kinesthetic learners. In this respect, Brain Gym exercises (see Appendix A) can be particularly effective for all learners.

Sensory experiences, both external and internal, shape a person's way of imaging and thinking. As new sensory experiences modify and change, making the individual's images of the world ever more complex, so new learning occurs: sensory input is essential to learning, thought and creativity. **Whole brain learning is a multi-sensory approach engaging the senses, which provide input to the brain and balance the two brain hemispheres that process information differently** (Fairbanks 1992:1).

4.7 Neuro-linguistic programming and visualisation

According to O'Connor & Seymour (1993:1), Neuro-Linguistic Programming (NLP) is the art and science of personal excellence. It is an **art** because people bring their unique personality and style to what they do, which can never be captured in words or techniques. It is a **science**, because there is a method and process for discovering the patterns of human excellence. Some individuals might consider the techniques to be uncomfortably manipulative, but many people practise them on an unconscious level: NLP is just a new way of coming to terms with what the individual already knows.

The patterns, skills and techniques discovered by this process of 'modelling' are being used increasingly in:

- counselling (for personal development)
- education (for accelerated learning)
- business (for more effective communication) (O'Connor & Seymour 1993:1).

NLP is a group of psychological techniques, based on the way the brain codes learning and experience, which can help an individual understand how he/she thinks, to understand how his/her mind works, and then use this understanding to help change behavioural patterns (Linden 1997).

Neuro – refers to the mental pathways of our thinking and understanding (and consciousness)

Linguistic – refers to the individual's ability to use and understand language, and to communicate this understanding

Programming – refers to how the individual acts and which sequences of behaviour are used to achieve results.

4.7.1 Pre-suppositions for NLP

Certain pre-suppositions are necessary for the process of neuro-linguistic programming:

Table 4-4

Pre-suppositions for NLP

Mental processing pre-suppositions	• People respond according to their 'created' reality • Mind and body affect each other • Individual skills function, by the developing and sequencing of representational systems (visual, auditory, kinesthetic) • Each individual's model of the world is respected: NLP does not deal with content – it is a process
Pre-suppositions about human behaviour/responses	• Person and behaviour describe different phenomena. People "are" more than their behaviour • Every behaviour has utility and usefulness – in some context • Behaviour and change are evaluated in terms of context and ecology (is a change ecologically sound?).
Communicational pre-suppositions	• It is not possible to *not* communicate • The **way** people present their communication affects perception and reception (people have to take responsibility for their actions) • The meaning of communication is indicated by the response received • The individual with the most flexibility/choices, exercises the most influence in the NLP system • Resistance indicates a lack of rapport
Learning/choice/change pre-suppositions	• People have the internal resources they need for the empowerment to succeed • All communication should increase choice • People make the best choices available to them in a specific situations • People exist as "Response-Able" individuals – able to control their own brain as well as their responses.

4.7.2 The pillars of neuro-linguistic programming

According to Hofmeyr (NLP for musicians 1999), NLP is built on four pillars:

- **Rapport** – with oneself and others. Rapport with others can be effected by building trust on a non-verbal level by 'pacing' (discreet mirroring of another person's posture, movements, and voice) and then 'leading' (changing one's behaviour so that the other person follows)
- **Outcomes** – focusing on the goals of the individual

- **Sensory acuity** – becoming alert to the senses, and learning to differentiate using the senses. A key concept of NLP is that **"the meaning of communication is the response one gets"** (Lawlor & Handley 1996:88)
- **Flexibility** – changing a particular technique that is not successful. The form of communication should continue to be changed, until the message receives a favourable behavioural response.

4.7.3 Visualisation

Visualisation is an exceptionally effective, though much neglected, aid to the learning process, focusing on an individual's goals and their outcomes. To be an effective aid, it should make use not only of visual images, but involve the other senses as well (sensory acuity): **hearing**, **physical movement** and **feeling**, and sometimes **taste** and **smell**.

Most individuals experience a preference for creating images in one sense more than in others. The majority prefer the visual sense to create images, but others find it easier to create mental sounds or the feeling of physical movement or touch. The following are some of the more relevant ways in which visualisation can be used:

- to create a clear mental picture or an organisational or personal goal
- to arouse interest in a new subject/discipline
- to assist the understanding of a technical process
- to create a clear mental picture of learning and achievement goals
- to improve commitment to carrying out a specific plan
- to stimulate creative thinking
- to enhance the self-image as a learner/achiever.

It is, however, important to encourage individuals to make deliberate use of as many senses as possible when visualising images. The reason for this is that the subconscious mind will react to a clear, multi-sensory mental image as if it were reality: it is not possible for it to distinguish between such an image and the 'real thing' (Lawlor & Handley 1996:110,111).

4.7.4 Applications of visualisation

By taking control of this unconscious mental process, the individual can turn the process to his/her advantage. The created mental images of planned goals will be accepted by the subconscious mind as valid and produce actions which will tend to make them real. In a similar fashion, visualisation can be used to stimulate creative thinking for solving problems.

The neural pathways of the brain that are activated when an individual creates a clear, multi-sensory mental image of performing a specific action, are very similar to those involved when the individual actually performs the action. This implies that a new skill (particularly if the kinesthetic sense is involved) can be rehearsed by a person visualising him-/herself actually **doing** it (Lawlor & Handley 1996:116).

Some people find it difficult to create mental images and may find it helpful to make use of certain techniques in preparation for visualisation, such as:

- physical/muscular relaxation (Baroque compositions: see Appendix B)
- concentration (Brain gym: see Appendix A, or Music: Appendix B)
- mind calming/mind relaxation (Brain gym; Baroque music) (Lawlor and Handley 1996:111).

4.7.5 The use of music

Baroque music, as well as certain types of New Age music, can create a very effective background to the 'spoken' voice, helping to make mental images clearer and more credible to the subconscious mind. The term 'New Age' is often used to refer to a quiet instrumental style that became popular in the mid-1980's. It has been suggested that only music created to aid in healing, meditation or worship can properly be referred to as 'New Age'. Unfortunately all atmospheric, genre-blurring music also falls under this category in record stores, making it unusually difficult to define New Age. The name does not necessarily imply a connection with New Age spirituality, and most artists who are assigned to this category have no connection to any particular spiritual movement (Echo Glossary 2001).

Certain music can:

- make periods of silent reflection more acceptable
- make thinking more creative
- make a cold, empty environment feel warm and secure
- energise and enliven
- produce a state of relaxed awareness
- make teaching more holistic by appealing to several senses.

4.8 The mind-body link

The exponentially growing information base about mind/body function and the essential link of movement, the senses, and emotions to effective learning, need to be taken seriously. Although modern science has underlined the importance of body-movement in learning, modern life-styles are making it increasingly difficult to benefit from this information. Young learners tend to spend lengthy periods of time watching television, computer, and video screens, a lifestyle that pre-empts regular exercise.

In addition to this, most people's daily existence is highly stressful, plagued by the fear of personal violence which is amplified by the media. To counter all this stress, many people resort to the alternative of drugs, which not only markedly decrease ability to learn, but also make it impossible for them to reach their full potential as human beings (Hannaford 1995:14,16). There are a number of 'mind-body' factors that play a crucial role in brain development, before and after birth, many having a marked influence on an individual's learning ability.

4.8.1 Neural plasticity

Neural plasticity is an intrinsic, beneficial characteristic of the human nervous system, giving it enormous potential for change and growth: giving people the ability to learn, and in response to damage, the ability to re-learn.

Brains can no longer be considered as 'blank slates' or assumed to be similar in quality at birth (Sperry 1985:19) (see 4.3.1). Different mental disciplines employ qualitatively different forms of cognitive processing that require different patterns of neural circuitry, the basic cerebral requirements for which are largely **pre-wired** (see 2.6.7). (Gardner 1982b:20 refers to a similar view held by Noam Chomsky with respect to language development, who views the child as being equipped with requisite knowledge from the beginning, and the unfolding of that knowledge being merely a question of time.) Whatever the individual's pre-wired neural circuitry, and given the proper quantities of nutrients, oxygen, stimulation and freedom to move, each individual has the same immense potential available to him/her.

Learning proceeds as individuals start interacting with the world around them. In the brain this 'learning' constitutes a form of communication among neurons. The process of nerve cells connecting and networking to form patterns of communication, that through the process of myelination become 'pathways', and through regular use, 'highways', is in reality learning and thought (Hannaford 1995:16-18).

4.8.2 Effects of nutrition on learning ability

The ancient idea of "*Mens sana in corpore sano* – a sound mind in a sound body" was given new emphasis towards the end of the twentieth century (Ostrander et al 1994:199). A new understanding of how the brain, mind and memory work, and the impact of biochemical and energetic aspects of optimal performance, can no longer be ignored, in particular with respect to the individual's learning ability.

The **power** of the brain is largely dependent on:

- the **number** of neurons
- the **richness** of their inter-connections.

Some of the inter-connections are made automatically, but most are made by 'using' the brain. Since many of the neuron inter-connections are made before the age of five, the **nutritional** considerations for the brain before birth and in early childhood, play a paramount role in the child's learning ability.

Nutrition is vital during the formation of brain cells, in particular adequate amounts of protein and amino acids before birth, as well as in the early years after birth. In societies where mothers are undernourished, it is possible that children may have up to fifty percent fewer neurons than those children whose mothers are well nourished. In addition to this, it is possible that the part of the brain responsible for limb co-ordination can also be seriously affected/impaired. Malnutrition does not only reduce the number of neurons, but also the number of connections between nerve cells (see 2.5.4).

4.8.3 The vital role of oxygen

Pollution in both water and air has reduced their oxygen content by as much as fifty percent in some cities in the USA (Ostrander et al 1994:192). The brain needs enormous amounts of **oxygen** to function: it is a vital constituent of the brain before and after birth. The fetus of a woman who smokes receives less oxygen than the fetus of a non-smoking woman, and this has been found to have a negative effect on the reading scores of children (Rose 1993:6,7).

Oxygen is vital for brain function (see 2.5.4). According to Ostrander et al (1994:192,193), a number of researchers have identified the organic form of *germanium* as a major oxygen catalyst and a detoxifier in the body. It has the capacity of removing many toxic substances in the body: some, such as lead and mercury contamination from food (and on occasion from dental fillings) can cause brain damage and affect the individual's ability to learn well. Diseases such as *candida albicans* (see Glossary 1.6) which can be caused by one single micro-organism, have been known to cause memory loss, serious learning problems, poor concentration, allergies, hyperactivity and excessive fatigue in many people: symptoms which are being successfully treated with 'oxygen therapies' in a number of clinics.

Organic germanium has been found, in extensive tests, to increase mental capacity, or to relieve mental decline, memory loss, and senility. In the human body's role as a 'generator of electricity', organic germanium acts as a semi-conductor, discharging excess electricity or stimulating the flow, as required by the body to balance its electrical system.

4.8.4 Learning disorders

Comments on a recent pediatric survey and a variety of press reports in the USA, create cause for alarm with respect to "poor health" leading to "poor academic performance". This health-care crisis in the classroom can lead to an array of social problems (Ostrander et al 1994:198, 199). There are indications that there is a substantial increase in the number of people affected by depression (happening at younger and younger ages); anxiety disorder; dyslexia; attention deficit disorder (ADD); hyperactivity; retardation (autistic and brain-damaged individuals), and those affected by Alzheimer's disease.

4.8.5 Possible remedies for learning disorders

Many new discoveries are making it possible to remedy some of the disorders. It is possible to increase the amount of oxygen in the body:

- In its organic form, germanium is found in foods such as: watercress, garlic, pearl barley, aloe, and ginseng
- Other forms of increasing internal oxygen are by adding small amounts of 'electrolytes of oxygen' to drinking water, or alternatively magnesium peroxide (Ostrander et al 1994:195).

The treatment of ADHD learners is discussed in 3.6.1.

4.8.6 The effects of gender differences on learning ability

There are definite differences in how male and female brains develop, with conclusive evidence that **hormones are the key to whether the brain develops as a more male or female brain**. Jensen (1995b:283-286,297) points out that there are demotivating influences on females in academic circles and subsequent career choices in the fields of technology, mathematics, science, and computer-related sciences.

There are "Distinct, Measurable, Structural Differences Between Male and Female Brains" (Jensen 1995a:86). Some examples of sexually determined physical differences include:

- length of nerve cell connectors
- nucleus volume in the hypothalamus
- pathways the neuro-transmitters follow
- density of nerve cell strands
- the shape of the nucleus in the hypothalamus
- the thickness of the left and right side of the cortex control centres
- the number of vasopressin neurons in the hypothalamus
- the thickness and weight of the corpus callosum
- the location of control centres for language, emotions and spatial skills.

There are differences between the genders in **brain-sensory** intake and thought processing. Some of the main differences discussed by Jensen (1995a:88-90) are summarised in Table 4-5 below:

Table 4-5

Gender differences in brain sensory intake

SENSE	GENDER DIFFERENCES
Hearing	• The female ear is better at picking up nuances of voice and other sound • Females retain better hearing longer throughout life • Females have a greater clarity of voice, learn to speak earlier and learn to speak languages more quickly • Women process language faster and more accurately than males • Women excel at verbal memory.
Smell and taste	• Women have a stronger sense of smell • Women are more responsive to aromas, odours, and subtle changes in smell • Women have a significant advantage with respect to olfactory memory • With the use of neuro-radiological imaging to assess brain shrinkage, women have been found to be more susceptible to the damaging effects of alcohol. (Of particular significance are the effects of alcohol in conjunction with poor nutrition and/or diminished oxygen supply as a result of smoking, on the development of the fetus).
Touch	• Females have a more diffused and sensitive sense of touch, in particular in fingers and hands • Females are superior in performing new motor combinations and in fine motor dexterity • Women react faster and more acutely to pain • Women can endure pain longer than men.
Vision	• Men have better distance vision and depth perception • Men see better in bright light than women • Women excel at peripheral vision and visual memory • Women have superior eyesight at night and are more sensitive to the 'red' end of the spectrum

Research on differences in problem solving between the genders has illustrated very different ways of approaching and solving problems. Whereas women, for example, excel at mathematical calculation, precision and fine-motor co-ordination, language fluency and matching/locating missing objects, men excel at mathematical reasoning, spatial skills and locating objects/patterns from within another. Many male-female behavioural issues can be comprehended more easily in the context of brain development.

Educators and learners should remain constantly aware of the powerful influence sex hormones have on certain learning tasks. Examples include:

- verbal skill and muscle co-ordination is better in women when their oestrogen level is high
- spatial relationships are better in women when their oestrogen level is low
- video-spatial skills (mathematical and scientific abilities) are enhanced by the male hormones and depressed by female hormones (see 2.6.8).

In attempts to make education "gender-bias free", the crucial brain differences in the context of brain development have not been taken into consideration: "Equal education does not mean that everything should be done the same; it means providing equal opportunity" (Jensen 1995a:90).

The implications of the mind-body link on an individual's learning abilities are profound, and it has become imperative for teachers and learners to be well informed about this important link and its role in whole brain education.

4.9 Teaching and learning through multiple intelligences

Since early in the twentieth century, the 'measurement' of an individual's mental capacity/ intelligence has been reflected by an intelligence quotient (IQ). More recently, however, there have been doubts as to whether this is a fair reflection of an individual's intelligence and potential. Intelligence tests measure the ability of people to do well in intelligence tests: the IQ-test predominantly measures an individual's ability with linguistic and logical mathematical challenges as well as certain visual and spatial tasks. However, this form of testing fails to identify humans performing exceptionally well in fields other than those mentioned (see 3.3).

Recent research in cognitive and differential psychology suggests that not all human minds work in the same way and that not all human beings exhibit the same profile of cognitive strengths and weaknesses. This "characterisation" ought, according to Gardner (1999:160), strongly influence how students are **taught**, and how their knowledge is **assessed**.

4.9.1 A new perspective on cognition

Howard Gardner, Professor of Education and Adjunct Professor of Psychology at Harvard University and Adjunct Professor of Neurology at the Boston University School of Medicine and Co-director of Harvard Project Zero, claims that his approach to the study of intelligence was unusual, if not unique, by virtue of the fact that he minimised the importance of tests and of correlations among test scores (Gardner 1998:113). His "Theory of Multiple Intelligences" (MI), can be considered an 'alternative' view of human competencies that reflects not how **smart** an individual is, but **how** an individual is smart, embracing ideas from neurobiology, psychology, anthropology, philosophy, and history (Rose & Nicholl 1997:37). In his MI theory, Gardner sought to broaden the scope of human potential beyond the confines of the IQ score.

The MI theory is not a fixed programme. It can rather be describes as a meta-model of progressive education than a set programme of strategies and techniques. The essence of the theory is to respect the many differences among people, and the ways that they learn. During the past two decades, Gardner and colleagues at Project Zero have been working on the design of performance based assessments, education for understanding, and the use of multiple intelligences to achieve more personalised curriculum, instruction, and assessment (Gardner 1998:131).

Teaching and learning through Multiple Intelligences can also be interpreted as being about how to create open systems of education to make it possible for the human mind to flourish. The fundamental principles of the theory can be adapted to a variety of educational settings and can be made a regular part of classroom teaching (Armstrong 1994:v-x).

4.9.2 Definition and criteria for an 'intelligence'

Gardner's definition of an intelligence as an ability to solve a problem or fashion a product that is valued in one or more cultural settings, implies that intelligence can vary in context (Rose & Nicholl 1997:36,37).

Gardner (1993:17-24) originally defined seven autonomous intelligences:

- Linguistic
- Logical-mathematical
- Visual-spatial
- Musical
- Bodily-kinesthetic
- Interpersonal (social)
- Intrapersonal

to which, in 1997, he added an eighth intelligence, acknowledged "by a simple performative speech act":

- Naturalist/Environmental intelligence (Gardner 1998:118).

To provide a sound foundation for his MI theory, Gardner specified eight criteria that each intelligence had to meet to be considered a full-fledged intelligence, and not simply a talent, skill, or aptitude:

- An identifiable core operation or set of operations
- An evolutionary history and evolutionary plausibility
- A distinctive developmental history with recognisable/definable "end-state" performances
- The existence of savants, prodigies, and other exceptional individuals, distinguished by the presence or absence of specific abilities
- Potential isolation by brain damage
- Support from experimental psychological tasks
- Support from psychometric findings
- Susceptibility to encoding in a symbol system.

According to Gardner (1998:114), none of the original seven intelligences, nor the newly accepted eighth intelligence, fulfil **all** these criteria perfectly, but they do satisfy the majority of criteria. **Intelligences usually work together in complex ways**. Intelligences do not exist by themselves in life, except perhaps in very rare instances in savants and brain-injured individuals. The intelligences have been taken out of context in MI theory for the purpose of examining the essential features of each autonomous intelligence, and learning how to use them effectively. After formal study, they must be put back into their specific culturally valued contexts (Armstrong 1994:12).

4.9.3 Abilities and tasks reflecting a specific intelligence

A brief description of the abilities and tasks of each autonomous intelligence are reflected in the Table 4-6 below (adapted from Sternberg 1998:370):

Table 4-6

The eight autonomous intelligences and their abilities

Types of intelligence	Abilities and tasks reflecting this kind of intelligence
Linguistic intelligence	The ability to read, write, and communicate with words – reading a book, writing a paper/novel/poem, understanding spoken words
Logical-mathematical intelligence	The ability to solve maths problems; balancing a checkbook; logical reasoning; doing a mathematical proof
Visual-spatial intelligence	The ability to get from one place to another; reading a map; packing suitcases in the trunk of a car
Musical intelligence	The ability to sing a song, compose a sonata, play an instrument; appreciate the structure of a piece of music
Bodily-kinesthetic intelligence	The ability to dance, play basketball, run long distance, throw a javelin
Interpersonal intelligence	The ability to relate to other people; to understand another person's behaviour, motives, or emotions
Intrapersonal intelligence	The ability to understand ourselves; what makes us who we are; how we can change ourselves
Naturalist intelligence	The ability to recognise and understand patterns in the natural world.

All people possess varying amounts of the eight intelligences, which they combine and use in highly personal ways. Gardner's research reveals a wider view of human intelligence than previously believed and generates a refreshingly pragmatic definition of the concept of intelligence. The multi-cultural nature of his theory is underscored by his description of an intelligence as:

- the ability to solve 'real life' problems
- the ability to generate new problems to solve
- the ability to contribute something or to offer a service that is valued within one's culture (Campbell, Campbell & Dickinson 1996: xv).

Most people can develop each intelligence to an adequate level of competency. Gardner suggests that, given the appropriate encouragement, enrichment, and instruction, virtually everyone has the capacity to develop all eight intelligences to a reasonably high level of performance. Whether intelligences develop, depends on three main factors:

- **Biological endowment –** this includes hereditary or genetic factors, and insults or injuries to the brain before, during, and after birth
- **Personal life experiences –** including experiences with parents, teachers, peers, friends, and others who either activate or deactivate development of the intelligences
- **Cultural and historical background –** including the time and place of birth and childhood, as well as the cultural and historical context of the different domains (Armstrong 1994:21).

There are many ways to be intelligent in each category. There is a rich diversity of ways in which people display their gifts *within* intelligences, as well as *between* intelligences.

4.9.4 Applications of the Multiple Intelligence theory

According to Armstrong (1994:14), there are a growing number of learning-style **theories**, from which a variety of teaching/learning models have been developed. He describes a person's learning style as "*the intelligences put to work*", and that learning styles are "pragmatic manifestations of intelligences operating in natural learning contexts". MI theory relates to a **cognitive model** of intelligence(s), seeking to describe how individuals use their intelligences to solve problems and fashion products.

Armstrong (1994:14) further explains that the Visual-Auditory-Kinesthetic model differs from MI models, in that it is a **sensory channel** model, whereas models based on MI theory are not specifically tied to the senses. Based on another popular theory, the Meyers-Briggs model is actually a **personality** model. Although relationships and connections exist between all these models, they cannot be correlated with MI theory: each model touches upon a different aspect of the whole learner.

MI theory makes it possible to identify, nurture and support the unique capabilities of every student. It makes its greatest contribution to education by suggesting that there is a need for teachers to expand their repertoire of techniques, tools and strategies beyond the typical linguistic and logical ones. It can be considered a "metamodel" for organising and synthesising all the educational innovations required by many alternative educational models. It also opens the door to a wide variety of teaching systems and strategies (Armstrong 1994:48).

4.10 The role of the spiritual intelligence

The concept of a spiritual intelligence concerns how people understand themselves in all aspects and relations within the cosmos: describing the human capacity to create an understanding, or a system for understanding who they are and how they fit into the world. Most discussions on this topic create controversy in the sciences as well as in the academic world. Over the centuries, many organised systems that deal with spiritual issues have been constructed, making it possible for an individual in any culture to elect to adopt an already existing code or set of beliefs about the issues of ultimate concern, or create their own personal blend of spiritual knowledge (Gardner 1998:112-119).

Gardner's MI theory is confined to the "subtle and profound cognitive capacities necessary to address the ultimate issues of existence" (Gardner 1998:112). It does not include a 'spiritual intelligence'. The notion of a spiritual intelligence poses significant problems relative to its content and Gardner does not address questions of metaphysics or religious doctrine.

Research over the past two years has provided enough scientific data to support the existence of a spiritual intelligence (SQ) (see 3.3) (Zohar & Marshall 2000:3,4). The basic neural system of spiritual intelligence (SQ), together with the two basic neural systems of rational or intellectual intelligence (IQ) and the emotional intelligence (EQ), comprise all the possibly infinite human intelligences, of which Gardner's are variations of the basic neural systems and their associated neural arrangements (see 3.3).

MEG (magneto-encephalograph) studies have revealed the presence of the relatively fast 40 Hz oscillations all over the brain, in different systems and at different levels. Singer (1999:393) found that synchronisation of oscillations in the 40 Hz range is involved in cognitive processes and increases coherence of human experience. With respect to the SQ, Zohar & Marshall (2000:12) describe these 40 Hz oscillations as its neural 'substrate'. In the same way that linear or serial neural tracts enable rational, logical data processing (IQ) to take place, and parallel neural networks enable associative data processing (EQ) to take place, so the 40 Hz across-the-brain oscillations provide a means to bind the experience together and place it in a frame of wider meaning (SQ).

According to Zohar & Marshall (2000:5), neither IQ nor EQ, separately or in combination, can explain the full complexity of human intelligence, the human soul and imagination: they cannot consider the question 'why?'. SQ is used to wrestle with questions of good and evil and to envision unrealised possibilities: to dream, to aspire, to raise people up out of the mud.

Teaching and learning cannot thrive on only one or two of these basic neural systems; all three are needed to complete human intelligence in its totality.

4.11 Creative facilitation of social challenges

Challenges in a changing society can be used by educators as an opportunity to make a difference in the lives of other people. Advances in science and technology, in particular the developments in genetics and fertility (see 2.6), are changing perceptions of gender roles and identity. There is evidence that there is a breakdown in traditional family structures and in patterns of parenting and childcare.

The cultural profile in Britain, for example, has widened considerably, with profound changes in the food people eat, as well as in how people speak and dress, and how individuals see themselves in relation to other countries and communities. Many young people find themselves in a complex web of interacting cultures and sub-cultures, involving families, gender, peer groups, ideological convictions, political communities, and ethnic and local traditions. In addition, their sense of identity is affected by a global culture driven by commercial interests, creative energies and information technologies.

There is a growing sense of awareness that education needs to respond to an increasing diversity of society, as well as to the interaction between world cultures.

4.11.1 Personal challenges

> All young people have different capacities, aptitudes and biographies. They have different pasts and different futures. One of the roles of education is to help them find their future and understand their pasts. This begins by helping them to discover their own strengths, passions and sensibilities (NACCCE 1999:23).

The needs of young people are not only academic, they are also social, spiritual, and emotional. To develop the unique capacities of all young people, they need an education that helps them to find meaning and to make sense of themselves and their lives, to provide them with a basis on which they can build lives that have purpose and fulfilment.

4.11.2 The problem of disaffection

According to the British NACCCE (1999) report, the Mental Health Foundation found that there are growing numbers of young people experiencing emotional problems and disturbances. This could be remedied by finding ways of enabling young people to explore and express their own emotions and feelings in a positive and constructive manner, something which falls beyond the scope of a conventional academic curriculum.

Some of the pressures and tensions young people face worldwide, and thus in South Africa as well as in Britain, can be evidenced in the rising tide of drug abuse, gang culture and street violence. A growing number cast doubt on the value of education itself. Although truancy and disaffection at schools only affect a minority, it has become a significant problem.

Disaffection that has been internalised may be manifested in truancy and disruptive behaviour, lack of motivation, unhappiness and sometimes exclusion (as a result of poor behaviour). Among young people who feel a conflict between their own cultural values and identity, and those of the schools they attend (or the areas where they live), the problems of disaffection are particularly acute. Problems of under-achievement among children from ethnic minority families have recently been confirmed in a report from the UK Office for Standards in Education (OFSTED).

4.11.3 Social culture, 'high art' and popular culture

The term 'culture' has, particularly over the past century, been used in more general terms, to mean a community's overall way of life. The social definition of culture is based on the concept of shared values: ideas, beliefs, and attitudes, which hold different social groupings together. Most people belong to a variety of cultural groups: national, local, ethnic, religious, ideological, and professional, each with its own distinctive culture. The **values** of the group are influenced by a number of factors:

- by human nature itself
- by the physical environment (including climate and geography)
- by relations/isolation with other communities
- by religious beliefs (or lack of them)
- by science and technology

- by economics
- by events/experiences (NACCCE 1999:41).

Cultural identity can be expressed and maintained in many ways, from a shared language (dialects, accents, and vocabularies) and styles of dress, to patterns and structures of social relationships. For the purposes of education, the broader **social** definition of culture can be described as: **"The shared values and patterns of behaviour that characterise different social groups and communities"** (NACCCE 1999:42).

Culture, however, is a term that can be used in many ways in different contexts, with a range of different, sometimes conflicting, meanings. Culture is usually strongly associated with the arts and humanities, often overlooking other aspects of human culture such as science and technology (NACCCE 1999:40). In more than one sense, culture has become synonymous with a general process of intellectual or social refinement, or the general field of artistic and intellectual activity through which this process of refinement was promoted. A distinction is often made between 'high art' and popular culture. In Western European terms, high art normally means opera, classical music, ballet, contemporary dance, fine art, serious literature, and certain forms of cinema.

Culture in the sense of '**high art**' can be described as the best that has been known and said, written, composed, painted, etc., sometimes referred to as 'elitist', whereas popular culture usually refers to those forms of creative practice that have mass appeal. The NACCCE report (1999:41) suggests that, because in practice there is an interaction and overlap between different cultural processes, including high art and popular culture, and the fact that many people enjoy both, cultural education should include both forms of culture. The use of creative practical engagement can provide opportunities to share different cultural influences, challenge different ways of thinking, and develop means for expression, critical thought and problem-solving skills.

4.12 The mission of whole brain education

At the start of a new millennium, the trends in teaching and learning used during the Industrial Age are inadequate to prepare a young learner with the basic attitude and thinking skills to survive in the Information Age of the 21st century. The Industrial Age view of learning and instruction was based on the assumption that human beings possess a single intelligence that is relatively fixed, and that psychologists can accurately assess through simple paper-and-pencil-style measures.

According to Gardner (1999:160), research evidence still supports certain aspects of this view, but findings from neuroscience, cognitive science, and anthropology converge to call into question most of this view. For example, the existence of a **single** intelligence, the claim that intelligence is fixed at birth, and the adequacy of standard psychometric measures, are now seriously questioned.

The change of focus from the Industrial Age to the Information Age is reflected in Table 4-7 below:

Table 4-7

Changing trends from the Industrial Age to the Information Age

(adapted from Fairbanks (1992:6)

INDUSTRIAL AGE	INFORMATION AGE
Linear thinking	Systems thinking
Trainer centred	Learner-centred
Content focus	Learner focus
Competitive	Collaborative
Uniform, standardised	Diverse, individualised
Data intense	Process intense
Information stuffing	Information accessing
Controlled, guarded	Expressive, open
Colourless	Sensory, evocative
Directive	Empowering
Sober, serious	Playful, enjoyable
Predominantly verbal	Verbal, visual, kinesthetic

To accommodate the trends of the Information Age, the mission of education should be, "to educate responsible, life-long learners to possess the skills, knowledge, creativity, sense of self-worth, and ethical values to survive and flourish in a rapidly changing, culturally diverse, global society" (Rose & Nicholl 1997:261). In devising a framework to facilitate whole brain education, they consider the following beliefs to be of intrinsic importance:

- **Every person can learn**
  - People learn at different rates and in different ways
  - Learning is a lifelong process

- **Every person wants to do a good job**
  - Self-esteem affects learning
  - Learning enhances self-esteem
  - Success 'breeds' success

- **Every person is part of a community**
  - Education and life-long learning are shared responsibilities of society
  - It is generally accepted that the community values education and community service
  - It is not possible to be all things to all people
  - Co-operative working is essential in a competitive world
  - A commitment to fundamental ethical values is necessary for the survival of democracy

- **Every person has an inherent self-worth**
  - Appreciation of individuality and diversity is essential
  - Accountability for individual decisions and actions is required

- **Educational performance can be improved**
  - Continuous improvement is desirable and possible
  - Innovation, risk-taking and adaptability are necessary for educational progress
  - A supportive environment is essential to the educational process
  - Physical and mental well-being is essential for learning
  - Education is enhanced by cultural diversity
  - A combination of creativity and knowledge is greatly valued
  - The multiple intelligences can all be developed to a high level.

4.12.1 Improving energy levels

Since the body plays a vital role in learning, the energy levels of a group of learners can be kept at an optimum by the regular introduction of exercises from Brain Gym (see Appendix A), such as "Brain buttons" or the "Elephant". To keep the brains of learners alert and receptive, they should be exposed to an abundant supply of fresh air, with opportunity for deep-breathing (oxygen) and relaxation exercises when appropriate (Lawlor & Handley 1996:12).

Learning itself is a part of a totally fulfilling life, and should play a central role from infancy to old age. The information age demands continuous learning through programmes using whole brain learning, and cultivating attitudes and practices to promote the learning process and learning potential of individuals: **"Learning is a progressive, constantly changing process that serves to enrich and expand our understanding throughout life"** (Hannaford 1995:83).

4.12.2 Interpreting brain research

According to Wolfe & Brandt (1998:8), many major universities in the USA (such as Chicago, Harvard, Massachusetts, California, and Washington) and in Germany (Hannover, Tübingen, Freiburg, and the Max Planck Institute in Leipzig), now have interdisciplinary brain research teams. Scientists, however, are wary of suggesting how their research could be used in schools, as there are no 'quick fixes'. The public is very responsive to some scientific interpretations, but often carry these ideas beyond their actual basis in science. Educators in particular are cautioned to resist using neuroscience as a means of promoting a "pet programme", because brain research does not advocate what should or should not be done in a learning environment.

It should be kept in mind that neuroscientists are concerned with providing accurate results from the experiments they conduct, but they are not concerned with the interpretation and/or application of these results. Since neuroscientific research is particularly complex, caution is advocated with respect to the interpretation of these findings. A few neuroscientific 'facts' are already fairly well established, with some validating what good educators have always done, while others necessitate a closer look at educational practice. Brain based information is **based** on scientifically proven facts, but has not necessarily been proven scientifically. Most information relevant to education falls into one of the following three categories:

- scientifically proven
- brain based
- behavioural.

Whatever the research findings may reveal, educators need to critically read and analyse the research to separate the wheat from the chaff. Without a functional understanding of the brain and its processes, educators will be "vulnerable to pseudoscientific fads, inappropriate generalizations, and dubious programs" (Wolfe & Brandt 1998:10).

The following scientific findings have been generally accepted as having relevance to the learning situation:

- The brain changes physiologically as a result of experience.
- The environment in which a brain operates determines to a large extent the functioning ability of that brain
- IQ is not fixed at birth
- Some abilities are acquired more easily during certain sensitive periods
- Learning is strongly influenced by emotion.

Research findings, in particular on early development, are in stark contrast to the current situation in most societies around the world. In the United States, the early years (which are most crucial for learning) receive the least emphasis in federal, state, and local programmes. Considering that about half of all children in the United States are in full-time day care within the first year of life, it is alarming to note that many day care centres are not only underfunded, but are staffed by untrained, low-paid workers and have a too high child/adult ratio.

A similar situation exists in South Africa. According to data in *The nationwide audit of ECD (Early Childhood Development) provisioning in South Africa* (Department of Education 2001), fewer than one sixth of the children in the 0-7 age cohort in the country are in some form of ECD provisioning. The financial base of support of the 23,482 sites that were audited, does not appear to be strong. In about half of all the sites, fees are not paid regularly, with more than a quarter of the sites reporting that they had no source of income other than fees.

Almost all (99%) the educators are women, most of whom have received their training from NGOs (Non-governmental organisations), and are thus 'unqualified' according to current Department of Education regulations (Department of Education 2001:1,2). Historical inequalities and language practices compound existing problems.

Within South Africa's own constitution, the *Bill of Rights* firmly locates children's rights as paramount. Provision has been made in the constitution for children's socio-economic rights, the right to basic education, and protection from neglect, abuse, and exploitation. However, poverty and the consequent low levels of nutrition, inadequate access to health care and education, and a lack of basic community and household resources, have undermined the development of children at all levels. As is outlined in a report by the National Children's Rights Committee (NCRC) and

NGOs, "South Africa still has a long way to go to effect quality of life for the majority of her children" (Department of Education 2001:8).

Wolfe & Brandt (1998:13) point out that the present system generally waits until children fall behind in school, and then places them in special education programmes. Money might be better spent on **early** intervention, which could reverse or prevent some adverse effects, rather than on special education services once the children have fallen behind.

In South Africa, the projected number of school leavers with 'matric exemption' for the year 2000 was approximately thirty-five percent beyond the number actually expected to pass with exemption, with the 'education system(s)' being given the blame. As they strive to focus their priorities, policy-makers and school administrators should be made aware how they, and all individuals in learning situations, stand to benefit by making use of the valuable guidance that brain research offers.

4.13 An overall view

Certain aspects concerning the interaction of inborn and environmental factors to produce specific behaviour have been examined in Chapters 2 and 3. The most important means by which the environment is able to alter behaviour in humans is learning. **Learning** is the process of acquiring information, and **memory** is the retention or storage of that information.

The study of learning considers:

- what conditions optimise learning
- how many different forms of learning there are
- the stages of memory formation
- what types of environmental relationships are learned most easily (Kandel et al 1991:997).

To construct a framework to facilitate whole brain education, it was necessary to examine:

- brain based learning
- barriers and constraints to learning
- the "dual" brain and the "triune" brain
- the sensory modes

- neuro-linguistic programming
- the mind/body link
- the theory of multiple intelligences
- the role of the spiritual intelligence
- social challenges.

On a practical level, it is particularly important that each learner discover his/her own dominance profile, and for the teacher to then organise his/her seating/grouping in the class according to their **easiest** sensory access:

- visual learners closest to the teacher
- auditory learners behind them, with **right ear dominants** seated on the left side of the room, and **left ear dominants** on the right side of the room
- *gestalt* fully limited at the back of the room with clay or wax to manipulate kinesthetically during the class (Hannaford 1997:153,154).

Short 'five minute' sessions of **brain gym activities** (Appendix A) can be introduced two or three times a day, to reduce stress levels in the classroom and to activate full sensory/hemisphere access. Hannaford reports that as learners discover their own brain profile and fully realise their unique human potential, they develop a deeper understanding of their preferential patterns and learning strengths. This new awareness can contribute to a society "where all people succeed at learning" (Hannaford 1997:154).

Although many important principles of learning have been defined by purely behavioural studies, many fundamental questions about learning require direct examination of the brain. The brain is very complicated anatomically, and the structure and interconnections of many of its parts not yet fully understood. Only recently has it been possible to combine cognitive psychology with brain imaging to visualise the regional substrates of complex behaviours, bringing with it the optimism that the principles underlying the biology of mental functions will be fully understood (Kandel et al 1991:16).

CHAPTER 5

The musical intelligence in brain based music education

5.1 Introduction

In recent years, the increasing public interest in brain research has also reached the fields of arts and music. The topic is addressed regularly in newspapers, journals and television reports, and books such as Jourdain's *Music, the brain, and ecstasy* have, according to Altenmüller et al (2000a:99) been rated among the best-sellers in Germany.

"Musicological" brain research has produced some spectacular results, and has provided information about the brain that has revolutionised the understanding of many so-called 'mysteries of the mind', or "why it is that we do what we do" (Odam 1995:vi). Not only has the broader public shown more interest in neuromusical research, but also the academic community. They have concentrated their efforts on understanding the brain mechanisms underlying music processing. The term "neuromusical research" is indicative of the new approach to music and music learning in music physiology and music psychology.

Music education world-wide has been confronted by a continued shortage of public funding, and musicians and music educators are looking to brain research to provide them with strong arguments in support of the importance of music education. New brain imaging techniques such as electroencephalography (EEG), the positron emission topography procedure (PET), and more recently, functional magnetic resonance imaging (fMRI) have made it possible to investigate "how our brains think" (Altenmüller et al 2000a:99).

Hodges (2000:17) points out that there are many questions concerning 'mysteries of music' for which music educators would like answers, such as:

- Why are human beings musical?
- How does music processing take place in the brain?
- Are there strategies to be uncovered that would allow people to learn music more efficiently?

- Is there an optimal time for learning music?
- How is it possible for cognitively impaired individuals to be musically proficient?
- Does music make people "smarter"?

One of the reasons why many music educators find it difficult to obtain recent information about music and the brain, is that neuromusical research is often published in scientific journals in language that is difficult for them to comprehend. If such information appears in the popular press it is often watered down to the extent that actual facts are distorted or obscured. It is therefore essential to provide current neuromusical information in ways that are **accurate** and **accessible** to music educators. Training music educators in music physiology and music medicine would facilitate their ability to access accurate neuromusical information.

According to Wilcox (1999:31,33), it would appear that the results of short-term exposures to music/music instruction provide considerable controversy. Results of many studies reveal that musicians generally have higher spatial test scores in adolescence and adulthood than do non-musicians, but as yet any resulting physical changes in the brain and how this could lead to improved brain function remain unknown (Shaw 2000:255). The new Brain Electric Source Analysis (BESA), which scientists are using in conjunction with Magnetic Resonance Imagery (MRI) to investigate the neurological basis of music perception, could provide much-needed information on the distribution of music-related activities in the brain (Campbell 1997:128). Solutions to some essential questions can be provided by enquiring into the biological and psychological factors that underlie actions, by learning from some basic principles which govern the way that the brain receives and processes music (Odam 1995:vi).

Brain imaging techniques are, according to Flohr et al (2000:127), already providing valuable information about music processing, such as:

- the neural responses of trained musicians (to music) are different from those of untrained listeners
- mental rehearsal activates the brain as much as real physical practice does
- fear and anxiety can be reduced by using music as a catalyst to assist the brain in effecting a physiological change of the blood chemistry
- music performance activates the motor control areas of the brain to a high degree
- the organising energy of musical rhythm is effective in helping Parkinsonian and stroke patients regain control of their movements.

Until more such information is available, it is encouraging for music educators to take cognisance of certain clues that are emerging about what music can bring to young people. For example, "music participants on average receive more academic honours and higher grades than do students in the general school population" (Wilcox 1999:33).

The *acoustic* nerve is the first nerve to be myelinated (at about five months in utero), suggesting **a primacy of hearing** among the senses (Madaule 1998:36). **"The musical brain operates at birth and persists throughout life"** (Hodges 2000:19).

5.2 Development of the musical intelligence

It should be remembered that music is not limited to its aesthetic functions: it permeates all spheres of education and constitutes an intrinsic part of whole brain education. Music **education** focuses on the development of the musical intelligence, and is described by Elliott (1995:12-13) as having at least four different meanings:

- **education *in* music**: the teaching and learning of music and music listening (music appreciation) (see 5.3)
- **education *about* music**: the teaching and learning of propositional knowledge about music (see 5.4)
- **education *for* music**: the teaching and learning of procedural knowledge for making music (performer, composer, teacher, etc.) (see 5.5)
- **education *by means of* music**: involving the teaching and learning of music, with the focus on direct goals such as:
    - brain development
    - accelerated learning, as a specific facet of whole brain development
    - improvement of health and spiritual well-being (see 5.6).

For many music educators the development of 'musical intelligence' remains ill-defined, usually confined to one (or more) of Elliott's first three 'meanings' of music education. By implementing **all four** meanings of music education to develop the musical intelligence, an important dimension can be added to that of existing music education: 'brain based' music education. The nine aspects of recent brain research that impact on teaching and learning (see 4.1.2) are also relevant to music education.

The first three of the four meanings attached to music education by Elliott require a music educator to have achieved a certain level of musical training and experience. Education **by means of music** requires that certain musical activities be incorporated into lessons to facilitate the learning of other academic content, and does not necessarily require any specific musical training. In this way, it is possible to foster a positive attitude towards music and to recognise its relationship to other kinds of learning, with the additional benefit of stimulating the development of the musical intelligence (Campbell et al 1996:136).

Altenmüller et al (2000a:105) clarify the meaning of an "intelligence" by referring to Gardner's Theory of Multiple Intelligences (see 4.9), which includes eight autonomous intelligences. The linguistic, mathematical, and spatial intelligences form parts of the usual IQ testing procedures. The intrapersonal intelligence describes the ability to be aware of what is going on in an individual's own mind, and the interpersonal intelligence an awareness of what is going on in another individual's mind. The environmental intelligence describes an individual's relationship with nature; the musical intelligence describes how an individual responds to music/sound; the bodily kinesthetic intelligence is associated with bodily movement.

Concerning the effects of music education on the other seven domains of 'intelligence', certain data supports the notion that there is a 'transfer' effect from one intelligence to another. In **tonal** languages such as Chinese, many East Asian, and African languages, melodic contour is used for semantic cueing, leading to improved verbal memory. It is possible that trained melodic memory in musicians could have a similar effect (Altenmüller et al 2000a:105).

The link between music and mathematics was expressed in the teachings of Pythagoras and his followers (in approximately the sixth century BC). The popular belief that mathematical abilities are closely linked to musical abilities features high on the agenda of neuromusical research, in particular that of the M.I.N.D. Institute in California (Shaw 2000:11-34). Although there are no scientific research results available to substantiate the 'link' at present, Shaw (2000:255) presents some experimental results that provide a strong indication that in the future, music will be recognised as a "window into higher brain function". The following 'over-lapping' abilities can be considered with respect to the musical intelligence:

- Counting rhythms or organising 'fingering' for musical performance, require basic mathematical operations.

- In most situations, playing an instrument requires control over body movements in three-dimensional space. It could be argued that instrumental playing is necessarily linked to a training of spatial abilities with respect to "self-referential coordinates" (Altenmüller et al 2000a:105).
- An important feature of musical ability is that it appears to have a strong genetic component (Kandel et al 1991:821,995).
- Psychologist Galley (Interview 2001) indicated that "intelligence" cannot be **increased**. Rushton (2000:65,71) presents evidence for a strong genetic basis for intelligence that suggests support for the above view. Altenmüller et al (2000a:105) consider the fact that "musical intelligence is improved by music education" to be "trivial". The implications of these views are that musical intelligence cannot be **increased** by music education, but that existing musical intelligence may be developed by music education.
- The transfer to other movement patterns of sensorimotor skills acquired during instrumental practice, has recently been demonstrated (Altenmüller et al 2000a:105).
- Although no transfer studies are available with respect to the personal intelligences, it seems plausible that music education may improve insight into the *self*: when playing an instrument, the player must know how to express his/her feelings. For example, in a chamber music 'scenario' musicians need to develop their interpersonal intelligence: to communicate their feelings they have to listen to each other and resonate emotionally (ibid).
- Although scientifically based evidence is rare, Altenmüller et al (2000a:105) claim that music education and active instrumental playing are intrinsically linked to multiple, highly demanding cognitive procedures.

This could be an indication that music education and instrumental playing may indeed influence, and even improve, many of the cognitive domains that constitute human "intelligence".

5.2.1 Real musical experience

> Somehow the very act of teaching can seem to push real musical experience into the background. Too often the symbols we use appear to get in the way of the sounds they represent; sometimes they replace them altogether. Real musical experience engages both cognitive perception and feeling response, and involves the participant at a deep personal level. It happens when the conditions are right and cannot be totally assured by planning. Its first condition is that music must be heard; the second is that those involved in making or listening to it, or both, must be willing to be captured by the experience. They do not come to it. It comes to them. Real musical experience involves us fully in thinking and feeling and is, in effect, a form of spiritual experience (Odam 1995:v).

In most other cultures where the education of their musicians is based on aural tradition, aural memory is of prime importance and is developed through imitation and the development of technique: there is no particular difference between the roles of performer and composer. In this way **real** musical experience becomes the central focus: the musician is involved in **thinking** and **feeling** and in effect, the musical experience becomes a form of **spiritual experience** (the involvement of all three neural systems: IQ, EQ and SQ as discussed in 3.3).

Western European approaches to music education lack emphasis on **real** musical experience, and rely on the 'written word' or notation to the extent that the development of a sensitive aural perception is often neglected. This system treats music as 'a language' and somehow encourages pupils to separate the two areas of listening and performing as discrete disciplines, which indicates that music taught in this way lacks essential musicality. Since musical stimulus usually starts in the right brain by eliciting a reaction of 'feeling', it is advisable that music educators make certain that the **right brain functions are given preferential treatment** so that the sound (right brain) precedes the symbol (left brain) (Odam 1995:3,29,30).

Furthermore, the **cognitive** can be considered mainly a left-brain function: it is dominant in present-day society since it promotes verbal reasoning, computation, and logic. The **affective** can be considered a right-brain attribute: it promotes intuition and feeling response, reacts to visual and aural stimulus, processes overall shapes and contour, is subjective and holistic and understands metaphor. **Psychomotor** plays an important role: movement is of fundamental importance in the learning process, making use of repetition.

The teaching of an art should begin in those areas of understanding not reached by other subjects, with the aim of achieving synthesis of right and left-brain procedures through the mediation of physical action (cross-lateral movement). This synthesis is paramount, and often referred to as 'holistic'. "The starting-point and the true end of music education must always be the development of the ear" (Odam 1995:3,30).

5.2.2 Neuromusical research

Altenmüller et al (2000a:103) describe making music as one of the most complex human achievements. It makes simultaneous demands on human hearing, motor control, body-awareness, and those parts of the brain involved with processing emotions.

During the past 'decade of the brain', research into the neurological foundations of music learning and musical performance has developed quite dramatically. The new brain imaging techniques have made it possible to monitor how the brain learns and thinks. "Neuromusical research" introduces a new approach to music and music learning, with an ever-increasing interest in understanding the effects of music learning on brain activation patterns and brain networks (Altenmüller et al 2000b:47).

It has been illustrated that neuronal processing networks are distributed over **both** brain hemispheres to varying degrees. Listening to a melody in an interval-based manner makes use of an analytical cognitive strategy, and is processed mainly in the left auditory/temporal areas of the brain. Listening to a melody in a contour-based manner makes use of a holistic way of thinking, and is processed mainly in the right auditory/temporal areas.

In general, time structures are processed to a greater extent in the left temporal lobe, whereas pitch structures may be processed primarily in the right temporal lobe networks (Altenmüller 2001b:2).

With respect to temporal structures, two levels of organisation may be identified**: rhythm** and **metre**.

- **Rhythm** is defined as the serial relation of durations between acoustical events in a train of sounds. Rhythm could be said to represent a serial durational pattern.

- **Metre** involves a temporal invariance in terms of the regular recurrence of pulses or beats marking off equal durational units that can be organised as measures. Metre can therefore be said to represent a more acoustical "gestalt", since its perception and production require information on sound intensity of accented and unaccented events, as well as on the periodicity of rhythmical events (Altenmüller 2001b:3).

Of particular interest, is that musicians and non-musicians process musical information differently. During a melodic pitch discrimination test done in 1989, Altenmüller found that non-musicians are restricted to a sort of 'feeling' about the melodic contour and activate primarily the right temporal lobe. Musicians, however, tend to make use of analytical cognitive strategies and additionally activate the left temporal and frontal lobe.

5.2.3 Music centres in the brain

According to Altenmüller's personal bibliography which he gave this author in the personal interview conducted with him, he and his colleagues in their laboratory at the Institute for Music physiology and Performing Arts Medicine at the Hochschule für Musik und Theater, Hannover, have performed many studies to investigate the impact of music education on brain activation patterns.

The results of these studies demonstrate that **musical expertise influences auditory brain activation patterns**, and that changes in these activation patterns **depend on the applied teaching strategies** (or different ways of music learning) such as music, verbal explanations, visual aids, notations and verbal rules. One of the questions addressed in the research is how brain networks adapt and change due to music training. They found that among the factors influencing brain activity during music learning, there were two important factors:

- the individual's instrumental training
- the instructor's teaching strategy.

Figure 5-1 below represents a tentative, simplified model by Altenmüller, to illustrate **the interdependency between the increasing complexity of neuronal networks involved in music processing (*y*-axis) and the increasing complexity of auditory information processing (*x*-axis)**. An additional dimension accounting for the effects of acculturation, can be added on the *z*-axis.

The complexity of neuronal networks increases with the complexity of processing demands. Training and practice add additional mental representations of music that are processed in different brain substrates. Professionals presumably have developed and use larger, more complex neuronal networks during music processing than do non-professionals.

The vertical axis of the small cross "*P*" (plasticity) represents a reciprocal replacement of brain functions by other brain structures. The horizontal axis indicates that listeners may add or reduce the complexity of auditory processing, by adapting their listening strategies.

The larger cross on the right of the diagram symbolises Learning Biography (*LB*) and auditory strategies. *A*1 stands for primary auditory cortex; *A*2 stands for secondary auditory cortex; *audit.assoc.a.* stands for auditory association cortices (Altenmüller 2001b:6,7).

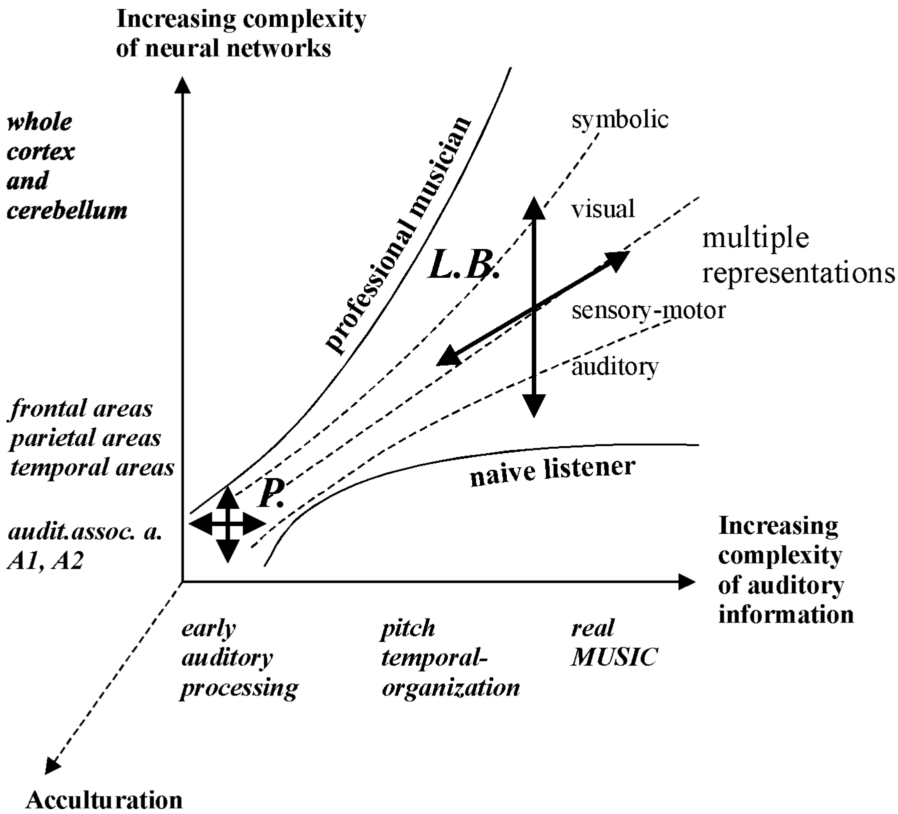


Figure 5-1

Music centres in the brain

(Altenmüller 2001b:7)

The researchers propose that neuronal networks related to the processing of musical information reflect the individual's 'auditory biography' (personal experiences during auditory learning), and conclude that in "high order" musical processing, "many and individually connected brain areas underlie music perception" (Altenmüller et al 2000a:99,101).

Hannaford (1995:79) maintains that both hemispheres contain all functions until specialisation starts to occur. The gestalt hemisphere tends to exhibit a growth spurt of dendrites between the ages of four and seven, and the logic hemisphere between seven and nine years, with complete hemispheric specialisation in place between the ages of nine and twelve.

> Neuro-musical research supports the notion that music is a unique mode of knowing. The literature clearly supports the notion that music is dissociated from linguistic or other types of cognitive processes. Therefore, it provides a unique means of processing and understanding a particular kind of non-verbal information … musical insights into the human condition are uniquely powerful experiences that cannot be replaced by any other form of experience (Hodges 2000:21).

Based on available research information, it is therefore plausible that the **increased neural activity** resulting from musical processing **improves cognitive abilities in general**. This indicates that the musical intelligence appears to play a vital role in whole brain education, making it advantageous to develop it for its role as an autonomous intelligence, **as well as** for its role in the development of the 'whole brain'.

5.2.4 The energising/de-energising effects of sound

The French physician, psychologist and educator, Alfred Tomatis, describes "energy through sound" as an "inexhaustible source of power and joy in life" (Tomatis 1991:224). According to Tomatis (1991:186), the **ear** can be considered "a transmitter of energy", and provides ninety percent of the electrical charge or energy to activate the cortex. **The ear is not only made for hearing, but is designed to energise the brain and the body.** This is effected by means of:

- the vestibular apparatus (which organises and controls equilibrium and verticality)
- the cochlea (which functions as a sound detector).

The view that low sounds move over the body without providing it with any dynamic charge, and high frequency sounds activate the cortex enabling it to think, is supported by James (2001), and has a number of practical applications such as cymatic/vibro-acoustic therapy (see 5.8.2). A brain that is rich in "neuronic potential" is more likely to use its cognitive functions, making it particularly important to 'care' for and develop the brain.

Through the brainstem (medulla), the auditory nerve connects with all the muscles of the body, having an influence on muscle tone, equilibrium and flexibility. The vestibular function of the ear influences the eye muscles, affecting vision and facial movements, as well as influencing chewing and taste. Through the *vagus* nerve, the inner ear connects with the larynx, heart, lungs, stomach, liver, bladder, kidneys, and small and large intestines. The effect of the ear's vestibular function on the body suggests that "auditory vibrations from the eardrum interact with the parasympathetic nerves to regulate, control, and 'sculpt' all the major organs of the body" (Campbell 1997:53).

The role of the ear in the development of the **human vertical posture** is of particular importance. Sitting or standing upright (with head, neck and spine erect) allows a human to have maximum control over the listening process and stimulate the brain to full consciousness. In this way, the entire body can be compared to a receptive antenna vibrating in unison with the sound source. Other aspects of posture, such as right/left orientation, can have a dramatic effect on listening.

Tomatis (1991:206) explains that the listening function does not only affect the ear, but mobilises the entire nervous system by means of the vestibular apparatus. The vestibular apparatus, in turn, controls everything in connection with posture and gesture. He is convinced that research aimed at a **revitalisation** of the 'whole self' by means of the cochlear-vestibular apparatus, must be pursued further.

5.2.5 The importance of an integrated cochlear-vestibular system

According to Madaule (1998:35), the evolution of the vestibular system was necessary for primates to acquire a vertical posture, which Tomatis (1996:170) claims is unique only to humans. The vestibular system contributes to establishing an individual's 'body image' by creating an awareness of the body's movement in three-dimensional space and enabling the person to deal with gravity. Sometimes referred to as 'pre-language', it provides the non-verbal dimension of listening. This 'body-listening' is sometimes found to be weak or missing in children with developmental disorders or autism.

With the emergence of sound, the need for a system dealing with sound perception was required, and it would appear that the cochlear system evolved from the vestibular system to fulfil this requirement. Humans may perceive sound and movement as distinct experiences, but if the influence of music on human development is to be understood, it is necessary to understand it in the context of a functionally integrated cochlear-vestibular system.

Music can be considered a combination of rhythm and melody. The **rhythmic** dimension of music induces and conveys movement that stimulates the function of the **vestibular** system. **Melody**, on the other hand, can be associated with the **cochlear** system. The discovery of possible sound combinations, tonal differentiations, and blends of human voices can start during the pre-natal period and extend throughout the years of speech and language development. Madaule points out that to develop a clear, accurate perception of the acoustic content of words, music can be used effectively to train and prepare the ear. Language difficulties that involve writing can be associated with poor listening skills.

Tomatis (1996:56) refers to the possibility that "the fetus already participates in the sonic activity of the world it strives to enter". He claims that a fetus 'listens': a high level ability that expands into consciousness (Tomatis 1991:208). Madaule (1998:36) further indicates that "The acoustic nerve which transmits both the vestibular and cochlear neural input to the brain, is fully myelinized at five months in-utero, meaning that the fetus brain begins to receive information from its ear". The primacy of the hearing function can be supported by the fact that the acoustic nerve is the first to myelinize. A child's motor and linguistic development can be facilitated and enhanced by pre-natal, cochlear-vestibular stimulation such as the singing, talking, and/or rhythmical rocking movements of the mother.

Music can be used for a variety of **musical** and **non-musical** purposes:

- music is neither **all** rhythm nor **all** melody, but a combination of both. It stimulates the vestibular and cochlear systems separately, as well as in an integrated manner (movement and singing contribute to cochlear-vestibular integration)
- music with a predominance of melody and little or no rhythm ('cochlear music') is effective for meditation and spiritual 'matters'
- music with a predominance of rhythm and little or no pitch differentiation ('vestibular music', music with a heavy beat, such as rap or rock) is music that stimulates the **body** primarily through the vestibular system
- music offers a unique space-time dimension, insofar as people claim to gain a new perspective of the 'future' and the 'present' after a (music) listening training programme (Madaule 1998:39)
- music with the emphasis on melody stimulates the cortex via the cochlea, and can aid in organising and clarifying the mind/flow of thought
- musical sounds energise the brain (the richer the music in high harmonics, the more energy it provides).

Madaule (1998:41) maintains that music educators have a significant role to play in developing children's listening ability throughout their years of language acquisition, a view strongly supported in this study.

5.2.6 The properties and impact of sound

To understand the impact of **sound** on the brain, it is necessary to examine the properties of sound:

- ***Frequency*** (referring to **pitch**)

  Sound, in particular high frequency sound (3,000 to 8,000 Hertz) provides the necessary 'energy' charge from outside.

- **High frequency sound** energises the brain, affecting cognitive functions such as thinking, spatial perception, and memory, while simultaneously releasing muscle tension, balancing the body and affecting body posture (Ostrander et al 1994:92,93).
- **Middle frequencies** (750 to 3,000 Hertz) tend to affect the heart and lungs, as well as influence the emotions.
- **Low frequencies** (125 to 750 Hertz) affect physical movement and concentration by making an individual feel 'groggy' (Campbell 1997:32), or according to Tomatis (1991:209,222), introduce somnolent or even hypnotic effects. If the frequency content of sonic messages favours low-pitched, fatiguing sounds, a listener can enter a state of inertia that often precedes a depressive syndrome.

- ***Intensity*** (referring to **loudness**)

  Sound intensity is measured in decibels, with a normal conversation measuring about 60 decibels and loud rock music about 110 decibels. The decibel scale is logarithmic, with an increase of ten decibels indicating an increase in sound intensity of ten times the previous number. For example, loud music at 110 decibels is 100,000 times louder than a normal conversation at 60 decibels. According to Campbell (1997:33), pain begins at 125 decibels.

- ***Timbre*** (referring to the **quality** of a sound, regardless of pitch or intensity)

  A major characteristic of sound that distinguishes it from other sounds, is its timbre. There is no scientific scale to measure timbre (even though it is primarily a function of wave form), and thus it is often described in terms of adjectives normally used in other fields, such as "clear", "warm", "soulful", "rich", "vibrant", etc.

- ***Pulse* and *pace*** (referring to **beat** and **tempo**)

  " . . . the pulse of music subtly defines the boundaries of our physical, mental, and social environments, influencing how strongly, harmoniously, and fluidly life moves within and around us" (Campbell 1997:81). The pace of sound, fast or slow, can determine whether an individual will experience feeling healthy, rushed, relaxed, in control, or 'lost'. Music without an organised beat may create a feeling of temporary invigoration, but could after a time, lead to a feeling of irritation or annoyance.

  It follows that when music is selected for specific therapeutic purposes, the pulse and pace of the music plays a crucial role.

5.2.7 The "Mozart Effect"

Sounds from 5,000 to 8,000 Hertz have been found to **energise** the brain most rapidly, with the fastest 're-charge' coming from 8,000 Hertz. Tomatis (1991:186) found that low sounds pass over the body without providing it with any dynamic charge, whereas the high frequency sounds (as found in Mozart's violin concertos) activate the cortex, enhancing the human's ability to think (see 6.6).

According to Flohr et al (2000:129), the term "Mozart effect" has become a 'catchphrase', with the publicity surrounding this so-called phenomenon having become both beneficial and injurious to music education. The much-discussed "Mozart effect" refers specifically to a study by Gordon Shaw in 1993. The study demonstrated improvement on a single spatial reasoning task as exhibited by college students after ten minutes of listening to Mozart's Sonata for two pianos K448, the conclusions of which were re-tested in a 1995 study providing similar results. The results were, however, interpreted as having a different cause, and several subsequent attempts by other researchers to replicate the Mozart effect under similar conditions have failed (Demorest & Morrison 2000:34).

The publicity the phenomenon has been given has sparked the interest of **people seeking alternative healing methods that are easy-to-follow, safe, effective, inexpensive, and preferably self-administered** (see 3.3.3). Parents motivated to buy Mozart CD's for their children will certainly not harm them with the music, and possibly provide them with a certain degree of cultural enrichment (of the Western music culture). In this case the information made available to the public by the popular press was based on inconclusive/insufficient research. **It is unacceptable**, even harmful, **to view the results of the studies as a rationale for music education**, or even as a curriculum guide (Demorest & Morrison 2000:34).

Reimer (1999:38-42) contends that the argument supporting spatial-temporal reasoning development as the point and purpose of music teaching in schools, places music educators in the position of having to justify music on this new basis. He contends that the spatial temporal argument for the value of music study is perhaps the most extreme that the music profession has ever faced, and has the imminent potential to force music education over the line that separates its devotion to musical learning and replaces it with associative learning.

Campbell (1997:11), on the other hand, views the "Mozart effect" as tapping the power of music to heal the body, strengthen the mind, and unlock the creative spirit, and discusses it in the context of an 'alternative healing method'. The use of **sound** as a healing medium is discussed in more detail in 5.8.

As in this study, if music education were to focus on the development of the musical intelligence **including all four meanings of music education**, Reimer's contention would not be an issue. Associative learning as well as the use of music for therapeutical and other purposes would then be **included** in musical learning, instead of limiting it to the devotion of an exclusive, aesthetic meaning of music education.

5.2.8 The neurobiological relationship between music, intelligence, and learning

The controversy concerning the "Mozart effect" detracts from the valuable research done by Dr. Gordon Shaw (the 'discoverer' of the Mozart effect) and his colleagues at the Music Intelligence Neural Development Institute (also referred to as the M.I.N.D. Institute or MI), formed in 1997. Shaw (2000:xix) claims that the scientists at this Institute are at the very beginning of their explorations into the relationship between music, intelligence, and learning, using **music** as a window into 'higher brain function'. The focus of the research is not about music, but about:

- how music can facilitate an understanding of the neural machinery of higher brain function
- how music can enhance the way people think, reason, and create (spatial-temporal reasoning).

At the core of the research is "the structured **trion model** of higher brain function that makes clear predictions about the relationship of music and the neural machinery of mammalian cortex" (M.I.N.D. Institute 2001). The trion model patterns 'explain' how one part of the brain communicates with the other parts (Shaw 2000:127).

According to Shaw (2000:15), it is often stated that there are many mathematicians who claim to be proficient musicians, but only relatively few musicians who claim to be proficient at mathematics. He suggests that the musicians are probably lacking in proficiency in 'language-analytic mathematical reasoning', rather than in 'spatial-temporal mathematical reasoning'.

A successful pre-school study, published in 1997, that involved three-year-old children receiving six months of piano keyboard training, produced an improvement in spatial-temporal reasoning that was thirty percent higher than in the control groups. The enhancement lasted for several days, long enough to indicate major educational implications. On the strength of these results, Shaw (2000:22) urges that "music education be given in our schools, starting preferably in pre-school", in order to develop the necessary 'hardware' in the child's brain required for spatial temporal reasoning.

There are strong indications that "a newborn (infant) does not emerge with her or his cortex being a blank slate, ready to mold" (Shaw 2000:255), but with a brain that is sophisticated, with far greater spatial-temporal abilities than have previously been understood. Xaiodan Leng and Shaw have predicted that early music training (as early as age three) may enhance a child's overall mental ability. The reason why children respond to music by composers such as Bach and Mozart is assumed to be that humans are born with certain brain cells that respond to musical sounds. "These neurons fire in patterns that can be expanded as a sort of 'pre-language' to perform evermore complex interactions – even before the brain has developed verbal language skills . . . So, music training amounts to exercising not muscles, but brain cells" (Shaw 2000:169,170).

There are many indications that music might enhance child brain development, but neuroscientific evidence to substantiate the claim is still inconclusive.

5.2.9 Basic premises of neuromusical research

Odam (1995:18) suggests that it would be foolish to disregard recent scientific research findings on the basis that they are incomplete, as they point to the fact that there is a resonance between the problems of integrating sounds and their musical symbols, and between brain laterality and whole brain thinking. While many neurological findings do not have direct applications to the daily practice of music education, collectively they can make a large contribution to the profession. Certain basic premises can be made on the basis of recent neuromusical research:

- **The human brain is able to respond to and participate in music**
  One of the hallmarks of human beings is the capacity of **all** individuals to respond to and participate in the music of their environment. Music education should therefore not be reserved for the 'talented' few, for those who can afford it, or for those whose caregivers consider it important.

- **The musical brain functions at birth and remains operative throughout life**
  At one end of the life spectrum, the six-month old fetus is capable of responding to music, suggesting the existence of neural mechanisms specifically suited to processing musical

information. At the other end of the spectrum, certain projects have revealed that forms of cognitive dementia can be avoided by increased learning in childhood (Hodges 2000:19).

More specifically, the newborn baby has the ability to hear sound as low as 16 cycles/second and as high as over 20,000 cycles/second. As humans age, their ability to hear becomes impaired, sometimes from ear infections, but mostly from noise pollution, with resulting physical fatigue due to their inability to hear the higher pitched sounds which could re-energise them (Ostrander et al. 1994:93). Wilcox (1999:34) claims that musical involvement can help adults remain "more alert at any age, including the later years".

The ear provides ninety percent of the energy required to activate the cortex, with the cochlea of the ear functioning as a sound detector and the vestibular apparatus organising and controlling equilibrium and verticality. Because of these special features of the human brain and the muscular system to which it is bonded, music education can make a unique contribution to enhancing mental ability. The complex relationships between the left brain, the right brain, and the psychomotor must concern music educators as much, if not more, than most other educators. Hodges (2000:19) further considers that knowledge of bi-lateral brain function can greatly enhance effective teaching.

- **Early and ongoing musical training affects the organisation of the musical brain**
  It is not yet certain that music education necessarily improves an individual's performance in other forms of cognition. There are, however, indications that those who study music, particularly at an early age (presumably developing an 'awareness' of musical sound and a certain proficiency/skill at making music), show neurological differences compared to those who have not received any musical training. The effects of increased neuronal activity in those who started playing an instrument at an early age has implications for music education, but Hodges (2000:19) cautions that it is probable that **anything** that is done in early childhood has an effect on brain organisation.

- **The musical brain consists of extensive neural systems involving widely distributed, but locally specialised, regions of the brain**
  Neuromusical research shows that music is not limited to the right hemisphere of the brain, but can more accurately be thought of as being processed in widely diffuse areas of the brain. Music experiences are multi-modal, involving the auditory, visual, cognitive, affective,

memory, and motor systems simultaneously, all of which are likely to be handled by different neural mechanisms.

- **The brain is highly resilient**
  People who are blind, deaf, emotionally disturbed, profoundly retarded, or affected by conditions such as Alzheimer's disease or savant syndrome, are all able to have meaningful musical experience, irrespective of the degree of disability or illness (Hodges 2000:21).

5.2.10 Special features of brain function affecting musical behaviour

Positron Emission Tomography (PET) has allowed researchers to study brain action as it takes place. They have found that when the brain is stimulated by music, the right side is highly active and the left side remains active, but at a lower level. The use of topographical brain mapping, made possible by the combination of computers and brain research, has shown that the brains of those listening to music involve the right and left hemispheres differently, according to the type of stimulus. **The right is stimulated by *concordant* sound**s, whereas **the left is stimulated by *discordant* sounds**. This indicates that our appreciation of octaves, fourths, and fifths is linked with the understanding of overall rhythmic procedures and tonal centres, and associates itself with our intuitive, spiritual thinking processes. Sevenths and seconds are associated with logic and formal, arhythmic, objective and rational thinking (Odam 1995:18).

This new information has implications that cannot easily be ignored:

- From the earliest Western musical history, the unison, fourth, fifth, and octave have been described as being spiritual in effect
- Over the last seven hundred years, the development of discord as well as the evolution of notation in Western Europe suggest an increasingly left-brain function in the creation of music
- The opposition of the intuitive musical response of the right brain and the linear cognition of the left brain reflect why many musicians experience some opposition between the use of aural memory and notation
- It also suggests that different styles of music will engage a more right or left-brain approach from the composer as well as the listener
- Where right-brain function is accentuated through the use of specific tonality, **concord** and intuitive processes, strong emotional reactions can be created in the listeners

- Conversely, if the music is founded on **dissonance**, with arhythmic and atonal properties, it will engage the listener at an objective and intellectual level (Odam 1995:15,16).

Although the above interpretation of certain research data may not illustrate all the complexities involved, it could be considered an acceptable explanation for the purposes of music education. It should be noted, however, that in a study by Schuppert et al (1997:31) to assess deficits in musical perception of patients with brain lesions, their preliminary findings contradict a strong hemisphere specificity, and suggest that highly individual neural substrates underlie music processing.

According to Altenmüller et al (2000a:99), the cerebral cortex can be functionally separated into **sensory**, **motor**, and **association** areas, with a further distinction between primary, secondary and tertiary areas in each of these. Their research indicates that the primary auditory cortex processes mainly the fundamental elements of music (tones and loudness), with the secondary auditory cortex identifying harmonic, melodic, or rhythmic patterns.

With respect to the hemispheric **lateralisation** of musical functions, it must be kept in mind that although the two hemispheres of the brain are **specialised for specific brain functions**, both hemispheres **interact very closely** via the *corpus callosum* (see 2.3.2 and 3.5.1), with the information exchange between the two hemispheres taking place in as short a time as ten milliseconds. Since humans are able to switch from one mode of cognition to another (analytical/global), a **static** concept of hemispheric lateralisation is not appropriate. According to individually acquired cognitive strategies and actual demands, neuronal networks processing the respective music stimuli must be distributed over **both** hemispheres (Altenmüller et al 2000a:100).

5.2.11 The concept of neuronal plasticity in musical learning

The wiring of the brain is exposed to a continuous re-organisation process: the permanent re-organisation process is referred to as "neuronal plasticity", which can be considered as forming **the basis of musical learning**. Sensory information of new experiences is processed in the cerebral cortex, some of which is selected and stored as a new mental representation. One of the most important functions of the cerebral cortex is its ability to accumulate knowledge throughout life in a vast memory system that provides the basis for the human learning ability.

In an experiment to compare hemispheric lateralisations during music processing in non-musicians, amateurs, and professional musicians, it was found that:

- The majority of non-musicians activate primarily the **right** hemisphere
- Musicians to a greater extent activate neuronal networks located in the **left** temporal and frontal lobes.

These differences can be ascribed to the different cognitive strategies that are used. For example, musicians tend to analyse melodies in an interval-based manner. However, besides cognitive strategies and expertise, emotions accompanying music listening also influence brain activation patterns. Humans are well able **to learn to choose** whether they wish to process the information analytically or globally. This further illustrates the importance of understanding the essentials of 'how-the-brain-works' to be able to use it to good advantage.

5.3 Education in music: promoting music listening

Cultures where music performs a functional role accept 'music-listening' as an integral part of music-making. Unlike Western cultures, the 'art of listening' (music appreciation) is not treated as a separate entity. In this study the main focus of "promoting music listening" is on Western music, but it is not exclusive of other musics.

Musical "meaning" and "understanding" are essentially sound-based. Listening to music is a whole brain task involving involuntary physical activity (such as foot-tapping or movement of the vocal folds), which may or may not be perceptible, and changes in pulse according to the stimulus provided by the music. "Listening to music can be a profound and beneficial experience, inherent in us but much enhanced by learning" (Odam 1995:83-85): it is possible to develop high-level skills through attentive listening.

5.3.1 Emotions during listening

Certain neuro-biological mechanisms underlie the processing of emotions during music listening. From lesion studies, Schürmann et al (1997) postulated that positive emotions are processed primarily in the left hemisphere, negative emotions in the right. Negative emotions were elicited by more dissonant sounding pieces of music, whereas positive emotions were attributed to compositions in the softer pop, baroque, or classical style.

"The conception of pleasure as satisfaction of anticipations accounts for the pleasures of the mind, such as we find in music . . . " (Jourdain 1997:324). This implies that familiarity with the music contributes to listening pleasure. Enough repetition of listening material is therefore required to familiarise the listener with the music.

Odam (1995:92) explains that enjoyment of music depends to a large extent on "the ability of the memory to hold information and to recognize patterns and sounds which have been heard before". In addition to this, it requires a high level of expectation to be raised and gratified. The simpler the musical patterns, the easier they are to understand, and the more instant the gratification. "Popular" music (not only 'pop' music, but also all those pieces that remain firm listening favourites) depends on instant gratification for popularity. However, if the music has a high level prediction of success, the gratification is short-lived and the listener tends to 'reject' the experience. To prevent musical stimulus from becoming aesthetically 'stale', the brain requires something more complex to memorise and predict, other than simple, easily understood/ assimilated and memorised patterns (ibid).

5.3.2 Listening skills

A **good** sound source is vital to the foundations of good music listening skills. Many teachers give very little regard to the quality of sound reproduction, often making use of a small audio-cassette tape deck that the children themselves are allowed to use with audio-phones. With a small loudspeaker, the range of sounds available is limited and entirely deficient in some vital areas.

In a concert situation where the common stimulus is strong, "finger-tip temperature measurements in listening show clearly that when the music is judged to have a high emotional content then there is a consequent involuntary temperature change in all the audience", suggesting that collective listening can be socially beneficial (Odam 1995:85). With the invention of the radio, gramophone, tape recorder, CD player and hi-fi stereo, the nature of the 'concert' listening experience has been changed. The accent is moving to individual listening, which is also a pleasurable experience. Individual listening has a "specific and positive physical effect on us", with the car becoming one of the main concert arenas. Here the listener can select music specifically suited to his/her 'therapeutical' requirements (ibid).

5.3.3 Listening and movement

The relevance of the special cochlear/vestibular features of the human brain and the muscular system to which it is bonded, are of particular importance in developing the musical intelligence. Wilson (1985:42) maintains that the mind does not grow without bodily movement. Because humans are primates and walk upright, their upper limbs are not required to support their body weight against gravity, making it possible for the extraordinary refinement of the movement of the upper limbs, as well as exceptional control over the muscles of the face and oral cavity. This unique control of the upper limbs and vocal apparatus provides a strong urge for humans to communicate.

The process of making music involves the full exercise of these innate and special human capabilities by providing an exacting and progressive blend of scientific, artistic and physical disciplines which can be developed and enjoyed from an early age and have long-range value. **The value of a disciplined study of the arts is in the power it provides individuals over their own intellectual, emotional, and physical lives**.

"Formal collective dancing enhances listening to music and maximizes the beneficial physical effect of music on the recipients" (Odam 1995:86). The sound of strong rhythmic beating is linked to collective and social physical action such as dancing, which has the effect of dispersing aggression. In a society where formal warfare is seldom encountered, it has become necessary to provide 'outlets' for aggressive behaviour. The more sedentary and inactive the youth become, the more they experience the need to work off the aggression by dancing.

The collective nature of modern disco dancing enacts the problems experienced in living in an increasingly dense world population as members of a society that is becoming increasingly individualistic as it becomes more crowded. Modern disco dancing is undoubtedly 'collective', but the action for any one participant is entirely individual. Experience has shown that where young people are exposed to collective 'traditional' dancing, they are actually prepared to talk to one another: they start communicating and become less self-absorbed (ibid).

5.4 Education about music: turning symbols into sounds

Making musical symbols sound clearly in the memory so that they can be converted to the appropriate live sound when required, would appear to be the central task of effective music education. This implies stimulating opposing areas of the brain concerned with thinking and feeling, and integrating them to form a new 'whole': **making musical symbols sound**. Thinking in sound, imagining sound, constructing sounds in the head and improvising music should all be established skills before the appropriate symbols are learnt (Odam 1995:3,4).

Relying on the written/notated form, fundamentally affects our willingness to trust in and develop our aural memory. The notion that music actually is a language is, according to Odam (1995:1), a metaphor commonly subscribed to. However, **the more music is treated as a language, the more important the written notation or verbal descriptions of sound become in the study of music**, with the possibility that actual sound will be treated as an optional extra.

For quality music education, **real** music experiences must synthesise the cognitive and affective responses. If the focus of the learning is not in the sound, but rather on learning the words of a song, writing or drawing, or on technical matters of instrumental performance, then the real musical experience has been bypassed. Teachers lacking good music education in their own formative years experience problems in the perception of music and in the identification and understanding of its procedures (Odam 1995:7,8). This is often reflected by an increased response from learners to trained music educators.

5.4.1 An important perspective of notation

The symbol systems such as staff notation, chord notation, tablature, and sol-fa of the Western musical tradition are helpful teaching and learning devices that have a profound effect on the development and aspirations of music and musicians. When they are appropriate to learning, children need to experience these systems, but Odam (1995:123) warns that all of them carry a fundamental learning problem. Because written symbols are processed mainly in the left brain hemisphere, and since many individuals are more adept at left-brain processing, there is an inherent danger that the fine processing system for sound in the right hemisphere may be 'by-passed', resulting in a musical action that could be considered profoundly unmusical.

With the emphasis on sight-reading from music notation at a premium in Western society, in particular in Britain, where the accent is on amateurism rather than professionalism, many children and adults are required to sing and play at sight to a high level. Odam (1995:104-106) claims that the 'musicianship' of many good professional and amateur players is limited due to the dominant role of notation. Many are unable to improvise: they are unable to create musical ideas of their own or create new interpretations of existing music. He suggests that the training of a "cathedral chorister" in the British tradition, provides a model of practice worthy of attention.

5.4.2 Essential differences between choral and instrumental tuition

Through continual working with the voice, a chorister develops the essential musical skills that focus on the development of aural alertness and good memory, with notation acting as a **memory aid**: an excellent foundation for continuing musical practice. Table 5-1 illustrates these differences:

Table 5-1

Essential differences between choral and instrumental tuition

CHORAL TUITION	INSTRUMENTAL TUITION
Normally a large group of students	Normally a small group or individuals
Clear musical end-product; incentives to learn quickly; high motivation	Often a vague musical outcome; isolation of individual instrumentalists can be de-motivating
Choral rehearsal develops the voice, the ear and tone quality	Technical exercises not essentially sound-focused. They are divorced from aural development
Teacher provides constant musical stimulus by performing him/herself	Often teaches NOT through performing, but through comment and critique
Exercises need to engage the ear	Exercises are sensori-motor movement based, and can be performed without engaging the ear or feeling response. Often an end in themselves
Immediate or planned application	Exercises processed by left brain only. When exercise is disguised in a piece requiring right brain processing, the left brain controls are not Readily accessible.

For the chorister, a well-developed musical memory is essential, with notation serving as a memory aid. One of the most outstanding foundations for continuing musical practice is the provision of a combination of aural alertness and memory, and gradually growing reading skills, all based on the 'voice' (Odam 1995:104-106).

5.4.3 Development of the ear as a priority

The fact that "music is a sounding symbol" confirms that ultimately musical meaning can only be approached, expressed and understood through its medium of sound: "the successful study of music depends on developing the ear. Nothing is more important than this" (Odam 1995:129). Considering the importance of the ear as the central tenet of the Tomatis Method, which stresses the fact that one cannot reproduce (musically) what one cannot hear, it would be foolish to ignore the fact that the development of the ear is **crucial** to developing the musical intelligence.

It is common for instrumentalists to be categorised as either "sight-reader" or "player by ear". **Sight-reading** requires the brain to scan and interpret music notation at a very fast speed. It also requires the brain to pre-determine possibilities of what can be expected. The more information (such as 'new' styles of music) that has to be absorbed, the more difficult the task of sight-reading becomes. The facility to interpret symbols for precise pitch and tempo is situated in the **left hemisphere**. A sight-reader who relies exclusively on playing the 'right' notes and using the 'right' tempo, is making use of the left brain analytical processes, with the resulting performance commonly being described as "unmusical" (Odam 1995:109,110).

Playing by ear relies on associative auditory functions, which create expectancies for harmonic progression. This facility is ascribed to the **right hemisphere**. **Only by integrating left and right brain functions is it possible to produce musical playing**. Music learning can be considered most successful when there is an effortless, fluent interaction between the cognitive (thinking), affective (feeling) and psychomotor (doing), as well as a coalition between the 'sound' and the 'symbol'.

5.5 Education for music: instrumental teaching and learning

When considering the process of instrumental teaching and learning (which is ultimately focused on **performance**), it is important to be constantly reminded of the **three** main components:

- **the composition** (for a specific instrument/group of instruments)
- **the performer** (human capabilities and limitations on a physical, emotional and spiritual level)
- **the performance** (as an outcome of the teaching/learning process).

At present, the focus of instrumental teaching is still very much on the **propositional** knowledge required to be able to 'read' the notation of the composition, combined with the **technical** instrumental skills required to transform the notation into a 'performance of musical sound'. The **human element** seldom receives the recognition it deserves. There is a need for a 'human' awareness that takes into consideration, for both the teacher and the learner:

- personality profile (emotional preferences)
- dominance profile (eye, ear, hand and foot preferences)
- the ability to select hemispheric processing (to achieve a balance between analytical and global hemispheric processing, which may ultimately lead to a spiritual experience).

This human awareness could greatly assist in solving problems pertaining to, for example, the emotional 'suitability' of a certain composition to a learner, technical problems that could arise as a result of a specific dominance profile, or misunderstandings resulting from different modes of hemispheric processing.

Learning is a lifelong process of building neural networks, with growth spurts of 'nerve-net' development, not only in childhood, but also at approximately age thirty. The last is of particular importance to musicians, as this is when further refinement of muscle movement, in particular of the hands and face, takes place. "Increased fine motor co-ordination leads to greater achievements for musicians like pianists and violinists who can move their fingers with more agility. We also see it in vocalists who are now able to command a greater range with their vocal cords (muscles)" (Hannaford 1995:83).

For effective learning, knowledge from the neurosciences (including periods of neural plasticity and gender differences) and information about how bodily movement, emotional expression, nutrition, and the social and physical environment influence learning, should all be synthesised to contribute to the 'human element' of teaching and learning music.

There is, according to Odam (1995:104,111), a growing dominance of all forms of Western music on a world-wide scale. This can partially be ascribed to the virtues of the art form it contains, the skills required to sustain it, and its capacity to communicate with many different people. In an interview, Odam indicated that this growing dominance could, however, be impeded by 'street culture' with its accent on oral/aural culture, leading to the emergence of a new 'global' music. In

an essentially aurally based music, **memory** is crucial, moving the focus from developing sight-reading skills to the development of memory skills.
The physical and technical demands required to play a musical instrument are often so time-consuming that educators are inclined to ignore the following 'shared' basic principles of instrumental teaching:

- developing an individual musical response in students
- developing problem-solving skills
- enabling students to learn and develop on their own, with positive self-criticism.

Essentially, performing is a **shared act of communication** between performer and audience. There are certain negative aspects to performing that should be considered, in particular the impact that high-level performing has on the mental and physical health of the performer, emanating in part from the demanding life-style of professional musicians. Some negative aspects, however, can be traced back to an inadequacy in the initial methods of music education.

5.5.1 Focal limb-dystonia

At the Institute of Music Physiology and Performing Arts Medicine in Hannover, research is being done on the physical affliction of 'musician's cramp', also known as focal dystonia or focal limb-dystonia. There are some specific qualities connected to the sensory motor skills in performing instrumental musicians:

- musical learning begins in early childhood in a playful atmosphere
- the routines for stereotyped movements have to be rehearsed for extended periods of time, with gradually increasing degrees of complexity
- to become an outstanding performer, a soloist needs to be music-loving, ambitious, and a perfectionist.

Focal dystonia presents as a painless loss of voluntary muscle control in extensively trained and refined complex movement patterns while playing an instrument, in particular those which require both force and skills at the same time. It is more common in highly talented performers, occurring predominantly in male soloists playing classical music. It is more frequent in guitarists and pianists, possibly because they are known as 'heavy workers', who rehearse on average more than four hours a day. This affliction usually heralds the end of the artist's career, requiring medical treatment and psychological counselling (Jabusch & Altenmüller 2001).

5.5.2 Communicating emotions

According to Weinberger (2001:3) there are four basic emotional states produced by music:

- sadness
- happiness
- anger
- fear.

Weinberger (2001:3) refers to a study in Sweden, where guitarists were asked to play the **same** musical selection at four different times to express each of these four emotions. Tapes of these performances were played to adults who had received a moderate amount of musical training, to see to what extent music is able to convey emotions. The listeners correctly labelled each tape by the intended emotion, illustrating that it had not been the **composer's** emotional intention that was converted into music, but rather that of the **instrumentalist**.

Further analysis of the structure of each performance pointed to two musical dimensions that could explain the transfer of emotional content: **tempo** and **articulation**. Table 5-2 below illustrates how the four basic emotional states can be transferred from the performer to the listener (Weinberger 2001):

Table 5-2

Association between emotion, tempo, and articulation

EMOTION	TEMPO	ARTICULATION
Sadness	Slow	Legato
Happiness	Fast	Staccato
Anger	Fast	Legato
Fear	Slow	Staccato

It would appear that the performance cues (tempo, articulation) used by performers to convey emotion, are the same cues that listeners use to receive the intended emotion. Furthermore, different genuine emotions can be physiologically defined (changes in heart rate/ blood pressure), and the emotional reactions to the music are 'genuine'. In other words, music doesn't simply convey intended emotions that listeners can recognise, but rather **induces** genuine emotions in the listener (Weinberger 2001:3-5).

5.5.3 Posture and physical attributes

Initially it is particularly important to focus on establishing posture and correct physical attributes, giving attention to the students' ease and comfort and helping them to feel 'at one' with their instrument. Odam (1995:103) suggests that this can be done using imaginative movements that are integral to the particular instrument, while the teacher provides the sounds the students should be making. In this way, the children are provided with the correct aural stimulus as they establish the psychomotor routines that will be required to play the instrument. **It is of paramount importance that good, healthy and effective psychomotor skills are secured from the beginning.**

In addition to these skills, it is necessary to establish an analytical and acute musical ear (needed for musical interpretation), as well as the reading of notation (a necessary skill for Western musicians). However, it should be noted that an over-reliance on notation could hamper:

- aural development
- the development of a problem-solving approach required for performing and/or
- the development of long-term musical memory.

5.5.4 The effects of piano training on brain activation patterns

For the instruction of instrumental playing (piano training is used as a proto-type in this study) to be most effective, it is vitally important that instructors have an understanding of the complex behaviour of 'making music', to facilitate employing the correct teaching strategies. This complex behaviour is an example of sensorimotor integration at the highest level. An expert pianist reading a piano score hears the notation as an auditory representation in his/her (inner) ear, while at the same time may feel the sound as a kinesthetic representation in his/her fingers. The convergent neural representation is processed mainly in the multi-sensory association areas of the brain where information from the different sensory or motor areas is integrated.

Exceptional musical performance belongs to the most demanding human sensorimotor skills. Musicians are expected to perform complex movement patterns that require high-speed motor control under an "unyielding auditory feedback" (Altenmüller et al 2000a:103). In addition to this, these movements are closely linked to emotions. Musicians want to express or communicate their feelings, but at the same time, may be afraid to make mistakes. This 'double linkage' to emotions is reflected in the strong reward-punishment system found in professional musicianship. According to Altenmüller et al (2000a:103), the motivation for an individual to practise ten thousand hours over a period of ten years during childhood and adolescence as a prerequisite to becoming an expert pianist, is based on the reward system.

Piano practice can be described as the assembling, storing, the constant improvement of complex sensorimotor programmes, and repeated execution under attentive control of the auditory system, over long periods of time. As a result of many years of practice, a strong hard-wired linkage develops between the auditory and sensory motor regions of the brain. This is often reflected by professional pianists moving their fingers automatically while listening to piano music played by another pianist.

5.5.5 Traditional piano teaching in particular

As with the teaching of scales and arpeggios, technical studies are often subjected only to analytical processing in the brain, whereas the playing of studies should involve the whole brain. It is possible to learn to assimilate instrumental **technique** through either or both brain hemispheres. At a piano lesson, the student normally plays from notation, with the teacher observing the student's performance, occasionally commenting (verbally) on a point of technique, skill or interpretation. Often instructions are given negatively, concentrating mainly on what is going wrong in the performance.

In contrast to the choir-trainer, who models all the procedures leading to musical expression by example and demonstrating with music (see 5.4.2), the traditional piano teacher does not play. He/she usually sits next to the student and acts rather as a critical audience than a model, **with students rarely hearing any music that is not their own**. The close presence of the teacher could provide a 'security' at lessons that cannot be provided in a performance situation, affecting the student negatively. The development of musical memory and aural acuity are stimulated only by accident, and considered by many music teachers to belong to quite a different section of the student's course, and therefore often pertinently neglected.

Too often, instrumentalists/pianists are unaware of the important role of body language in communication, and seat and dress themselves in ways that do not enhance their performance. As performers rely increasingly on recording as a means of communication, the need for relationships between people as a function of a live performance is diminishing (Odam 1995:108-111).

A working knowledge of neuro-linguistic programming could prove invaluable to instrumentalists in a performance situation, and should be recommended and made available to all instrumental students (Neuro-Linguistic Programming Seminar 1999).

5.5.6 Outcomes-based instrumental teaching

It is important to remember that 'learning' is not all in the head: the active, muscular expression of learning forms an intrinsic part of that learning. The neural connections between the motor cortex and the formal reasoning area of the frontal lobe underscore the importance of **movement** to thought processing. **Real learning**, the kind that establishes meaningful connections for the learner, is not complete without some output, some physical or personal expression of thought. Musical expression represents highly skilled integration of body, thought and emotion. Hannaford (1995:87) points out that "much of learning involves the establishment of skills that enable us to express our knowledge".

The following points can serve as guidelines to 'lift' instrumental teaching into the realm of whole brain education for both teacher and student:

- The outcome of instrumental teaching should be carefully considered, by establishing what each student's aspiration is and setting targets and goals based on these aspirations, as well as those of the teacher.
- It is important to ensure that the greatest part of the lesson is involved with musical sound; building up 'sound memories' is an essential component.
- The best physical habits of posture and technique have to be established by the teacher, and then learnt and practised by the student. A feeling of **"one-ness" between the student and the instrument** has to be cultivated so that playing becomes second nature.
- A balance between the demands of sight-reading from notation and developing an aural memory must be established to facilitate committing musical procedures to the long term memory.
- The exploration of musical repertoire should be treated for students as a 'journey of discovery', that will hopefully continue for the rest of their lives.
- **It is essential that teachers are up to date with information concerning possible medical problems associated with the playing of their instrument**, and for them to remain alert for any signs of these occurring (Odam 1995:119).

- With respect to music education, the goal is to achieve a balance between emotional and analytical brain processing, plus the ability to harness either type of processing at will as the operation and circumstances demand.

5.5.7 Group instruction

Group instruction should be planned as a group experience, with the material adapted for each of its individual members. Provision must be made for different learning speeds and varying skill levels by using musical arrangements that are flexible, with the greatest part of the musical information coming from the teacher's example. Music educators working with large groups experience particular problems and may find the focus of **choral** training helpful (see 5.4.2).

With young children in particular, the **body** plays an essential role in learning, indicating that musical activities should focus on making music and experiencing music through body movement. Prior to the age of four, the child takes most of its behavioural cues from what it sees, rather than from spoken commands. From approximately four years of age, verbal communication starts becoming meaningful and effective, and until around age seven, children literally 'think out loud'. It is also between the ages of four and seven years that approximately eighty percent of the individual's adult hearing is formed: a clear indication, especially to music educators, that this period of development should focus on the auditive development of the child (Michels 1996:45,46).

In general, the focus should be on developing the musical memory, making use of the emotional processing of the brain wherever possible, and ensuring a lively connection to the analytical processing of the brain. Odam (1995:119,123) maintains that if the early training of the **musical** brain has been well-founded (as in choral training), the habitual connection across the *corpus callosum* will be fundamentally from **emotional** to **analytical** processing.

5.6 Education by means of music: the role of music education on brain development

The role of "education by means of music" is often ignored in music education. Eagle (1991:43) has been particularly concerned with the effects of music on human psycho-physiological functioning, developing a data base of literature from the combined fields of music and medicine. His findings show that during the 1980's, music studies were published in over 300 medical journals, representing some 35 medical specialities in 40 different countries. With many other subsequent research findings, there is now enough empirical evidence to justify the importance of this particular category of music education.

To maximise the use of the brain in any task, it is necessary to understand some of the processes it employs in initiating, controlling, and monitoring the three areas of thinking, feeling, and doing. To achieve this, teachers need to know how children learn and children need to be aware of the potential the brain has, and how to develop it. At the seminar on "Whole brain learning to achieve outcomes-based education" (1996), it was stressed that educators should be aware of, and well-informed about personality and intelligence profiles to aid whole brain development. Children also need to be aware of the potential their brains have, and how best to enhance it. This information should be shared and discussed with their parents/guardians. The hope was expressed that this information would eventually reach the general public and 'those in authority'.

Central to the brain process is the duality of **thinking** and **feeling**, especially for those involved with the arts, where feeling is as important as thinking. Music education should be **as** concerned with stimulating the feeling process as with the thinking process, and in fully integrating them (Odam 1995:9). Although most people are accustomed to thinking and feeling, the focus has been on educating thinking with little or no concern that **feelings** may actually dominate decision-making. The duality of thinking and feeling can be better understood by the following 'pairs' set out in Table 5-3 (adapted from Hannaford 1997:18-34):

Table 5-3

Duality of cognitive and affective processing

Cognitive	Affective
Thinking	Feeling
Symbol	Sound
Logic	Metaphor
Technique	Perception

In a series of studies to investigate the impact of music education on brain activation patterns, the results demonstrated that musical expertise influences auditory brain activation patterns, and that changes in these activation patterns depend on the applied teaching strategies (Altenmüller et al

2000b:49). One of the most important strategies of an educator, should be to aid children in identifying **how** and **when** to use **what** brain processes, and in particular, to make them function together to create mental and physical harmony: in other words, to facilitate the use of appropriate brain processes for specific tasks.

5.6.1 Music in the subconscious

Whether an individual is musical or not, a series of brain wave experiments conducted at the Max Planck Institute for Cognitive Neuroscience in Leipzig, Germany, have provided evidence that 'musicality' is an inherent part of brain function (Persaud 2001:36). They found that the brain registers surprise at musical incongruities long before the listener consciously registers surprise. The brain is therefore processing music at levels long before it reaches awareness, suggesting that music is indeed a fundamental biological part of the function of the brain.

Many listeners perceive the aesthetic 'violation' of sound expectancies and musical surprises as appealing. This would appear to be the reason why composers have sought to expand the repertoire of dissonances and ambiguities throughout the history of music, to prevent music from becoming 'boring'.

Humans use music **and** language to communicate. Language would seem to be most useful for the precise conveying of information. Music has a power beyond language to communicate mood, and indeed to co-ordinate human emotional states. For example, music at a wedding or funeral helps to ensure that everyone present reaches the equivalent emotional highs or lows at the same time.

Persaud (2001:36) suggests that, emerging from this latest neuroscientific research, "music has always played a vital role in producing and cementing society". This, in turn, suggests that "music has a more fundamental role in determining who we are than we have so far dared to guess".

5.6.2 Community involvement

The music educator has a professional interest in developing the musical intelligence of **all** of a community, and **all** of its people. Wilson (1985:42) advises music educators to take cognisance of an enormous untapped reservoir of music students: **the parents** of the young children they are educating, most of whom have no idea of the benefits of music. Mothers and fathers are the child's first music teachers, and are able to exert a powerful and durable influence on the child's emotional, social, and linguistic development through specific musical activities (Wilson 1991:39).

Music education can be considered the business of:

- parents who wish to introduce their children to music
- tutors of music and music education
- instrumentalists who teach others to play and who play to other people
- composers who write music for others and who teach others to compose
- those who work as musicians in a community
- those who provide opportunities and motivation for current and lifelong music participation, training others for a lifetime involvement with music (Odam 1995:6).

As schools move in the direction of becoming community education centres, Fox (2000:25-27) advocates parental involvement in music classes, both with regard to music for their children and music for themselves, with parents and professionals shaping the curriculum for early childhood education. To enrich the lives of young children and their families for the long term, it is necessary to bring together funding sponsors, researchers, early childhood educators, parents and music educators, to provide the highest quality musical experiences for young children.

With regard to "which music experiences are the most important" for children, Fox refers to brain research and current childhood education, which indicate that:

- *active* engagement (not passive response) is what influences brain development, with active making of music as the defining factor
- *passive* listening may change the mood or emotional climate, **but cannot be considered sufficient pedagogy for enhancing music learning**.

Any listening activities should be designed to involve children in *active* and expressive modes of music making, such as singing, moving and playing sound-making objects/instruments.

Extensive evaluation of children to investigate the relationship between musical aptitude and musical achievement (Gordon 1990:331), reveal that experiences before the age of nine are critical to full development of potential: a 'critical' period for musical development. It is always possible for the child to improve skills after this age, but will require greater effort, and the results will not be the same as what they might have been, had the child started study in early childhood (Wilson 1991:40).

5.6.3 Effects of early music experiences

Fox (2000:23,24) states that "it is very clear that babies are musical, that they have innate musical behaviours, and that they use music as meaningful communication in their earliest years of development". Research points to the importance of active musical engagement as a factor in brain development.

The brain of a young child is not the same as that of an adult. Certain electro-encephalogram (EEG) studies on the benefits of music training for children have revealed that the brain appears to be more plastic and malleable during the first decade of life than in adulthood. It is typical for a child to have up to twice as much neural activity and twice as many neural connections in their brains as adults. These connections are made during the pre-natal period and throughout life.

Other studies have indicated that forty percent of short term neuron connections and seventy percent of long term connections are influenced by heredity, suggesting that between thirty and sixty percent of the brain's connections come from environmental influences, or an interaction of heredity and environmental influences (Rushton 2000:60,61). The view that some of the connections have been found to be pre-determined genetically (approximately seventy percent), while others develop as a result of environmental influences (thirty to sixty percent), is supported by Flohr et al (2000b:30).

Once the brain is 'wired', there are limits to the brain's ability to create itself: time limits or critical periods, sometimes referred to as 'windows of opportunity'. With respect to vision, an example of a critical period is the short period when circuits connect the retina to the visual cortex (Begley 1996:42). A significant research finding for music educators is based on the fact that several patients with a lesion in one small area of the brain, suffered an involuntary total recall of all the music heard between the ages of eight and eleven years. This indicates a critical stage of development for music education and the vital importance of music education in the Intermediate Phase, expressing a need to involve children in quality musical experiences at this crucial time.

Music educators can make an important contribution to optimising the child's intellectual development by developing his/her musical intelligence, from an early age. According to Rose &

Nicholl (1997:230), fifty percent of the brain's neural connections are effected during the first five or six years of life and form "the foundation upon which all future learning will be based". The brain circuits for music, mathematics, language and the other intelligences, mature at different times (neural plasticity), and need to be stimulated at the appropriate times. For example, the appropriate time to stimulate cochlear-vestibular hearing is from the fetal age of four-and-a-half months to about nine years of age, and musical memory in particular from the age of eight to eleven years (as mentioned above).

5.6.4 Early development of the ear

The ear is an organ that matures early, and on which is grafted the desire to communicate. The human ear is fully developed as an anatomical organ from the first months of life in the womb: the *embryo-fetus* is already a listening entity. From the fifth month of fetal life, the whole neuronic apparatus attached to the cochlear-vestibular ensemble, is functional, with the auditory-temporal lobe of the brain fully developed at birth (Tomatis 1991:217). The ear of the fetus perceives the voice of his/her mother in a remarkable way, creating a real communion/inter-communication between the mother and her child. It is with the mother's voice that the desire to listen begins, and **should this vital desire to listen remain dormant, deep communication problems may appear.**

In South Africa, the University of Potchefstroom's "Audio-psycho-phonology" unit is involved in the treatment of communication problems resulting from a dormant desire to listen that has not been successfully activated by the mother's voice, or for lack of the mother's voice.

Developing the ear is based on imitation of sound and its conscious analysis. Rote learning is powerful and teachers must ensure that what is learnt in this way is of the best quality available. This means that the models the pupils hear must be good ones. The best models are live, and nothing can surpass the teacher as performer in voice and instrument. Live music communicates differently from and far more strongly than recorded music. The teacher's performance must, however, be good enough. A "good enough" teacher's performance requires that it be in tune, and needs accuracy, fluency and expressive power, however simple the piece performed. This applies equally to the unaccompanied nursery rhyme as to the accompanied aria, to music for movement as to playing in and out at assembly (Odam 1995:32,33).

Rose & Nicholl (1997:236) report that brain stimulation, or the **increase of sensory activity**, changes the brain cells, making it possible for children to attain higher levels of sensory abilities (such as seeing and hearing) and skills (such as performance at school).

Educational decision-makers should be convinced that pre-school and primary school teachers need to be given "thorough musical training". This need not be done by preparing them to become virtuosos, but rather by making genuine teachers of them, capable of guiding children towards well-constructed speech by means of counting songs and other children's songs. "To make children sing a language is to go to the very source on which it is built neuro-anatomically. This prepares the listening faculty necessary to learn the mother tongue". By encouraging children to express themselves through song and movement, they are enabled to fully enter the fascinating world of music. Tomatis (1991:221) further observes that music is gradually gaining ground once more among educational activities at home and at school. Music is "the bearer of harmony and energy, alertness and creativity . . ."

In the *Nationwide audit of ECD provisioning in South Africa* (2001) the curriculum has been changed for the Foundation Phase to focus on eight learning areas. For this Phase, three broader "learning programmes" have been identified: literacy, numeracy, and life skills. In the guidelines provided for teachers for Grade R (reception year, sometimes referred to as Grade 0), one of the guidelines is to encourage communication through "art, movement, drama and language". Of concern, is that there is **no** mention of **music** or **music education** for the Foundation Phase in any of the guidelines (Department of Education 2001:17).

5.6.5 Music as a bodily kinesthetic experience

Experiments have revealed that **hearing** music elicits actual physical changes, including changes in heart rate, blood pressure and biochemistry of the blood, which in turn may result in affective changes (see 5.8.2). **Making** music is a bodily-kinesthetic experience, putting musicians in the category of "small-muscle athletes".

Wilson (1985:41), assistant clinical professor of neurology at the University of California School of Medicine in San Francisco, music educator and author, introduces the concept that virtually everything we experience in life depends in some way on a transformation of brain activity into muscular activity. The response to the incessant flow and interchange of information within the central nervous system (the brain), is **to translate thought into action**. What humans know of the world is the result of their dynamic interaction with it: **the mind does not come into being, or grow, without bodily movement.**

Movement learning, in particular **cross-lateral movement**, is critical to all humans: it is through the mediation of movement that sophisticated thought processes in both the left and right brain begin to develop. The cross-lateral movement involved in a baby's crawling is vital to activating the development of the *corpus callosum*. Missing this stage often leads to learning difficulties at a later stage. Jourdain (1997:225) points out that in adults who started playing the piano before the age of eight, the *corpus callosum* is fifteen percent larger than in those who started later. This fifteen percent increase suggests a remarkable increase in information flow (see 2.9.3).

Actual physical involvement in learning music is crucial in early childhood: it operates pre-verbally (Aronoff 1988:18), and children need to know what it 'feels' like. Recent information on brain development has provided a seemingly new rationale for the support of early experiences for young children. Although there is at present no conclusive scientific evidence on the effect of music on infant brain development and subsequent school success, research has indicated that music making in humans increases the areas of the brain that are allocated to processing music.

In the early years of schooling in any culture, the use of movement as a specific learning process is fundamental to many areas. Personal experience supports the claim that **much early music education is inseparable from movement education**. Even with adults, education of and through psychomotor control plays a vital role, a reminder that **therapy is fundamental to all of us, and not only for those with a special need** (Odam 1995:13,14).

5.6.6 Selection of brain processes

It is important to understand that the working of the brain is infinitely adaptable and flexible, and that, like any other vital body structure, the younger it is, the more flexible it is, and the greater is its ability to adapt. The outcome of a task depends on which part of the brain is given that task: **it is possible to select which part of the brain (or combination of areas) we use for a specific task**. Most people are not aware of this possibility of choice and therefore do not use it to their advantage, often resulting in 'chaotic' thinking.

Learning to make such choices leads to increased efficiency in achieving goals. According to Odam (1995:10), one of the most important functions of a teacher is to help identify "how and when to use what processes, and most particularly how to integrate them for mental and physical harmony". Music educators who promote verbal reasoning and logical thought processes for a specific task may find that an alternative strategy, employing aural and spatial perception and contour identification, may be equally successful in bringing appropriate brain processes to the task.

5.6.7 Musical preference

Musical preference/taste appears to be a complicated phenomenon, as people are drawn to music for a variety of reasons. According to Persaud (2001:34-36), the brain dictates an individual's musical taste. An ever-increasing number of reports are being filed in medical literature, of musical preferences that are dramatically transformed in patients suffering from brain-degenerating dementias. This 'regression in preference' assists in identifying which parts of the brain are involved in musical perception. For example, two years after being diagnosed with dementia, a patient who was once a lover of classical music but who detested pop music, developed an unusual interest in pop music, becoming almost fanatic about listening to a particular pop band at full volume. Similar changes in musical taste have been reported, and linked to a particular kind of rare dementia that affects mostly the front of the brain without affecting memory much, but producing a marked deterioration in judgement and abstract thinking.

There are several interesting explanations/interpretations to account for regression in musical taste:

- The change in musical taste that parallels the erosion of certain brain functions could be linked to "hard-nosed intellectual function" (Persaud 2001:35).
- The frontal lobes are most involved in the exercise of complex judgements, abstract reasoning, and planning ahead. Insofar as forward planning involves the ability to inhibit impulses to act immediately or to delay instant gratification, it is possible that normal, intact frontal lobes appear to inhibit the appeal of pop music as discernment develops and the ability to delay gratification increases. In fact, **constraint** appears to be a considerable and necessary part of 'what the brain does'. In the event of being able to bring all information to mind **all** the time, it would be virtually impossible to focus on any one item: consciousness would be too overcrowded for normal functioning.
- The development of new musical talents as a result of a degenerative dementia affecting the left side of the brain, has far-reaching effects for the understanding of the relationship between brain and music. It has recently become possible to localise musical talent in the

brain, and there are indications that the innate human musical talent (usually associated with the right hemisphere of the brain) may be inhibited/constrained by the less musical left hemisphere. When dementia affects the left side of the brain, it could release some of the constraints imposed on the right side.

- It is possible that the loss of social skills and inhibitions caused by dementia may facilitate 'art' in some patients. The disregard of social conventions is a common phenomenon among artists and would appear to be associated with a freer, more creative output.

For many people, musical 'function' is more important than any considerations of musical quality, and they remain unaware of the limitations of the 'genre' of music they listen to. They are unskilled at listening to complex music that "tells a story" (Jourdain 1997:267), and prefer simple music that is easy to listen to.

5.7 Music as a component of accelerated learning

The foundation of the educational science known as "accelerated learning", "whole brain learning", "superlearning", "optimalearning", "integrative learning" and other names, is based on the discoveries made by Georgi Lozanov, Bulgarian psychiatrist and professor of education. He was the first scientist to systematically research the factors involved in rapid learning, and the techniques he evolved were among the first to fit the category known as "**whole brain learning**" (Webb & Webb 1990:32).

The purpose of whole brain/accelerated learning is to involve both the right and left hemispheres, and the cortex and the limbic system of the brain, in the learning process. The optimum state for learning is a calm, relaxed state, both physically and mentally. In this relaxed state the brain produces *alpha* brain waves, which characterise a calm, but alert state that is conducive to the rapid, effortless assimilation of information.

5.7.1 The benefits of accelerated learning

Most people use only a small fraction of the brain's total capacity, not because the capacity is not there, but because they have not been taught how to access and use what they already have. To develop their true potential, they have to discover their own personal combination of intelligences and learning preferences. The accelerated learning techniques can be compared to a 'master programme' of a computer: they are not the programme itself, but it is possible to run all other programmes on them (Rose & Nicholl 1997:67).

The benefits of accelerated learning can be listed as follows:

- It addresses barriers to learning
- Input is presented in a playful, multi-modal, relaxed, and positive way
- It is compatible with how the brain works
- It uses a consistent, congruent training methodology
- The physical environment plays an important role
- Techniques such as "skills, knowledge, beliefs, and attitudes", are used to develop whole brain learning
- It is effective across subject areas, age and instructional settings
- Tested techniques are incorporated, from experience to research
- It makes use of active presentation and learning
- It builds collaborative learning
- It develops and employs creativity
- It taps the non-conscious mind
- It emphasises relationships and systems thinking
- Diverse learning styles are accommodated
- Learners are empowered, respected and supported
- Utilisation of training time is maximised (Fairbanks 1992:3).

In many studies of academic, scientific and mathematical achievement, music formed an integral part of the curriculum. Learning through music and sound and rhythmical activities **activates the whole brain** and makes it possible to master difficult, abstract concepts faster, more easily, and with greater retention (Brewer & Campbell 1991:11).

5.7.2 The logic for using music in accelerated learning

Webb & Webb (1990:2,3) claim that music provides balance, proportion, rhythm and pleasure to the educational experience, accelerating and integrating 'information' into short and long term memory. Modern technology has provided sound reproduction of an abundance of music, giving most people access to music of different genres and styles, from different historic periods. For example, much of the music composed in the Baroque and Classical eras was intended strictly for 'elite' audiences, and only became accessible to the general public by means of recordings during the twentieth century.

In the midst of "such unprecedented musical abundance" (Webb & Webb 1990:3) which is now accessible, society relegates music mainly to one of three roles:

- entertainment
- background music
- advertising.

The world of advertising in particular, exploits the power of music, song, chant, rhythm and rhyme to encode memory at the deepest levels of the conscious/subconscious mind. Within the context of the present growing and rapidly changing information load, it would appear appropriate for music to be restored to its eminently practical place: **at the core of learning and memory.**

5.7.3 Music in history

According to Webb & Webb (1990:4,6): "It is accurate to say that human civilization is built upon the bedrock of philosophies, religions and systems of government which owed their structures to music." The more successful ancient cultures placed music, or what was considered to be the intelligent organisation of vocal and instrumental sound, at the centre of their critical, social endeavours, including education, government, religion and healing. In some cases, the quality of government and/or the morals of the people, were judged by the quality of their music.

A 'divine origin' was ascribed to music by Greek mythology. The word "music", derived from "muse", had a wider connotation: activities in pursuit of truth (science) or beauty (arts) involved music as a primary element. With respect to **memory**, it is of interest to note that performers at Athenic festivals chanted the Iliad to the accompaniment of a lyre, played at heartbeat rhythm (ibid).

To Pythagoras and his followers, music and arithmetic were inseparable: those who understood numbers were credited as having the key to understanding the whole universe. The system of musical sounds and rhythms, being ordered by numbers, was an example of the harmony of the cosmos, and corresponded to it. "Music was that principle of order by which all things were held together in unity" (Webb & Webb 1990:4).

By approximately 350BC, Plato and Aristotle recognised that certain music could have an unsuitable influence that could endanger the state, and advocated that music used for educational purposes, should be regulated by law. Similarly, the writings of ancient Church Fathers contain warnings against specific kinds of music.

In ancient China, each musical composition incorporated an "energy formula" (made up of rhythm, melodic patterns, and instrument combinations, that were specifically selected) which exerted influences over individuals and society. Ancient Indian music was considered capable of influencing the mind and emotions of the individual, and literally shaping and changing physical events.

Other than influencing religious and educational systems of the ancient world, music was credited with healing powers. A sick person was considered to have lost inner harmony: he/she was no longer in tune with the universe and its vibratory laws. Specifically chosen rhythmic chords and melodies could harmonise and realign the human organism with "universal sound", changing behavioural patterns, emotions and belief systems. In this way, the healing process was accelerated (Webb & Webb 1990:4-10).

Many aspects of the ancient scenario of music and the 'power of music', can be recognised in contemporary society. The main differences are, however, that humankind has only been aware of the location of the brain for about the past five centuries, and that only since the advent of computers and the development of imaging techniques a few decades ago, has neuro-musical research been able to play a meaningful role in society.

5.7.4 The use of music in accelerated learning

In an educational or training environment, music should be used purposefully for best effect. Not only is the study of music beneficial in itself, it has many other benefits, such as:

- promoting relaxation and stress reduction (stress inhibits learning)
- fostering creativity through brain wave interaction
- stimulating imagination and thinking
- stimulating motor skill, speaking and vocabulary
- reducing discipline problems
- focusing and aligning energy as a group
- providing a background to concert readings/presentations.

The state of **relaxed alertness** is the main requirement for an integrated learning state. This state is characterised by *alpha* and high *theta* waves in co-ordination with relaxed body rhythms, and is emphasised in accelerated learning and listening techniques. In this way, optimal conditions are created for learning facts, synthesising information, enhancing memory, and inspiring creativity. To obtain the co-ordination of mind-body rhythms, **music** can be used to entrain the mind and body into relaxation, but at the same time to provide a stimulus that keeps the subconscious mind alert and receptive to new information.

While running, walking, doing simple chores, taking a shower or driving a car, the mind often moves into an alpha state which enhances the consolidation of information. This quiet, reflective time can strengthen the process of creative thought, and is an important part of learning. The process of creative thought can be strengthened in a learning situation by providing learners with time for reflection. Since each type of music elicits a different type of psycho-physiological state, a variety of music is required for different learning situations (Jensen 1995a:221):

- **At the start of a lesson**
  Music that creates a state of anticipation or excitement, such as grand movie themes or 'upbeat' Classical
- **For storytelling**
  Music that has built-in peaks and valleys, and engages in fantasy and emotion, such as Classical or Romantic
- **For background**
  Low volume Baroque music.

Jensen (1995a:221) recommends that, as a general rule, music can be included for about thirty percent of the total learning time, an exception being a music class where a higher percentage is required, probably in the vicinity of seventy percent.

5.7.5 The benefits of music education

Campbell, Campbell & Dickinson (1996: xvi) claim that evidence of musical intelligence is found in individuals who display a sensitivity to pitch, rhythm, melody and tone. Musical intelligence is the earliest form of human giftedness to emerge, probably because this intelligence is not contingent upon accruing life experience, and the foundations for this interest can be laid down at an early age. Insofar as each intelligence is comprised of sub-intelligences, the musical intelligence includes:

- playing music
- singing
- writing and reading musical scores
- conducting.

Extensive research has been conducted to establish what the effect of music/music education is on the development of the brain. This research has substantiated the importance of learning to play a musical instrument for social/aesthetic purposes, as well as producing compelling data regarding music education's relationship to students' success in other subjects.

On the basis that the more neural pathways a child develops the better his/her brain functions, research results indicate that learning to play a musical instrument establishes more neural pathways in the brain than would normally be the case. Approximately eighty to ninety percent of the brain's motor control capabilities register stimuli to and from the **hands**, **mouth**, and **throat**, and by developing "highly refined control" in these areas during early childhood, almost the entire brain is stimulated.

The reason for the increased intelligence in the artistic child could also be ascribed to the fact that he/she optimises the brain's **bi-lateralism**. Brain scan studies indicate that "music more fully involves brain functions in **both** hemispheres than any other activity the researchers studied" (Lehr 1998:56). With respect to brain wave rhythms, Brewer & Campbell (1991:105) state that "music, movement, and art are especially valuable as integrating tools in synchronisation" of the two hemispheres.

5.8 The impact of noise, sound and music on health and spiritual well-being

Everything that affects our physiological functioning affects our capacity to learn. Stress management, nutrition, exercise and relaxation, as well as other facets of health management must be fully incorporated into the learning process. The natural development of both body and brain, as well as each individual's natural rhythms and cycles, influence the 'timing' of learning (Caine & Caine 1991:80,81).

Odam (1995:14) points out that music therapy is not "merely medicinally helpful to those in distress or special need, but is fundamental to all of us". Music medicine research is using music to effectively reduce fear and anxiety in surgical and pain patients. Hearing music affects the biochemistry of the blood, which may lead to affective changes, indicating that music does not function only as a psychological 'distractor', but actually elicits physical changes in the system (Hodges 2000:20).

5.8.1 The physical and psychological properties of sound/sound waves

Music is sound, but sound can also be experienced as **noise**. To understand how music, sound and noise are experienced, it is necessary to re-examine the properties of **sound waves** (see 5.2.4). The way sound waves are sensed and processed psychologically, is dependent on three physical properties of sound waves:

- **Sound amplitude** (intensity) corresponds to the sensation of loudness. The unit of measurement for sound intensity is the *decibel*
- **Sound frequency** (pitch) corresponds to how high or low a tone sounds. The unit of measurement for the frequency of sound waves is *Herz (Hz)*
- **Sound timbre** (quality) depends on the fundamental frequency of a single tone and certain distinctive *harmonics*.

When certain irregular and unrelated sound waves are added, the result is 'noise' (Sternberg 1998:140,141).

5.8.2 Cymatic/Vibro-acoustic therapy

The study of cymatics (the study of shape created by sound) focuses on sound, the structure of matter and how they interact. When atoms, electrons and subatomic particles are considered "energy in a state of oscillation" and sound understood as vibration, it can be assumed that the body is a natural resonator, and that resonant sound is capable of interacting at this level with the human body to restore it to its "operative vibrational state": **healing** (James 2001).

Cymatic/Vibro-acoustic therapy was initiated by Olaf Skille in Norway approximately two decades ago and was devised for children with severe mental and physical disabilities. He created a special environment in which the children could be immersed in sound: a "musical bath". Using a range of New Age, classical and popular music, he succeeded in relaxing the children by reducing muscle tension. According to Campbell (1997:69), researchers found that vibro-acoustic training increased the range of movement in the spines, arms, hips and legs of patients suffering severe spastic conditions.

Cymatic therapy uses the direct application of sound on the body for healing. The human body responds to sound, **whether it can be consciously heard or not**, irrespective of whether the sounds are positive and life enhancing, or out of harmony with the human vibrational system and experienced as negative and debilitating. Taking into consideration that different parts of the body vibrate at different audible frequencies, it has been found that when a part of the body becomes diseased or injured, it vibrates out of harmony with its natural resonance (Halpern & Savary 1985:38 and Webb & Webb 1990:19).

By therapeutically applying the correct frequency to that part of the body, the 'disharmonious' vibrations are displaced, and as the natural vibratory rate returns, healing takes place and the diseased body part is restored to health. It has been found that generally, music in the lower frequencies (40 to 66 Hz) resonates in the lower back regions, pelvis, thighs and legs. As the frequencies of the music increase, the effects are felt more in the upper regions of the body: chest, neck and head.

The human body (as a total system) vibrates at a fundamental rate of approximately 7.8 to 8 Hz, which is inaudible. As seen in Table 2-3, the frequency of brain waves produced in the alpha (relaxed) state is also in the 8 Hz range. The earth itself vibrates at this same fundamental frequency of 8 Hz (this is known as the Schumann resonance) and the nervous systems of all forms of life are attuned to this fundamental frequency (Halpern & Savary 1985:38).

It would therefore appear that **sound environments**, be they electronic, mechanical or musical, **that are in harmony with the natural vibrational patterns encoded in the body, are able to provide humans with a greater sense of happiness, energy and sound health**. Halpern & Savary (1985:39) suggest that since the human body creates and resonates to vibrations, the phrase "*being in harmony with oneself and the universe*" may be far more than a beautiful poetic image.

5.8.3 Biorhythmic entrainment

Jensen (1995b:206) claims that the body resonates at a stable molecular wavelength. Music has its own frequencies that either resonate or conflict with the body's own rhythms. When music and body are in resonance, a powerful feeling of being "*in synch*", more aware, and more alert is experienced. The phenomenon of resonance may be viewed as *sympathetic vibration* or *sympathetic resonance*.

Some of the neurobiologic effects of music on the body are:

- an increase in muscular energy
- an increase in molecular energy
- a change in heartbeat
- changes in metabolism which affect physical energy
- a reduction of pain and stress
- accelerated healing.

The universal phenomenon of **entrainment** takes place whenever two or more oscillators are vibrating at **nearly** the same frequency and shift their pulse so that they vibrate at **exactly** the same frequency. When the body is subjected to vibrations from the outside, that are nearly at the same pulse as some part of the organism, entrainment is likely. Should the frequency of the outside stimulus be powerful and consistent enough, the organism is likely to be entrained to the outside source and lose its own natural rhythm: it 'goes out of tune' with itself (Halpern & Savary 1985:44-46). Because the entire body responds naturally and effortlessly to music, it is particularly well suited as an external stimulus for **biorhythmic entrainment**.

People have individual tastes in music: what delights one person may displease another. Although it is possible to focus on relaxation of the body at cellular and molecular levels, it is also possible to trigger psychological responses by engaging the emotional, intellectual, imaginative and associative faculties of the mind in establishing a healing environment. These two approaches are not mutually exclusive: they can both be used to achieve relaxation. Though each is different, they each succeed for different reasons (Halpern & Savary 1985:49).

5.8.4 The impact of music on individuals

Quantum physics is the science that has pioneered a new vision of reality. In his description of "Quantum physics for musicians", Eagle (1991:52) offers the concept that: " . . . music is the basic stuff of the universe". Based on research results over the past ninety years, he claims that the 'stuff' of the universe consists of not only of tangible particles and **mass**, but also of non-tangible particles and **energy** (vibrating waves of energy). Therefore music with its vibrations, frequencies, and pitches moving through time can be described as: **nothing less than the fundamental substance of reality**. This gives music a **unique** role in therapy and in education (Eagle 1991:60).

Eagle's Theory of Quantum Musichanics maintains that: **music is energy**, and **energy is music**. People make music, but music also makes them. Ultimately then, **music matters because music is matter**, making the music people hear more than what meets the ear. He further ventures to suggest an interpretation of John 1:1 from the Holy Bible as follows:

> In the beginning – which is always beginning – comes forth the Word – which is Sound. In turn, Sound is Music, and Music was with God, and, dare I say it?: Music is God (Eagle 1991:56).

Although most people enjoy listening to music, they are largely unaware of the impact it has on them. As a synthesis of 5.8.1-5.8.4, the following table (compiled from Campbell 1997:64-81) serves to illustrate some of music's effects :

Table 5-4

Therapeutic uses of music

POWER OF MUSIC	IMPACT OF MUSIC
Music masks unpleasant sounds and feelings	Music can be used to repel or override invasive noise: the voice can be used to 'massage' away painful sounds
Music can slow down and equalise brain waves	Brain waves can be modified by both music and self-generated sounds. Playing recorded music can facilitate: • the creation of a dynamic balance between the left- and right- brain functions • 'focusing' and increasing mental organisation: restoring order to the brain waves • shifting states of consciousness • moving awareness from the left- to the right hemisphere: to 'loosen up' the individual
Music affects respiration	By slowing down the tempo of music, or by listening to music with longer, slower sounds, it is usually possible to slow down the breathing and allow the mind to calm down
Music affects the heartbeat, pulse rate and blood pressure	Music acts as a natural pacemaker to the heart, which responds to the musical variables of frequency, tempo and volume. The converse is also valid: the heartbeat can determine an individual's musical preferences. Although the mechanism is not entirely understood, it is possible to use a variety of musical styles to reduce blood pressure by as much as ten percent

Music reduces muscle tension and improves body movement and co-ordination	Due to the connection between the inner ear and body muscles by the auditory nerve, muscle strength, flexibility and tone, are influenced by sound and vibration (see 5.8.5). In a study of students in an aerobics class, researchers reported that music increased the students' strength and improved their ability to pace movements, with the rate and precision of movement tending to match the rhythm and tempo of the music. In addition to this, their mood and motivation were enhanced
Music affects body temperature	Sounds and music exert an influence on body temperature: • **transcendent** music can create a flood of warmth • **loud** music with a **strong beat** is capable of raising body heat by a few degrees • **soft** music with a **weak beat** can lower the body temperature
Music can increase endorphin levels	Recent biomedical research suggests that endorphins are able to lessen pain and induce a natural 'high'. The exhilaration produced while listening to certain music (movie sound-tracks, religious music, march-ing bands, drumming ensembles) are the result of endorphin release by the pituitary gland, boosting the spread of electrical activity in a region of the brain connected to both the limbic and autonomic control centres
Music can regulate stress-related hormones	Anesthiologists report a significant decline in the level of stress hormones in those listening to relaxing, ambient music. In some cases the need for medication is replaced
Music and sound can boost the immune system	Current research in immunology indicates that insufficient oxygen in the blood may be a major cause of immune deficiency and degenerative disease. Certain types of music (including singing, chant, and various forms of vocalisation) can boost the oxygen intake of cells, increasing the lymphatic circulation in some cases to as high as three times the normal rate
Music changes the individual's perception of space	Campbell (1997:73) claims that music can affect the way people experience the space around them: it can make the environment feel lighter, more spacious, elegant, orderly, efficient and more active
Music can change the individual's perception of time	In certain settings where time is dragging, 'up-tempo' music can seem to make time pass more quickly. A stressful atmosphere can be 'softened' by the use of highly romantic or New Age music, sometimes creating the sensation that time is standing still
Music can strengthen memory and learning	In much the same way that music can extend the individual's stamina when exercising, so too can it extend the stamina when studying. Memory can be enhanced by the use of music
Music can improve productivity	The training time for some firms has been virtually cut in half by the use of creative music programmes. An increase in efficiency and accuracy has also been reported
Music enhances romance and sexuality	Music can inspire or extinguish passion. Music that creates a leisurely emotional environment would be suitable
Music stimulates digestion	Researchers have found that rock music encourages people to eat faster, and a larger volume of food than normal. Fast-food chains tend to use bright and briskly-paced music for a quick 'turnover' of customers. A certain restaurateur uses a harpist, violinist and pianist to 'pace' each course of the meal, with a Strauss waltz to "move their conversations out of the restaurant"

Music fosters endurance	For many centuries, people have worked to the accompaniment of songs. Audio tapes that promote the synchronisation of cardio-vascular and muscular activity, are available for sport that requires stamina: cycling, jogging, skiing
Music enhances unconscious receptivity to symbolism	The sound-track of a film is of vital importance to its success. New experimental therapies make use of music to effect relaxation, and tap into the 'unconscious' to release traumas
Music can generate a sense of safety and well-being	The popular music of each generation declares its collective concerns, and creates a sonic sanctuary. Campbell (1997:77) claims that contemporary youth uses music as a refuge, through high volume, high energy and forbidden lyrics, contemporary hip-hop, rap and punk, young people feel insulated in a world that appears overly materialistic and hypocritical to them.

Campbell (1997:78) suggests that the above examples are an indication of how the power of music can take people back to self-generated healing systems, connecting them to a deeper meaning of life. The ever-increasing need for a 'meaning' to (the meaning of) life can, according to Zohar & Marshall (2000: 26-29), be traced back to the beginning of the 'scientific revolution' in the seventeenth century and has reached 'crisis' proportions in modern society. It would appear that **one of the ways a society reflects its need for 'wholeness'**, is **by becoming obsessed with health**: "to be healthy is to be whole".

5.8.5 The effects of noise

Some sounds and noises seem to have a harmful effect on the body, whereas others seem to be therapeutic (white noise). Noise is usually associated with an assault of sound on the ears, minds and bodies of those trying to live in a highly complex environment, adding to their stress load, putting their bodies out of tune and out of their natural rhythms. However, noise does not necessarily have to be loud to be harmful.

- **Harmful noise**

  High levels of noise in the home, from television sets, radios, vacuum cleaners, dishwashers and many other household appliances have, according to Halpern & Savary (1985:16,17), been shown to disrupt the sensory and motor skills of children during the first two years of life, including verbal development and exploratory activity. With 'quiet noise' (rumble of a refrigerator, hum of fluorescent lights, and others), most people are unaware that noise has affected them. Studies have demonstrated that even while sleeping, the long-term effects on the cardio-vascular system of low noise during sleep are greater than expected.

Research over the past two decades has indicated that the long range ingestion of noise:

- creates damage to the ear
- disrupts the central nervous system
- creates perceptual disturbances in hearing (and possibly other senses).

The effects of noise do not necessarily disappear when the noise ceases (Halpern & Savary 1985:27).

- **Therapeutic noise**

  All noise is not necessarily harmful. "White noise" (a complex signal or sound that covers a wide range of frequencies or tones, all of which possess equal intensity) in a radio transmission, is what "snow" is in a television transmission, sometimes also referred to as "innocuous background noise". It can be used to block out unwanted noise (noise screening) and to encourage sleep. White noise is also used to increase the chances of a restless new born baby falling asleep (Encyclopaedia Britannica 2001). ('Pink' noise contains more high frequencies; 'blue' noise contains more low frequencies.)

  CD discs that provide "straight white noise" are available from *whitenoiseCD.com*, and because of the CD format, the volume, bass, and treble, can be adjusted to suit personal taste (White Noise 2001).

5.8.6 Controlling noise

The environment does not adapt itself to the individual: the individual has to learn to either adapt to the environment, or change it. Where possible, certain negative elements of the environment can be identified and adjusted to counteract stress, induce relaxation, and promote health. "By understanding how sound and music can affect our bodies, emotions, and minds, we can begin to institute effective changes in our lives" (Halpern & Savary 1985:50,51,74). It is often possible to create and control sound in ways that are beneficial to body and mind.

Noise often results in stress and fatigue. Less environmental noise means less stress, improved health and enhanced resistance to disease. One practical consideration when acquiring new household appliances, is to select those models that are 'quieter' than the others, and where possible to instal the appliances with insulation and vibration mounts. Another antidote to sound pollution is to surround oneself with music that one experiences as 'useful' and harmonious.

5.8.7 Electronic 'smog'

Apart from the noise produced by common appliances and other sources encountered in everyday life, mind and memory functions can be impaired by electromagnetic pollution in the environment. Electromagnetic pollution can be caused by these very appliances and other 'noiseless' sources (such as power lines), causing confusion, depression, and poor mental function. Extremely low frequency (ELF) magnetic or electric fields are capable of producing hyperactivity and disturbed sleeping patterns in humans, by harming the neurotransmitters essential for memory: acetylcholine, norepinephrine and dopamine (see 2.5.3).

Electronic 'smog' has the power to affect memory, cause learning disabilities, depress the immune system and cause a variety of mental and behavioural disorders, including depression (Ostrander et al 1994:209). Other than create an awareness of 'noiseless pollution', it is beyond the scope of this study to suggest any specific solutions.

5.8.8 Selecting music to meet specific needs: music with a purpose

Certain rhythms and musical harmonies can affect emotions, either by intensifying them, or sometimes transforming them. Traditionally, major modes have often been associated with happiness and minor modes with sadness. These associations are, however, not always valid as many joyful gypsy dances as well as many 'uplifting' jazz tunes are in a minor mode, and country and western songs are written in major modes, yet evoke sad emotions in the listener. Melodic direction (ascending or descending) is another variable that generates different emotional responses (Halpern & Savary 1985:92,93).

Music has to be selected carefully to evoke a state conducive to learning. On examining long musical selections, the identification of their emotional effects can prove to be complicated. Although it is possible to use many different categories, the following three categories form a useful framework:

- music to calm
- music to energise
- music to focus.

For an individual, a recommended procedure would be as follows:

- choose a selection of music
- check pulse, breathing and mood before listening to it
- listen to the selection for about 20 minutes
- respond to the music in some way, by trying to relax (lie down, stand up, dance or sing), and after not longer than 20 minutes, check pulse, breathing and mood
- make a list of the responses as well as details of the musical selection.

In this way a list of music and its effects can be categorised, making it possible for the individual to locate music to meet his/her need(s) (James 2001). The music selections in Appendix B provide some guidelines.

For groups of children, social interaction, or the development of the **interpersonal intelligence**, can be promoted by the use of background music. In a study on the influence of background music on preschoolers' behaviour (a naturalistic approach), twenty-seven pre-schoolers were observed during natural classroom activities, either with background music present (folk or rock and roll) or no music. Behaviours were categorised in terms of social interaction, spatial location within the classroom, and posture. The presence of music favoured child-to-child social interaction (Weinberger 1998:7).

The following tendencies of certain genres of music, set out as therapeutic effects in Table 5-5 (complied from Campbell 1997:78-80), are general, and can be significantly modified by the **listener's frame of mind**, **dietary considerations**, the **environment** and **posture**:

Table 5-5

The therapeutic effects of different genres of music

TYPES OF MUSIC	PHYSICAL CHARACTERISTICS	THERAPEUTIC TENDENCIES
Gregorian Chant	Uses the rhythms of natural breathing to create a sense of relaxed spaciousness	Excellent for quiet study and meditation; can reduce stress
Slow Baroque (Bach, Handel, Vivaldi, Corelli, Teleman)	Steady, slow tempo; structured	Imparts a sense of order, stability, safety, predictability; creates a mentally stimulating environment for study/work
Classical (Haydn, Mozart)	The music has clarity, elegance and transparency	Improves concentration, memory and spatial perception
Romantic (Schubert, Schumann, Tchaikovsky, Chopin, Liszt)	The music emphasises expression, feeling, and invokes themes of nationalism, individualism, mysticism	Used to enhance sympathy, compassion, love
Impressionistic (Debussy, Fauré, Ravel)	Free-flowing musical moods and impressions; evokes dreamlike images	Can activate creative impulses; provide a connection to the 'unconscious
Jazz (blues, Dixieland, soul, calypso, reggae, other dance forms)	Expressive music of African heritage	Can uplift and inspire; release joy and sadness; convey wit and irony; affirm a common humanity
South American (salsa, rhumba, maranga, macarena and others)	The music has a lively rhythm and beat	Can set the heart racing; increase respiration; get the whole body moving. Samba can soothe and awaken at the same time
Big band, pop and top-40, Country-western	Regular beat	Inspires light to moderate movement; engages the emotions; creates a sense of well-being
Rock (artists such as Elvis Presley, the Rolling Stones, Michael Jackson)	Loud with a strong percussive beat; dissonance – chaotic, disturbing sounds	Can stir the passions; can have a disturbing influence; stimulate active movement; release tension; mask pain; drown other environmental sounds. Can have adverse effects such as tension, stress, and body-pain when listener is not in the mood for energetic entertainment
Ambient, Attitudinal, New-Age (music of Steven Halpern or Brian Eno)	No dominant rhythm	Elongates the sense of space and time; can induce a state of relaxed alertness
Heavy metal, punk, rap, hip-hop, grunge	Genres of rock with a strong rhythmic element; loud, harsh, distorted, murky, pounding sound. Vocals vary from hostile slogans to anguished, heartfelt, angst-ridden lyrics: a reflection of society	Can excite the nervous system leading to dynamic behaviour and self-expression; de-energises the brain; reflects the depth and intensity of the younger generation's inner turmoil (their dissatisfaction with a materialistic, hypocritical world) and their need for release
Religious/Sacred music (church hymns, gospel music, spirituals, shamanic drumming)	Devotional in feeling/used for church liturgy. Mainly consonant-sounding and expressive	Can be experienced as spiritually uplifting; create feelings of deep peace and spiritual awareness; can help to transcend and release pain.

5.9 An overall view

"Music is not a mere acoustic structure in time" or an artificial "stimulus created in a laboratory" (Altenmüller 2001b:2). It is a phenomenon of subjective human experience, based on a complex set of perceptive and cognitive operations represented in the central nervous system (ibid). The effect of music can be viewed in a number of ways:

- Music has a significant impact on learning, and should be applied scientifically at strategic points in the learning cycle for specific purposes

- Music can have energising or de-energising effects

- Music has an effect on health and spiritual well-being

- Music is the key to achieving relaxation, unlocking the subconscious and thereby enabling positive affirmations to succeed (Webb & Webb 1990:66,67).

The role of the musical intelligence in whole brain learning embraces:

- education *in* music
- education *about* music
- education *for* music and
- education *by means of* music.

Developing the musical intelligence should not be confined to one or more of the first three meanings, but should include **all four**, to justify the important role the musical intelligence has to play in whole brain education

Brain activation patterns during music listening and music processing depend on many factors. In addition to this, expertise and perceptive strategy (the way an individual listens) play a role. It seems plausible to suggest that music education may influence certain brain activation patterns in a specific way. The individual's "learning and listening biography, i.e. the associations connected or 'networked' to the auditory events are reflected in the brain activation patterns" (Altenmüller et al 2000a:105) (see 5.2.2). For example, auditory events such as:

- whether the piano is used during ear-training, or
- whether instructors encourage their students to sing

will be reflected in the activation patterns. A high inter-individual variability of brain activation patterns during music listening has been identified: every individual has his/her own individual networks for processing music. To remain healthy, the brain requires sensory stimulation that can be provided by music. Creating a 'sonic diet' by the careful selection of music with respect to pulse, pace, and pattern of music can keep an individual "energized, refreshed, and relaxed" through many different circumstances (Campbell 1997:81).

It has been found that musical processing increases neural activity, making it plausible that it improves cognitive abilities in general, with 'making music' an example of sensorimotor integration at the highest level (see 5.5.4). The fact that music is the first sense to develop in the fetus, and possibly the last to 'go' in cases of dementia, could be considered an indication of how an individual is 'enveloped' in music from the cradle to the grave. It also indicates how beneficial the development of the musical intelligence could be in whole brain, life-long learning.

CHAPTER 6

Conclusions, Future Trends and Recommendations

6.1 Introduction

The main focus of this study was to examine the role of the musical intelligence in the context of whole brain education. To understand what is meant by whole brain education requires a basic understanding of the physical brain and certain brain based functions with educational implications. In this study, whole brain education focuses on the involvement of brain functions within the framework of Gardner's Theory of Multiple Intelligences and the three dimensional perspective of IQ, EQ, and SQ. In the past, education concentrated extensively on the cognitive functions that could be measured by psychometric tests (IQ), at the expense of any emotional and/or kinesthetic influences affecting learners.

Since the concept **musical intelligence** has remained ill-defined for music educators, it was necessary to provide a comprehensive and comprehensible definition. This was done by examining each of Elliott's four meanings of music education and their contribution to the development of the musical intelligence. Music was found to be specially suited to represent higher cognitive functions. Although usually abstract, music ability conforms to complex rules requiring the operation of **many parts of the brain**. It clearly involves thought, emotion, and movement.

Whole brain education or accelerated learning requires an understanding of the physical brain and selected brain functions that impact on education. The current understanding of nerve cells, the brain, and behaviour, has emerged over the last century from the disciplines of anatomy, embryology, physiology, pharmacology and psychology. In recent years there has been a growing appreciation that in each species, including humans, learning is controlled by a unique set of biological constraints. All behaviour is shaped by an interaction of genetic and environmental factors, and there is no sharp distinction between learned and innate behaviours.

Zohar & Marshall (2000:39) (see 3.3) explain that human intelligence has its roots in the individual's genetic code and in the evolutionary history of life on this planet. They propose:

"Three kinds of thinking, three kinds of intelligence", all based on scientific evidence. An understanding of each of these three kinds of intelligence, IQ, EQ and SQ, is essential to the concept of **whole brain** education.

As far as possible, use has been made of scientific research results and brain based research studies. There are a number of conflicting interpretations of neuroscientific and neuromusical research results, in particular with respect to the simplistic, and now outdated, concept of left and right brain processing. The complexity of left and right hemispheric processing can, to a certain extent, be acknowledged by substituting 'analytical, sequential thinking' for left-brain activity and 'holistic, global/gestalt thinking' for right brain activity. In this way contradictory interpretations need not necessarily feature as a major issue, and the references used not be discarded or considered as providing incorrect information.

6.2 The physical brain and behaviour

The fact that all behaviour is reflected by brain function forms the central tenet of modern neural science (Kandel et al 1991:5) (see 2.1). The brain is made up of individual cells: neurons (nerve cells) and glial cells, and it is the task of neural science to:

- explain **how** the brain uses these units to control behaviour
- explain how the functioning of constituent cells in the brain is influenced by the environment (including the behaviour of other people).

The very sense of the individual as a *self*, or coherent being, is achieved by neurally connecting a 'family' of distinct operations carried out independently in the two cerebral hemispheres. In a study of epileptic patients in whom the two cerebral hemispheres had been surgically separated by cutting the connecting fibre (*corpus callosum*), it was found that each hemisphere carries an independent awareness of the self (Kandel et al 1991:15) (see 2.2.1). Neural representation of consciousness and self-awareness requires dealing with some of the deepest questions in biology, and it should be appreciated that understanding how complex behaviour is represented in the brain is still in the early stages. There is, however, considerable optimism in neural science that the principles underlying the biology of mental function will soon be understood.

To study the relationship between a mental process and specific regions of the brain, it is necessary to identify the components and properties of the behaviour that needs to be explained.

Of all behaviours, higher mental processes are the most difficult to describe and measure objectively. Anatomically, the brain is immensely complex: the structure and interconnections of many of its parts are still not fully understood. Cognitive psychology, brain imaging techniques, and new anatomical methods as conceptual and methodological tools, have combined to explore this complex organ.

6.2.1 Development as a guide to the regional anatomy of the brain

Although the anatomy of the brain is very complex, there is a logic to brain anatomy which becomes clearer with an understanding of how the brain **develops**. Early in the development, the regional anatomy of the nervous system is simple:

- From the outer layer of the embryo, the **neural plate** develops
- As the neural plate thickens and folds over onto itself, the **neural tube** is formed
- In the early stages the neural tube is composed of three vesicles: forebrain, midbrain, and hindbrain
- The forebrain vesicle gives rise to two additional vesicles: the **telencephalon** and the **diencephalon (**see 2.3.1).

The anatomy of the brain stem and spinal cord is relatively simple by comparison to the complex anatomy of the cerebral hemispheres. As a result of the folding and differentiation of the neural cells, structures belonging to functionally unrelated systems often come to lie next to one another. To a certain extent, this explains why local injuries to the nervous system indiscriminately affect all the functional systems within a given area of the brain. It also indicates why neuroscientific research is so complex.

6.2.2 New imaging techniques

Through the use of new brain imaging techniques, it is now possible to 'map' the activity of populations of neurons in the living brain in a behavioural context. A more precise understanding of the relationship between the regional anatomy and localised function of the central nervous system is gradually emerging: as modern imaging techniques make it possible for regional anatomy to be visualised in the living brain, the understanding of spatial relationships between neighbouring structures has been greatly facilitated.

6.2.3 Biological diversity

Gender differences cannot be reduced to those of reproduction: the interplay of specific hormones on the male or female brain, which is specifically wired to react with them, has a profound effect on each individual. There is a critical interplay between the hormones and the unformed brain of a fetus, in particular during the early stages of embryonic development. In any learning situation, cognisance should be taken of the differences between the male and female brain with respect to behaviour, emotion, ambition, aggression, skill, and aptitude.

Biological diversity is a scientific fact. Unfortunately this comes into conflict with political, ethical, and social precepts of equality, which in many cases leads to valuable scientific information being withheld due to political considerations.

6.2.4 The significance of brain wave patterns

The electrical activity of the brain can be mechanically recorded as a brain wave pattern, with the different brain waves reflecting different levels of consciousness. There are four main frequencies produced by the brain: delta, theta, alpha, and beta. The wave frequency is measured in cycles per second (CPS) or Herz (Hz). In cases where an individual is unable to access the beta brain waves, learning and emotional problems occur. The individual can, however, be trained to access beta brain waves when required, by means of neurotherapy.

Accelerated listening and learning, for example, requires both brain hemispheres to produce similar brain wave patterns to create a rhythmic 'synchronisation'. Valuable integrating tools to facilitate synchronisation are: **music**, movement, and art (see 5.7.1).

MEG studies have attached particular significance to the relatively fast 40 Hz neural oscillations, which are found in different systems and levels all over the brain. The presence of consciousness in the brain is associated with the presence of 40 Hz neural oscillatory activity, which disappears when the brain is in coma or anaesthetised (Zohar & Marshall 2000:75). In the same way that rational, logical, data processing (IQ) is made possible by **linear/serial neural tracts**, pre-conscious and unconscious associative data processing (EQ) is made possible by **parallel neural networks**. The **40 Hz 'across-the-brain-oscillations'** provide a means to bind experience of IQ and EQ together, and place it in a frame of wider meaning (SQ).

6.2.5 The senses

There are six ways by which humans sense the world (see 4.6):

- vision
- audition
- gustation
- olfaction
- somatic sensation
- gravity.

The sense of gravity, which the vestibular system uses to orient an individual in space (head and body movement), is not often included with the other five senses. Its importance should, however, not be underestimated. Each sensory organ has a specialised set of receptor cells for converting its own kind of stimulus energy into mechanical, electromagnetic, or chemical energy that can be processed by the nervous system.

The vestibular system, in particular vestibular hearing/listening, has proved to be of vital importance in developing the musical intelligence (see 5.3.3).

6.2.6 The mind/ brain/ body connection

The notion that mental activities are 'superior' to physical activities, is a societal bias that has led to the down-grading of physical achievements in the learning situation. "The whole point of a brain is to move . . . ultimately there is no aspect of our mental life that is not founded upon, and devoted to, motion. Movement is the concern of the whole brain" (Jourdain 1997:206,207) (see 2.9).

Learning involves the development of skills with which a learner can express knowledge. The process of developing these skills involves body muscles to establish neuromuscular routes and their connections to cognitive routes. Learning is not limited to cognitive processes, but includes the active, muscular expression of that learning (see 2.9). The response to abstract thinking can only be manifested by the use of body muscles: movement is an integral part of mental processing. If thoughts are to be remembered, they must be 'anchored' by movement.

6.2.7 Organisation of the brain

In the controversial *nature versus nurture* issue, education has treated the nurture aspect as dominant. However, the new biologically based brain theories maintain that *nature* plays the more important role (see 2.10.1 and 6.3.8), a view supported by evolutionary psychologists.

The functional grouping of the reptilian brain, the limbic/mammalian brain, and the neocortex, referred to as the **triune brain**, serves to explain some of the brain's complex functions in relatively simple terms. This particular 'construct' is not used in the discipline of neuroanatomy, but serves to promote understanding of brain functions in the educational (non-scientific) community. The 'dual' brain (left-brain/right-brain) organisation, which has presented many contradictory research results, is discussed in 6.1.

6.2.8 Future trends in brain research

Improvements in the methods of imaging the living brain will make it possible to understand the neural basis of human behaviour, linking behaviour with biology. Improved neuro-imaging may also make it possible to make more accurate diagnoses of problems, and to determine the efficacy of a given treatment.

Another area to be examined is the validity of various theories of behaviour. Closer alliances between studies of brain behaviour and brain development could shed new light on the biological bases of behaviour.

6.3 How different regions of the brain are specialised for different functions

Modern imaging techniques have made it possible to assign specific brain functions to different regions of the brain, and one of the 'cornerstones' of modern brain science is the idea that different regions of the brain are specialised for different functions (Kandel et al 1991:7).

When reviewing the literature on brain substrates of music processing, a puzzling variety of findings can be stated. The traditional view of a simple right versus left hemisphere dichotomy of brain organisation, with music being processed in the right hemisphere and language in the left hemisphere, is still represented in many textbooks. This simplistic view was challenged twenty years ago. Modern concepts emphasise the **modular** organisation of music cognition: different aspects of music are processed in different, although partly overlapping neuronal networks of **both** hemispheres.

"Music" in terms of brain substrates of music processing is not merely an acoustic structure in time, or "a stimulus created in a laboratory to fit a well-controlled experimental design, but a phenomenon of subjective human experience. Such an experience is not based on a uniform mental capacity, but on a complex set of perceptive and cognitive operations represented in the central nervous system" (see 5.9). It would appear that time structures are processed to a greater extent in the left temporal lobe, whereas pitch structures may be processed primarily in the right temporal lobe networks (see 5.2.2).

6.3.1 Language localised within the cerebral cortex

Language is a uniquely human ability and sets humans apart from other animals. Language is limited and shaped by the human sensory-motor apparatus and does not make use of frequencies of sound that cannot be heard by the human ear and produced by the human voice (Kandel et al 1991:994). Noam Chomsky suggests that humans have some innate programme that prepares them to learn language in general. Chomsky argues that the only plausible explanation for children's ability to acquire the grammar of their first language, and adults' ability to effortlessly use this grammar, is if one assumes that all grammars are variations of a single, generic "Universal Grammar" and that human brains all come complete with a built-in language organ containing the blueprint for this language (Deacon 1997:35).

Chomsky's view does not have scientific support based on neuroresearch. Linguists and psychologists now believe that the mechanisms for the universal aspects of language acquisition are determined by the structure of the human brain (Kandel et al 1991:842,843).

6.3.2 The physical process of hearing

Sound is produced by vibrations and is transmitted through air by means of pressure waves. These vibrations can, for example, be caused by the movement of speakers' diaphragms, piano strings or vocal chords that result in increased or decreased pressure of the surrounding air. This disturbance radiates outwards from the source as a pressure wave, with alternating peaks and valleys of pressure.

- The *frequency* of the wave, or the number of peaks passing over a given point per unit time determines the *pitch* of the sound, and is measured in *cycles* per second or *Hertz* (Hz). The human ear is sensitive to a fairly wide range of frequencies: from about 20 to 20,000 Hz.
- The *amplitude* of the wave is the maximum change in air pressure in either direction, and determines the *loudness* of the sound. The amplitude of pressure waves is measured in *decibels* (dB). The amplitude for conversational speech is about 65 dB, and the range of sound over which the ear responds is about 120 dB.

The physical act of hearing involves the cochlear-vestibular system of the brain. This system plays a vital role and suggests that **the mind does not grow without movement** (see 4.6.2).

6.3.3 Acknowledging emotional intelligence

The emotional intelligence is involved in the **control** and **regulation** of emotions. The development of certain emotions in the young child is crucial in determining the child's readiness for school, as the emotions affect the child's ability of knowing **how** to learn (see 3.2). Cognition and emotional intelligence should not be seen as opposing competencies, but rather as separate ones that complement one another, adding to an individual's qualities.

Emotional self-control is a basic skill, enabling an individual to exercise constraint instead of acting impulsively or demanding instant gratification. The ultimate state of self-absorption in a task of performance or learning where the attention is relaxed, but highly focused, is known as 'flow'. In a state of flow, neural circuits are most efficient, requiring only a bare minimum of energy. Students who are able to get into flow when they study are more successful and usually become high achievers.

Social incompetence can be described as a learning disability with respect to interpreting non-verbal/emotional messages. Socially incompetent learners become socially isolated, and their inability to read or respond to a teacher or another child creates anxiety, which interferes with their learning ability.

6.3.4 Spiritual intelligence (SQ) based on scientific evidence

Neurobiological research on language and symbolic representation indicates that humans have used their SQ to 'grow' their brains to become who they are. SQ provides humans with the potential for continued further growth and transformation (see 3.3.1).

Linear/serial neural connections make it possible for rational, logical data processing to take place, and form the basis of human IQ. Parallel neural networks make preconscious and unconscious associative data processing possible, and form the basis of EQ. Neither form of neural organisation is able to answer the question 'Why?'. A third neural organisation based on 40 Hz neural oscillations provides a means by which human experience can be bound together and placed in a wider frame of meaning (SQ).

Research on 40 Hz neural oscillations in the brain shows that consciousness is an intrinsic property of the brain, and that these oscillations are present during full, waking alertness as well as dreaming or REM (rapid eye movements) sleep. The 40 Hz oscillations could be termed SQ's "neural substrate". The various neural oscillations are associated with electrical fields in the brain, which are generated by large numbers of dendrites oscillating 'in concert'. MEG studies indicate that the relatively fast 40 Hz oscillations are found all over the brain (Zohar & Marshall 2000:68-76) (see 4.10).

6.3.5 There can be no learning without memory

To understand the neurobiology of learning and memory (see 3.4), it has to be appreciated that there are different 'types' of memory. Much has been written on the neurobiology of memory, most of which can be summarised as follows:

- Memory has different stages, and its representation is continually in the process of changing
- It is possible that long-term memory may be represented by plastic changes in the brain
- The plastic changes that encode memories are localised in multiple regions of the nervous system
- Reflexive memory (including forms of perceptual and motor learning: non-verbal expression) and declarative memory (including the learning of facts and experiences: verbal expression) could involve different neuronal circuits.

The distinction between short-term and long-term memory has its origins in neurology. The frontal lobes are concerned with the processing of short-term memory, whereas long-term memory is processed by a special system involving the middle and lower temporal lobes, and a structure just beneath called the *hippocampus*. Removal of this crucial structure renders an individual unable to form new long-term memories.

The emotional impact of what is learned in critical periods has a direct influence on the permanency of stored information. Music, in particular, acts as an excellent medium to successfully encode information. The pace at which information is processed has an effect on the amount of information a learner can recall. Learning appears to be more successful when the learning matter is distributed over time, rather than being crammed into a short period of time.

With respect to composing music, short-term/working memory is usually sufficient for trying out variations on a particular passage by audiation. Some composers are able to create complete compositions in their heads before writing them down, by making use of long-term memory.

6.3.6 The value of dominance profiles

Different parts of the body contribute to supplying the brain with the information it needs for learning. The eyes, ears, hands, and feet in particular, are important contributors to the learning process (see 3.5).

In the same way that an individual favours using a particular eye, ear, hand, or foot, there is also a tendency to favour one brain hemisphere over the other. Although information processing is far more complex than merely ascribing all logical, analytical functions to the left hemisphere, and all global, emotive, or intuitive functions to the right hemisphere, individuals do show a preference for processing information in either an analytical or gestalt way.

Insofar as the brain has a crossover pattern, with each side of the body communicating with the brain hemisphere on the opposite side (cross-lateral control), dominance profiles may be viewed as 'brain based'. At the same time, however, it should be noted that all aspects have not been subjected to neuroresearch. Dominance profiles have proven effective in practice as a personal assessment technique, and provided much-needed information about how individuals learn in new learning situations and in times of stress (see 3.5.3 and 3.5.4). It would be foolish to ignore the value of this assessment system on the grounds that all aspects have not yet been scientifically researched, but educators should exercise caution.

6.3.7 Selecting 'suitable' brain waves

Although brain scans are invaluable in locating the general distribution of function, much work still needs to be done to improve the quality of brain scans, in particular with respect to determining the precise localisation of functions. Scans have been found to be subtly misleading at times, so much work connected to music perception has focused on the 'evoked potentials' (brain waves), measured by electrodes that are placed on the scalp. The data is then fed through computers to detect subtle responses to "discrete musical events" (Jourdain 1997:285).

Researchers involved in developing techniques to enable children and adults, who have an excess of slow *theta* waves and relatively few fast *beta* waves, to retrain their brain waves, have found neurotherapy to be particularly effective (see 3.6.3).

In a similar way, the success of accelerated learning depends on the individual's ability to switch from the fast beta waves to the slightly slower *alpha* waves. The so-called meditative or 'alpha state', can be induced by using suitable slow Baroque or New Age music.

6.3.8 Implications of evolutionary psychology for learning/ teaching

The discipline of evolutionary psychology recognises that individual differences are caused by each individual's unique genetic inheritance, personal experiences and culture. There is enough significant research data available to support the view that heritability plays a powerful role in defining 'who' and 'what' we are (see 3.7.1). A specific environment may be conducive to the development of particular brain profiles, but may have little or no positive effect on other profiles.

People are usually encouraged to use 'logical' reasoning when making choices. However, evolutionary psychology suggests that emotions are the **first** screen to all information received (a function of the limbic system), and can never be fully suppressed. When comfortable and secure, people are 'hardwired' to avoid loss, but to defend themselves desperately when threatened. Because of the primacy of emotions, people in authority should be particularly careful to navigate negative messages with extreme sensitivity, keeping in mind that one negative message can erase any number of positive messages.

6.3.9 Future trends in research on brain function

One of the major tasks confronting the neurobiology of learning (and memory) is to determine how alterations in the brain are related to changes in behaviour. Another task is to determine the mechanisms responsible for the plastic changes that encode memory.

At present, most 'brain based' strategies have not been scientifically researched. As research makes evidence available, many of these strategies will have to be suitably adapted.

In choosing to ignore scientific data on the powerful role of **biogenetic identity** for the sake of political expediency, it is possible that humankind may not be served well with respect to 'who' and 'what' they are. Without this knowledge, flames of personal dissatisfaction may be fanned and false expectations created.

6.4 Whole brain education as 'superlearning'

Neurobiological studies indicate that the potentialities for **all** behaviour in an individual are created by genetic and developmental mechanisms that act on the brain. Certain environmental factors and learning accentuate specific capabilities by changing the effectiveness (and anatomical connections) of pre-existing pathways. It could be said that everything that occurs in the brain, from private thoughts to commands for movement, can be ascribed to **biological processes**.

From the convergence of neurobiology and cognitive psychology, a new perspective has been gained on perception, learning, and memory, and as knowledge of the two disciplines expands, the scientific description of 'thinking' will contribute to a unified biological understanding of behaviour (Kandel et al 1991:1028-1030).

Whole brain education requires a scientific understanding of brain mechanisms, how the brain processes information, and how certain malfunctions could impact on the successful completion of simple or complex learning tasks. The underlying mechanisms of emotion, cognition, memory, attention, and skill development play a crucial role in the development of teaching and learning strategies. These whole brain educational strategies include:

- Adapting instruction to auditory, visual, and kinesthetic learning styles
- Making use of multiple intelligences to achieve specific outcomes, rather than manipulating the learner's environment to achieve a desired behaviour.

The goal of life-long learning, as emphasised so strongly in South Africa's outcomes-based education system, earns new impetus with the knowledge that humans have the capacity to grow new neural connections throughout their lives. This impetus should be even greater when considering that the converse is also valid: neural systems that are seldom used, shrink, disappear or are taken over for other purposes.

6.4.1 Serial, associative, and unitive thinking

Scientific evidence of a spiritual intelligence adds an important new dimension to the two processes with which Western psychology is associated: IQ and EQ (see 3.3). A vital component of whole brain education is the utilisation of all **three** processes. In addition to an understanding of the concept of the **triune brain**, it is essential to understand the brain's different thinking systems and their neural organisation with respect to IQ, EQ, and SQ:

- **IQ (serial thinking)** (see 3.3): one kind of neural organisation enables humans to make use of rational, logical, rule-bound thinking. The advantage of serial thinking is that it is accurate, precise and reliable, and is useful for solving rational problems or achieving definite tasks. Serial thinking ability is the kind of mental ability tested for in standard IQ tests.
- **EQ (associative thinking)** (see 3.2): another kind of neural organisation allows people to make use of associative, habit-bound, pattern-recognising emotive thinking. Associative thinking is at the core of most of human emotional intelligence: the link between **one emotion and another**, between **emotions and bodily feelings**, and between **emotions and the environment.** It can be considered as 'thinking' with the heart and the body, and is, for example, the intelligence used to great effect by a musician who has practised painstakingly. Associative learning is heavily experience-based. People **feel** their skills, and **practise** their skills, without thinking or talking about them, because they provide a sense of satisfaction or a feeling of reward.
- **SQ (creative thinking)** (see 3.3): a third kind of thinking enables people to be creative, insightful, both rule-making and rule-breaking, and could be described as thinking "with our spirits, our visions, our hopes, our sense of meaning and value" (Zohar & Marshall 2000:43). With this kind of 'unitive' thinking, it is possible to reframe and transform previous thinking, and to constantly 'rewire' the brain.

The utilisation of the thinking processes incorporated in all three thinking systems, plays a vital role in whole brain teaching and learning.

6.4.2 Why whole brain education?

The teaching and learning skills required during the Industrial Age are no longer adequate to accommodate the trends of the Information Age. Many psychologists and educators have queried the existence of a single intelligence fixed at birth, turning the focus to educating 'life-long learners' in a culturally diverse, global society. Certain beliefs are basic to the facilitation of whole brain education, such as:

- all people can learn
- all people want to do a good job
- all people want to be part of a community
- all people have an inherent self-worth
- all people can improve educational performance.

It should be noted that there is substantial research data to support the view that intelligence cannot be **increased**, but that it can be developed to a satisfactory or high level.

6.4.3 Using memory-building techniques

Without memory there can be no learning. An understanding of the neurobiology of learning and memory requires an appreciation that there are different types of memory. Several different functional systems for memory and recall have been identified and labelled (see 3.4.5 and 6.3.5), and it is vitally important that both learners and teachers are aware of memory-building techniques, and know how to use them.

Memory-building techniques based on the principle of **association** are particularly effective: the more connections that can be created between new information and existing information, the better the brain can store that information, and later recall it. Natural mental (memory) 'maps' can be powerfully stimulated by music, stories, imagery, and celebrations.

The *locale* system registers mental/emotional maps that are continuously being updated, whereas the *taxon* memories consist of 'parts' (single words, concepts, etc.) that have been memorised. The *locale* system makes use of the contents of the *taxon* systems. Information to be stored in memory needs to have **man**y connections, and be of **such** a quality, that it can be accessed in any context.

6.4.4 The dominance factor in education

As discussed in 3.5 and 6.3.6, the eyes, ears, hands and feet are important contributors to learning. An individual's 'limited' or 'able' dominance profile provides vital information about **how** he/she learns in a relaxed atmosphere or in a new learning situation. There is a need for Dominance Profile assessment in schools, in particular to identify:

- Gifted and talented learners
- Normal learners

- Learners in need of remedial education (those with reading difficulties)
- Emotionally handicapped learners and those in need of special education (those with learning disabilities such as ADD and ADHD)
- High school students who need to be redirected.

Learners labelled 'gifted' and 'normal' have been found to be predominantly logic hemisphere dominant, demonstrating high linear and verbal abilities, whereas those in need of special education are mostly gestalt dominant learners, who tend to have lower linear and verbal skills. Due to **stress in the learning environment**, gestalt learners end up depending only on their dominant gestalt hemisphere. There is strong discrimination against gestalt learners in Western society.

In a random sample of 218 high school students, Hannaford found that on average, only 15% of the population had full sensory access, with the **Gifted and Talented** group having the largest number of **full sensory learners** (see 3.5). Fifty-two percent of the population had an **auditory limited profile**. With lecturing as the primary way of teaching, nearly half the audience would be unable to process auditory information. A relatively high percentage of students in both the Gifted and Talented group, and the Special Education students, had auditory limited profiles.

In the Special Education group, 89% were gestalt dominant and therefore **kinesthetic learners**, in comparison to the 22% of the Gifted and Talented group. As many as 85% of all students are kinesthetic learners.

Only about 28% of the Gifted and Talented group were visually limited (dominant eye on the same side as the dominant hemisphere) compared with just over 72% of the Special Education group. Left eye dominance, with the left eye's natural tracking movement from **right** to **left,** has a particular consequence for learners in a society where languages are read from left to right. The dominant left eye will want to look at the right side of the page first and then move to the left. In her study, Hannaford (1997:150) found that 81% of remedial students were left eyed/right hand dominant, experiencing reading problems such as reversing letters and numbers, and sometimes with writing difficulties or letter reversals. A number of left eye dominant students are able to switch to the non-dominant right eye, but in times of stress often revert to their basal left eye dominance.

The assessment of dominance profiles can make an important contribution to facilitating effective teaching and learning, by creating an awareness of 'limiting' or 'able' components in an individual's learning profile (see 3.5).

6.4.5 Development of the sensory modes

How people know, feel, learn, and think will eventually determine **what** they know, feel, learn, and think. The sensory-motor systems play a crucial role in how an individual experiences the world, in particular the vestibular system and proprioception, that provide information about gravity and motion, and the sensation of the body's position in space (see 4.6).

In the young child, the vestibular system is particularly active, making it possible to gain knowledge of the physical environment through movement.

6.4.6 The mind/ body link affects learning ability

Although teachers and learners are aware of the importance of movement, the senses, and emotions in learning, it has become increasingly difficult to apply this information. Modern life-styles are not conducive to regular exercise, with 'stress' playing a prominent role in day-to-day living. In many cases, people resort to drugs to alleviate stress, which impacts negatively on their learning ability.

Nutritional considerations for the brain before birth and before the age of five, play a crucial role. The power of the brain depends on the number of neurons and the number of their inter-connections, both of which are severely reduced by malnutrition.

In areas where pollution in both air and water has reduced the levels of oxygen, which is a vital constituent of the brain, there could be several negative effects on an individual's learning ability (see 4.8.3).

6.4.7 Cultural aspects

Contemporary psychologists emphasise the role of 'culture' in intelligence, pointing out that what may be considered intelligent in one culture could be considered stupid in another. Explicit theories of intelligence attend to issues of metacognition and the influence of culture. The language, legacies, needs, and beliefs of a society combine to form a concept of intelligence that is appropriate to that society. In certain aspects the concept may be similar to that of another culture, but the ways in which it differs should not be ignored. For one culture intelligence may have a cognitive orientation, whereas for another the focus may be on wisdom, cleverness, and responsibility. In investigating the complex phenomenon of intelligence, some have sought to understand it through 'systems models', such as Gardner's Theory of Multiple Intelligences.

6.4.8 The Theory of Multiple Intelligences

There are many alternative ways to study and understand 'intelligence'. The role of *metacognition* is emphasised by contemporary experts. This implies how people understand and control their own thinking processes during, for example, problem solving, reasoning and decision making. Among the many competing theories of intelligence, the main ones have focused either on a single general factor that dominates intelligence, or multiple equally important abilities that constitute intelligence.

Charles Spearman, whose book *The abilities of man* was published in 1927, is usually considered the pioneer of factor analysis. He concluded that intelligence could be considered in terms of a single general factor (g), and a set of specific factors (s), each involved in a "single type of mental-ability test", with the general factor derived from "individual differences in mental energy" providing the key to understanding intelligence. The *g* factor theory appears to still have considerable support from a number of psychologists, such as Rushton and Galley.

The concepts of intelligence have tended to become much 'broader' in recent years. A contemporary illustration of this broader concept is Howard Gardner's Theory of Multiple Intelligences, which is based on:

- evidence derived from the effects of localised brain damage
- specific patterns of development in each kind of intelligence across the life span
- studies concerning exceptional people that have been accorded the status of idiot savant or genius
- evolutionary history.

Gardner views intelligence as a complex system, and not a single, unitary construct. MI theory proposes eight distinct intelligences that function somewhat autonomously, but that may interact to produce intelligent performance.

6.4.9 Future trends in education

As a result of the complexities of neuro-scientific research, educators without a scientific training often have to rely on simplified interpretations of information pertaining to research results. In simplifying information of this nature, to make it accessible to a wide range of people, there is a real danger of distorting the 'scientific truth'. **Brain-based** activities and information such as Brain Gym, Neuro-Linguistic Programming (NLP), Dominance profiles, teaching and learning through Multiple Intelligences, and Accelerated Learning, have proved to be very effective for educational and developmental purposes, but they have not yet been scientifically researched and proven. It could prove to be foolish to ignore them on these grounds, but until scientifically proven, the above-mentioned should be **implemented with caution**, as various aspects of these brain-based activities are subject to different, sometimes contradictory interpretations.

To prevent **all** memories from being accessed at the same time in 'chaotic' fashion, it is necessary for the brain to exercise certain constraints with respect to the retrieval of processed information (see 4.3), making it imperative for learners to know how to access stored information, or memory, for purposes of learning. This points to a distinct need for educators to keep themselves informed on neuroresearch pertaining to education, which in turn suggests the need for teachers of the future to be provided with scientific training, to facilitate their understanding of how the brain really works.

A typical school curriculum usually offers very few (if any) kinesthetic learning techniques.
The health of an education system must necessarily depend on nurturing and promoting the learning of **all** its citizens. Appropriate curricula need to be established that synthesise whole mind/body processing, through regular art, music, and movement in conjunction with cognitive skills. Where appropriate, learners can be given mind/body integrative tools such as Brain Gym (see Appendix A) to stop the stress cycle and facilitate full sensory/hemisphere access. In other words, educational systems should encourage holistic, intuitive, image-based (as opposed to verbal-based) thinking, in an attempt to understand and facilitate the learning process of gestalt learners.

6.5 An inclusive perspective of musical intelligence

Elliott proposed that music education, as an accepted means of educating learners with respect to music, or developing their musical intelligence, has at least **four** meanings:

- music appreciation
- propositional knowledge **about** music
- procedural knowledge for **making** music
- education **by means of** music.

The music education philosopher, Bennett Reimer contends that spatial-temporal reasoning development places music educators in the position of having to justify music on this new basis, posing a threat to music education (see 5.2.7). The fact that the development of spatial-temporal reasoning could even be considered as a point of departure for promoting music education, points to a critical need **to re-define the role of music education in the development of the musical intelligence**. Now that there is enough empirical evidence available to lend significant support to education 'by means of music', there is no reason why the development of the musical intelligence should be confined to music education that is devoted exclusively to musical learning. The role of music in associative learning has also proved to be effective, and makes a significant contribution to the total development of the musical intelligence.

Education may not be able to **increase** 'intelligence', and similarly musical intelligence cannot be increased by music education, but can be **developed** to a reasonably high level by means of music education. To eliminate **any** of the four meanings of music education would seriously limit the possibilities of developing the 'musical intelligence' to this level. Neuromusical research has introduced a new approach to music and music learning, making it imperative to include all four meanings of music education in an **inclusive** approach, rather than an **exclusive** approach.

In terms of Gardner's MI theory, the musical intelligence can be viewed as an autonomous intelligence, as well as overlapping with the other intelligences, and has a vital role to play in whole brain education.

6.5.1 Music processing

Neuromusical research is providing valuable information about music processing. Brain imaging techniques have made it possible to understand how music learning affects brain activation patterns and networks, and to monitor how the brain learns and thinks.

'Making music' has emerged as one of the most complex human achievements, where simultaneous demands are made on human hearing, sensorimotor integration, and body-awareness, as well as involving those parts of the brain that process emotions (see 5.2.2). Musicians and non-musicians have been found to process musical information differently, with musicians tending to make use of analytical cognitive strategies, in contrast to non-musicians who are restricted to relying on a sort of 'feeling'.

In a study by Altenmüller (2001:4) on the impact of music education on brain activation patterns (see 5.2.3), it was found that musical expertise influenced auditory brain activation patterns. Changes to these activation patterns depend on applied teaching strategies such as music, verbal explanations, visual aids, notations, etc. The two most important factors influencing brain activation patterns during learning were found to be:

- the learner's instrumental training, and
- the teaching strategy used.

Increased neural activity resulting from musical processing can therefore be assumed to improve an individual's cognitive abilities in general.

Some of the basic premises based on neuromusical research indicate that:

- the 'musical brain' starts functioning in the six-month old fetus, and remains functional throughout life, even in cases of severe dementia
- early and ongoing training affect the organisation of the musical brain
- music is not limited to right hemisphere processing. Although certain authors refer extensively to left and right-brain functions, it is more accurate to think of music as being processed in widely distributed, locally specialised regions of the brain.

6.5.2 Education in/about/for music

The following meanings of music education all contribute to the development of the musical intelligence:

- Education **in** music focuses on promoting music listening. Although listening to music is an experience inherent in people, it can be greatly enhanced by learning. Emotions are processed during music listening, with negative emotions being elicited by more dissonant sounding music, and positive emotions being attributed to Baroque, Classical and softer Pop style compositions.

The social benefits of listening to music in a concert situation where the audience collectively experience the emotions of the music, is being changed to 'individual listening' of CD's, audio cassettes etc., that also provide a pleasurable experience. A good quality sound source is necessary to promote good music listening skills.

Movement is an intrinsic part of the musical listening experience. The scientific, artistic, and physical disciplines involved in making music have value in the power they provide individuals to control their own intellectual, emotional, and physical lives. Bodily movement is essential to the growth of the mind (see 5.3.3).

- Education **about** music involves the acquisition of propositional knowledge. This moves the focus to treating music as a language, with prime importance attached to written notation or verbal descriptions of sound. Where this is the case, there is a distinct possibility that the actual sound will not play a significant role, if any. Effective music learning and teaching can only take place when there is fluent interaction between thinking (cognitive), feeling (affective), and doing (psychomotor), as well as the facility to convert musical 'symbols' into sound.

  In Western musical traditions, the ability to interpret symbol systems such as notation, chord notation, tablature, and sol-fa has a profound effect on musical development. In aural musical cultures, the focus is directed to aural alertness and good memory.

- Education **for** music concerns instrumental teaching and learning with **performance** as the 'outcome' of the process. Too often, instrumental teaching focuses on the ability to read notation, and combine this with the technical skills required to transform the notation into musical sound, but largely **ignoring the human capabilities and limitations of the performer on physical, emotional, and spiritual levels.**

  Growth spurts of 'nerve-net' development at approximately thirty years of age have a particular significance for musicians. Further refinement of the muscles of the face and hands takes place, with vocalists now able to use a greater range with their vocal cords. With musicians like violinists and pianists, greater fine muscle control leads to greater achievements (see 5.5).

Instrumental lessons can often, quite unintentionally, centre on reading and motor skills and ignore any development of the ear or musical dialogue between teacher and student. Students often play without listening, with no remedial action by the teacher.

The demanding life-style of professional musicians involved in high-level performing, has an impact on their mental and physical health. At present, research is being done at the Hannover Institute for Music Physiology and Performing Arts Medicine, on the physical affliction of musicians' cramp (focal dystonia), which usually ends an artist's career and requires medical treatment as well as psychological counselling.

According to Weinberger (2001:3-5) (see 5.5.2), the two musical dimensions of **tempo** and **articulation** are responsible for the 'transfer' of emotional content in a performance. It has been found that the listener experiences **genuine** emotions in response to the music.

6.5.3 Musical taste

There are many reasons why people prefer particular genres of music. Certain forms of dementia affecting the frontal lobes of the brain have produced a regression in musical taste that parallels the erosion of brain functions involved in judgement, abstract reasoning, and planning ahead (see 5.6.7).

Forward planning involves the ability to inhibit impulses to act immediately or to delay instant gratification. As discernment develops and the ability to delay gratification increases, it appears that normal, intact frontal lobes possibly constrain the appeal of simple, popular music. For many people, **functional** music is more important than any considerations of musical **quality**. They are unskilled at listening to complex music, preferring simple music that is easy to listen to; they remain unaware of the limitations of the genre of music they listen to. This reflects the need to develop the musical intelligence to facilitate optimal brain function.

A lack of understanding concerning the connection between musical taste and brain functions involved in judgement, abstract thinking, and planning could possibly be an important reason why music education is regarded as an 'optional extra' by many educational authorities.

6.5.4 The role of music in accelerated learning

Georgi Lozanov was the first scientist to systematically research the factors involved in rapid learning (see 5.7). Accelerated learning attempts to achieve the optimum state for learning, and necessarily includes the involvement of both brain hemispheres, the cortex, and the limbic system. If learners wish to make optimum use of accelerated learning techniques and discover their true potential, they have to be aware of their own personal combination of intelligences and their learning preferences.

Music has played a powerful role in the history of human civilisation:

- In ancient cultures it was placed at the centre of their social activities, including education
- Music was used to increase memory (see 5.7.3)
- Music was that principle of order that held all things together and let people experience emotional 'highs' or 'lows' at the same time
- In China, specifically selected rhythm, melody, and instrument combinations exerted influences over society and individuals
- Even in the times of Aristotle and Plato, it was recognised that specific kinds of music could have an unsuitable influence on state matters and education
- Music was credited with healing powers. Specifically selected music was used to promote the healing process.

In present times, the study of music has been found to be not only beneficial in itself, but also to be particularly useful in promoting stress reduction, reducing discipline problems, and providing a background to 'concert' readings or presentations. The state of **relaxed alertness** is one of the main ingredients for achieving an integrated learning state. Music can be used to:

- entrain body and mind into relaxation
- provide a stimulus to keep the subconscious mind alert and receptive to new information.

Music can be effectively included in the accelerated learning process for about thirty percent of the total learning time (see 5.7.4).

6.5.5 How music impacts on health and spiritual well-being

The capacity to learn is affected by human physiological functioning, which in turn is affected by certain facets of health management such as nutrition, exercise, relaxation, and stress management. Music therapy is fundamental to **all** people and should not be limited to those in distress or special need.

Hearing music can effect actual physical changes in heart rate, blood pressure, and biochemistry of the blood, leading to possible affective changes. Virtually everything an individual experiences in life (including hearing), is dependent on brain activity being transformed into muscular activity, with the development of cross-lateral movement in particular, being critical to all humans (see 5.6.5).

Cymatic therapy makes use of sound waves for healing. It is based on the fact that different parts of the body vibrate at different audible frequencies, but in the event of disease or injury, the affected parts of the body vibrate 'out of harmony'. The therapeutic application of the correct frequency for that part of the body can facilitate the healing process. Sound environments that are in harmony with the natural vibrational patterns of the body are able to provide humans with a greater sense of well-being (see 5.8.2).

When music and body are 'in synch', there is a powerful feeling of being more aware and more alert. This phenomenon results from changes in metabolism, that increase physical energy, reduce pain and stress, and accelerate healing. (Table 5-5 illustrates a number of music's effects on the listener.)

Certain irregular/unrelated sound waves added to musical sounds result in 'noise'. Some sounds and noises appear to have harmful effects on the body, whereas others (such as white noise) can have a therapeutic effect. Long range exposure to harmful noise creates damage to the ear, disrupts the central nervous system, and can cause perceptual disturbances in hearing. The damage does not necessarily disappear when the noise ceases. Where an individual is unable to adapt to a specific noise environment, it is important to change the environment.

6.5.6 The role of the musical intelligence in whole brain education

Music is not limited to its aesthetic functions: it makes its way into all spheres of education. It is the first 'intelligence' to develop, and in cases of dementia, the last to go (see 5.6.7). Brain wave experiments at the Max Planck Institute of Cognitive Neuroscience in Leipzig have provided evidence that musicality is an inherent part of brain function, whether an individual is musical or not. The brain was found to register 'surprise' at musical incongruities that generated such rapid brain wave activity, that the listener was not even consciously aware of the occurrence.

- Learning to play a musical instrument as part of music education leads to a student's success in other subjects (see 5.7.5)
- Learning to play a musical instrument establishes more neural pathways in the brain than would normally be the case (see 5.7.5)
- Music involves brain functions more fully in both hemispheres than any other activity researchers have studied
- The *cognitive,* the *affective* and the *psychomotor* development play a vital role in the development of the musical intelligence, and are of fundamental importance in the learning process (see 5.2.1)
- The phenomenal recall of all the music heard between the ages of eight and eleven years reflects a critical stage of musical development (see 5.6.3).

6.5.7 Future trends in music education

Most other world cultures teach music through the imitation of its sound, whereas much Western music practice tends to start from the notation. Although there is a tendency at present towards a world-wide dominance of all forms of Western music, George Odam indicated in an interview (2001) that a new 'global' music is emerging that is essentially aurally based, making 'memory' and the development of **memory skills** crucial, and the development of the ear a central activity of music education. "Teachers must place most emphasis on aural experience by involving the aural memory and appropriate actions and by resisting early involvement of left-brain notational procedures. Musical listening is a certain and distinct kind of listening very different from, for instance, speech listening. It has its very own dedicated set of brain functions" (Odam 1995:30).

If education is to be improved, teachers need to:

- give credibility to the complex forms of instruction required to stimulate memory. The power of memory-building techniques will have to be recognised by teachers and learners, and put into practice
- enhance the aural acuity in a lesson by planning carefully, to ensure a holistic approach. The teacher should initiate good habits in performance, and regularly engage learners in analytical thinking arising from the **sound stimulus**. Constant reference to the intervallic constituents of the music discussed, and the use of the singing voice, can aid understanding

- achieve a balance between emotional and analytical brain processing, and develop the ability to access either type of processing as circumstances demand
- recognise that music has 'healing powers' which are capable of changing behavioural patterns, emotions, and belief systems, and be informed on how to use music to accelerate the healing process
- keep up to date with information about possible medical problems associated with the playing of their instruments.

Within the framework of Gardner's Theory of Multiple Intelligences, Elliott's four different meanings of music education, and IQ, EQ, and SQ, it has been possible to investigate the musical intelligence:

- as an autonomous intelligence, and its influence on the other intelligences
- with respect to its development, by four different approaches to music education
- in terms of IQ, EQ, and SQ
- and its role in whole brain education.

The musical intelligence can be developed to a reasonably high level, but not increased, by effective music education. With respect to music, the **composition** and the **performance** are often the main focus of teachers and learners, with the human constraints and aspirations of the composer/performer not receiving the consideration they deserve.

Although many of the brain based activities investigated have not yet been proven neuro-scientifically, they have proved very effective in 'enhanced' learning situations. The 'dual brain' and 'triune brain' functional models do not represent the complexity of whole brain function. Unfortunately they have been simplified to the extent that many of the functions attributed to them are scientifically inaccurate.

In many cases, analytical thinking can be equated with 'left' brain function, and global/gestalt/ emotional thinking with 'right' brain activities. Educators who wish to promote the role of the musical intelligence in whole brain education should, at all times, remain consciously aware of the fact that brain function is far more complex than a left-brain/right-brain activity. They should exercise **great caution** when interpreting scientific research results and applying them to 'brain-based' activities. Neuromusical research heralds an exciting new approach to music education in music physiology and music psychology, but it is still in its infancy, and should be treated with the appropriate respect.

6.6 Recommended research

After investigating the biological structure and function of the brain, it became increasingly clear that the musical intelligence has a vital role in whole brain education. Since behaviour is a reflection of what the brain does, it is essential that teachers and learners have a basic understanding of how the brain functions. Although neuromusical research has started providing 'scientific' research results, there are still research projects that have to rely on brain based information and behaviour.

To enable music educators to make appropriate use of neuromusical research, the value of including courses in neurophysiology and music medicine at pre-service and in-service levels should be investigated.

In preparation for the emergence of a new, aurally-based 'global music', music educators could make a valuable contribution by moving their focus from cultures where notation is highly esteemed, to a culture that promotes the integration of vestibular hearing and cochlea listening (Madaule 1998), and the development of memory skills. In addition to the musical benefits, this change of focus could play a vital role in the individual's learning ability.

There are still many aspects of the musical intelligence (not covered in this study) that could have a profound impact on music education, and need to be researched. One such aspect is the fact that the sound frequency limits of a specific language appear to affect the music of that particular culture. Another is the suggestion that a preponderance of low frequencies in the music of a particular culture could impact on the cognitive development of the individuals (see 5.2.4).

Neuromusical research has not yet been able to provide scientific evidence to define the role the musical intelligence in higher brain function. Preliminary results have, however, been encouraging, especially with respect to the stimulation of spatial-temporal reasoning.

6.7 An overall view

In terms of Howard Gardner's Theory of Multiple Intelligences, the Musical Intelligence is one of eight autonomous intelligences. This study sought to define the musical intelligence comprehensively within the confines of Elliot's four meanings of music education, and has indicated that to develop the **musical intelligence** all four meanings are relevant.

The influence of music on virtually every aspect of life is complex. It was found that music education cannot **increase** the musical intelligence, but can help to develop it to a suitably high level. For this purpose an 'inclusive' approach to music education needs to be adopted, which includes listening to music, making music, propositional knowledge, and **using** music for therapeutic and healing purposes and to facilitate brain function.

To understand the complex brain functions impacting on whole brain education, it was necessary to have a basic knowledge of the anatomical structure and the physiology of the brain. Learning was investigated, based on neuromusical research data, brain based functions, and behaviour, and it was found that the musical intelligence plays a vital role in whole brain education. With respect to teaching and learning, the involvement of the 'human element' features strongly in this study.

In the present 'Information Age', Western culture has been placing a decreasing emphasis on exposing young children to musical skills, art, and physical education. In the past, much of 'how' and 'what' music was taught, was based more on uncritical acceptance of tradition than research evidence. Neuromusical research, however, has started providing scientific data on which new approaches to music education can be based, as well as some very important answers to 'why' the musical intelligence needs to be developed in **all** learners, as an autonomous intelligence and for its role in associated learning.

There are indications that the development of the musical intelligence is linked to an individual's capacity for complex thought processing. Emerging from neuroscientific research, and based on the fact that "music has always played a vital role in producing and cementing society", Persaud (2001:36) suggests that "music has a more fundamental role in determining who we are than we have so far dared to guess". The important role of the musical intelligence in whole brain teaching and learning has become a reality that can no longer be ignored.

APPENDIX A

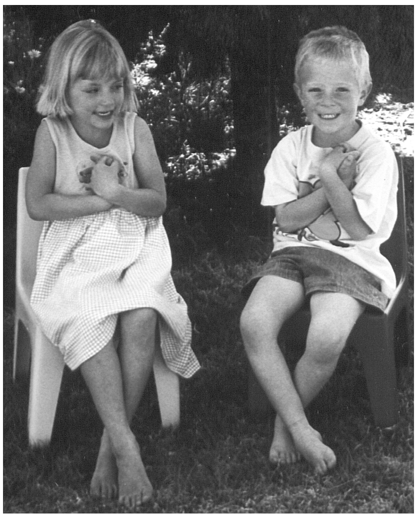
NEUROLOGICAL ACTIVATION PROCEDURES / 'BRAIN GYM'

The following Neurological Activation procedures include movements from the 'Brain Gym' repertoire, and are based on the "Introduction to neural development" by Human Performance technologies (Seminar on Brain Dynamics 2000), and Hannaford (1995:117-131). A compact programme, PACE, may be used as a 'basic' activation programme, and is followed by additional Brain Gym activities which may also be used as required.

PACE – Neurological Preparation

"P"

Hook-ups are used to promote a **P**-ositive frame of mind, reduce stress levels, quieten down and refocus (after distraction) in order to handle situations more efficiently.



Hook-ups are done by:

- first crossing one ankle over the other (whichever feels most comfortable)
- crossing the hands, clasping them, and then inverting them. Do this by
    - stretching the arms out in front, with the back of the hands together and thumbs pointing down
    - lifting one hand over the other, palms facing, and interlocking fingers

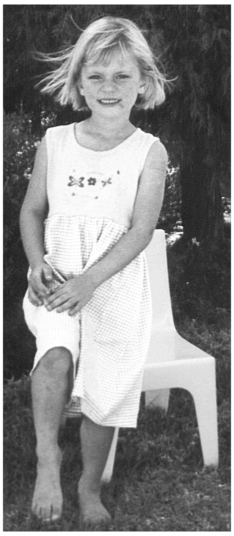
- rolling the locked hands straight down and towards the body, so that they rest on the chest with the elbows down
- resting the tongue on the roof of the mouth, behind the palette.

The complex crossover action has an integrative effect, which consciously activates the sensory and motor cortices of each brain hemisphere. When the tongue is pressed against the palette, a connection is created between the emotions of the limbic system and the reason of the frontal lobes of the cerebrum, giving an integrated perspective for learning and responding.

This exercise can be done for approximately 30 seconds. Change hands and repeat for a further 30 seconds. The total time can be extended to about 2 minutes if necessary.

"A"

Cross crawl **A**-ctivates both brain hemispheres and stimulates the Reticular Activating System (RAS).



Cross Crawl, or cross-lateral walking in place, can be done by:

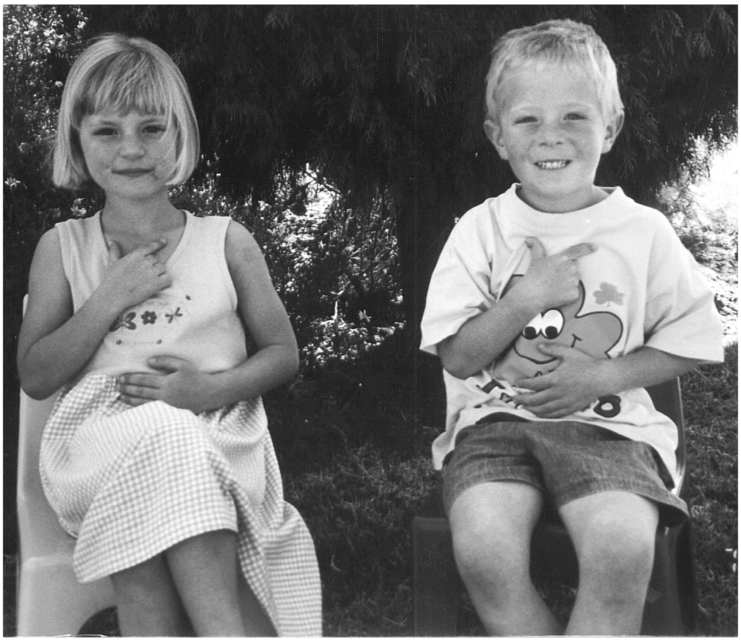
- touching the right elbow to the left knee, followed by the left elbow to the right knee.

The Cross Crawl has an integrative effect, stimulating large areas of both brain hemispheres at the same time, as well as facilitating nerve activation across the corpus callosum. If done on a regular basis, more nerve networks are formed and myelinated in the corpus callosum, promoting faster, more integrated communication between the two hemispheres, thereby stimulating high-level reasoning.

The exercise can be repeated about 20 times, taking a total of approximately 45 seconds.

"C"

Brain Buttons are used to **C**-lear the brain, by increasing the flow of oxygenated blood to the brain, and alerting the vestibular system.



Brain Buttons are done by:

- placing one hand over the navel, while
- stimulating points at the indentations between the first and second ribs directly under the collar bone, with the other hand.

Placing the hand on the navel brings attention to the gravitational centre of the body, stimulating the core muscles which are important contributors to bodily balance. This, in turn, alerts the vestibular system, which stimulates RAS activation. Rubbing/massaging the indentations between the ribs, is thought to stimulate the blood flow through the arteries to the brain, thereby increasing the oxygen supply to the brain.

The points between the ribs can be massaged for approximately 30 seconds, then change hands.

"E"

Water allows the body to release **E**-nergy.
Water improves the ability of the blood to absorb oxygen. It contains sodium and potassium ions that are essential for the conduction of impulses through the nervous system.

It is recommended that adults drink approximately eight glasses of water daily, increasing the intake when under stress.

"SWITCHING ON" BOTH EYES

Lazy 8's for writing

LAZY 8's (a sideways eight or infinity symbol) activate both eyes and are excellent for establishing the necessary rhythm and flow required for good hand/eye co-ordination. By tracing or feeling movement along a *Lazy 8*, the 'reader' is able to cross the visual midline without interruption, activating both eyes and integrating the left and right visual fields. These movements can be used to improve written communication, or in the case of learners experiencing stress and homo-lateral thinking while writing a test (by simply doing Lazy 8's on the desk/table-top), co-lateral thinking can be re-established.

Lazy 8's for **writing** are done by:

- drawing an infinity symbol or sideways eight on paper, with a flowing, continuous movement
- following the figure, starting from the middle, going counter-clockwise upwards and to the left, and around back to the middle. Then, in a continuous movement from the middle, going clockwise, upwards and to the right, around and back to the middle.

*This activity can be done with five or more continuous repetitions with each hand, followed by five repetitions with **both** hands together.*

Lazy 8's for eyes

Lazy 8's for **eyes** strengthen the extrinsic eye muscles, assisting network development and myelination of the frontal eye field area for fine motor tracking. The activity also establishes learning patterns that co-ordinate hand/eye and eye/hand muscle alignment.

Lazy 8's for **eyes** and **eye/hand co-ordination** are done by:

- 'drawing' an infinity symbol or sideways eight by holding a **thumb** at eye-level in the mid-field of the body, at about an elbow length from the body. Use a flowing, continuous movement through the airs

- activating maximum muscular movement, using **slow**, **conscious** movements
- holding the head still, but relaxed, and just moving the eyes to follow the thumb.

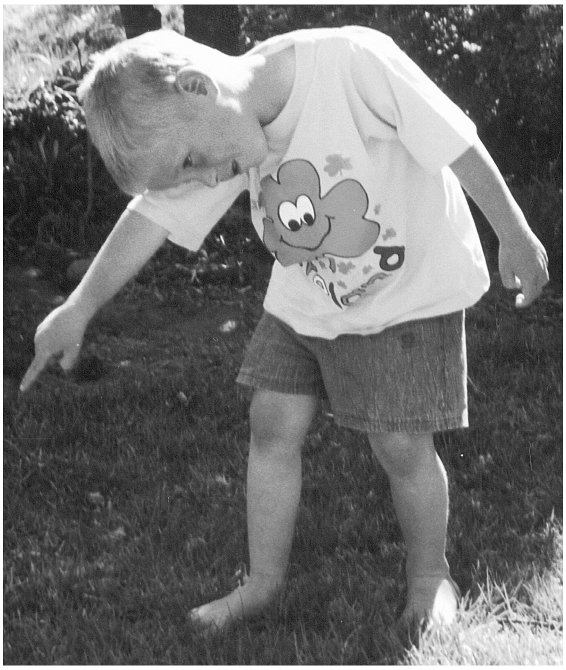
This even-flowing movement should be continued at least three times with each hand. Both hands should then be clasped with the thumbs forming an X, and the movement repeated while focusing on the middle of the X.

"SWITCHING ON" BOTH EARS

Lazy 8's for mind/body activation: "The Elephant"

'The Elephant" uses movements from the core muscles, activating the vestibular system. Hand/eye co-ordination is involved, as well as visual input. If elephant sounds are added, hearing mechanisms will also be involved. People who have suffered chronic ear infections find the exercise particularly challenging, but within a few weeks experience improved balance and equilibrium.

The Elephant can be done on a regular basis to stimulate the whole vestibular system, and where nerve networks have been damaged during ear infections, these can be largely re-established. This Brain Gym activity stimulates the full activation of the Reticular Activating System (which improves attention) and is highly recommended for learners labelled ADD.



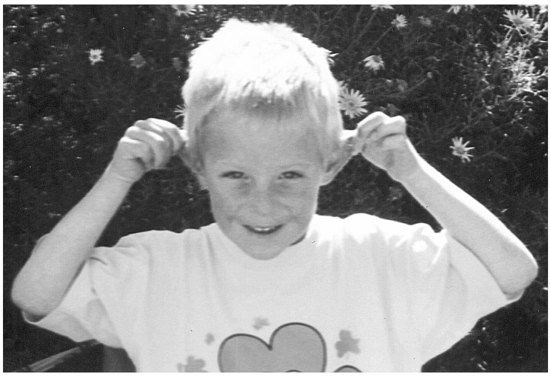
The Elephant is done by:

- placing the left ear on the left shoulder (tight enough to hold a piece of paper between them)
- extending the left arm like a trunk
- relaxing the knees
- using the left arm to draw a Lazy 8 pattern in the mid-field, following the movement of the 'drawing' finger/hand with the eyes.

This activity should be done slowly three to five times on the left, followed by an equal number of times with the right ear against the right shoulder.

The Thinking Cap

The Thinking Cap is used to 'wake up' the hearing mechanism and assist memory. Based on the fact that acupuncturists have identified more than 148 points on the outer ear which correspond to areas of the body (from the feet at the top of the ear, to the head at the ear lobe), the act of physically stimulating the tactile receptors of the outer ear, can 'wake up' the entire hearing mechanism.



The Thinking Cap is done by:

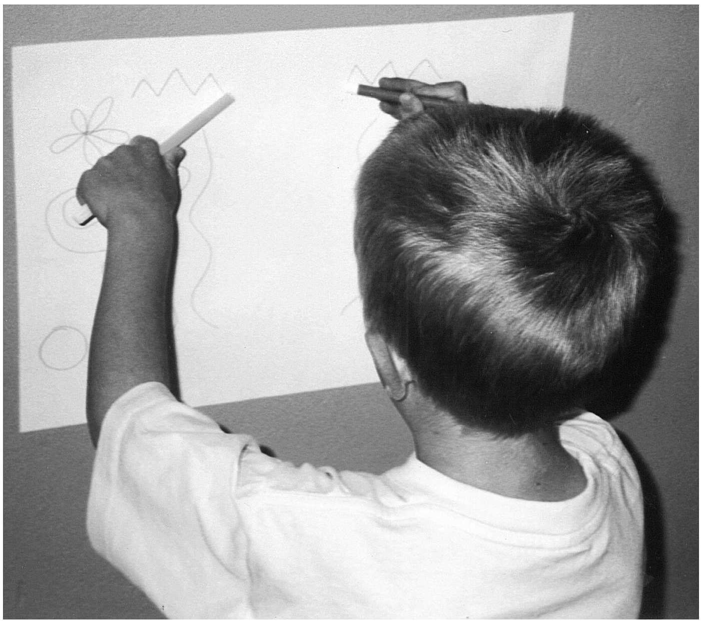
- using the fingers to unroll the outer ears from top to bottom

This can be done several times.

"SWITCHING ON" BOTH HANDS

The Double Doodle

The Double Doodle activates the brain for writing, using both hemispheres.



The **Double Doodle** is done by:

- writing/drawing with both hands at the same time, from the centre towards the outside, effectively creating a 'mirror image'.

"SWITCHING ON" FACIAL MUSCLES

The Energy Yawn

The Energy Yawn relaxes the facial muscles, facilitating full nerve function across the temporal mandibular joint, and improving all the nerve functions to and from the eyes, mouth and facial muscles. When an individual is under stress, the jaw often tightens up, reducing nerve function across this area. The relaxation produced by this activity can therefore also assist effective verbalisation and communication.

The Energy Yawn is done by:

- massaging the muscles around the temporal-mandibular joint (TMJ). This joint can be found in front of the ear opening where the lower jaw meets the upper jaw. Trunks from the five major cranial nerves responsible for gaining sensory information from the face, the eye muscles, tongue, and mouth, run across this joint, activating all the muscles of the face, eyes and mouth for mastication and vocalisation.

APPENDIX B

MUSIC FOR THERAPEUTIC and LEARNING PURPOSES

When selecting music for an educational or training environment, it should be used for a specific purpose: the particular physiological and emotional state that is to be evoked by the music must be determined. The following resource guide provides suggestions for educators, trainers, parents, or anyone who wishes to augment a specific activity, and should be viewed as a starting point (see 5.7.4, 5.8.8 and Table 5-5). Individuals should add to the list by including music suited to their own personal taste.

The selections below have been compiled from Halpern & Savary (1985), Webb & Webb (1990), Ostrander et al (1994), and Rose & Nicholl (1997).

Music suitable for meditation, relaxation and listening pleasure

Halpern, S.	*Dawn* (Halpern Sounds)
Kitaro	*Silk Road* (Canyon Records)
Winter, P.	*Common Ground* (Living Music Records)
Hoffman, J.	*Children's Meditation Tape.* *Music for mellow minds* *Rhythmic medicine*
Horn, P.	*Inside* (Golden Flute)
Roth, S.	*You are the ocean* (Heaven on earth)
Warner, P.	*Waterfall Music* (Waterfall Music Records).

Music for relaxation, introspection and calming

Copland, A.	*Appalachian Spring* *Quiet city*
Debussy, C.	*Clair de lune* *Sacred and Profane dances for harp and orchestra*

Halpern-Kelly	*Ancient Echoes*
Kreisler, F.	*Humoresque*
Ravel, M.	*Pavane for a dead princess*
Vivaldi, A.	*Oboe concertos*
Wagner, R.	*Evening star (from Tannhäuser).*

Music to calm hyperactivity and/or relieve tension

Bach, J.S.	*Air on a G-string* *Ave Maria*
Debussy, C.	*Images*
Franck, C.	*Symphony in D minor*
Grieg, E.	*Holberg Suite*
Mozart, W.A.	*Concerto for flute and harp* *Piano Concertos*
Pachelbel, J.	*Canon in D*
Vivaldi, A.	*Flute Concertos, Four Seasons*
Wagner, R.	*Evening Star (from Tannhäuser).*

Music (powerful) to release anger

Beethoven, L.	*Egmont Overture*
Brahms, J.	*Piano Concerto* (No.1)
Saint-Saëns, C.	*Symphony No.3* (last movement)
Tchaikovsky, P.	*Symphony No.5* (last movement)
Wagner, R.	*Ride of the Valkyries* (Lohengrin)

Music (soft) for soothing anger

Bach, J.S.	*Two Concertos for two pianos*
Gluck, C.W.	*Dance of the Blessed Spirits*
Handel, G.F.	*Concerto for Harp and Lute Largetto* (op.4, no.6) *Concerto for Harp in F major, Larghetto* (op.4, no.5)
Halpern-Kelly	*Ancient Echoes*

Schubert, F.	*Prelude to Rosamunde.*

Music for Superlearning

- **Slow Baroque selections**

Albinoni, T.	*Adagio in G min for strings*
Bach, J.S.	*Largo from Concerto in F min for Harpsichord, BWV1056* *Largo from Concerto in C for Harpsichord, BWV975* *Air on a G-string*
Corelli, A.	*Largo from Concerto No. 10 in F* (Twelve Concerti Grossi, Op.5)
Telemann, G.	*Largo from Double Fantasia in G for Harpsichord*
Vivaldi, A.	*Largo from "Winter"* (Four Seasons) *Largo from Concerto in D for Guitar and Strings* *Largo from Concerto in C for Mandolin, Strings, and Harpsichord.*

- **Contemporary selections**

Duncan, W.	*Exultate: music to expand learning* (60-beat guitar music)
Gagnon, A.	*Lullaby for my mother* (piano and orchestra).
Hoffman, Janalea	*Children's Meditation Tape* (features "The Dolphin Song", relaxation games, and guided imagery for ages 2-11) *Mind Body Tempo* (piano and orchestra) *Deep Daydreams* (instrumental music) *Music to facilitate Imagery* (piano and strings) *Music for mellow minds* (piano and strings) *Rhythmic Medicine* ('instrumental' music synchronised with visual images)

- **Music to energise/recharge and for vitality**

Bartok	*Mysterious Mandarin*
Beethoven	*Turkish March* (from Ruins of Athens)
Brahms	*Horn Trio* *Clarinette Trio* *Piano Concertos Nos. 1,2,4*
Clarke, J.	*Trumpet Voluntary*
Orff, C.	*Carmina Burana*
Rachmaninoff, S.	*Rhapsody on a theme by Paganini*
Schubert, F.	*March Militaire*

Schumann, R.	*Piano Quintet*
Sibelius, J.	*Alla Marcia* (from Karelia Suite)
Strauss, J.(Snr)	*Radetsky March*

Gregorian Chant performed by the Monks of Solesmes (France) and by the nuns of St. Cecilia's Abbey on the Isle of Wight, is also suggested.

- **Music as a background to presenting lesson material**

Bach, J.S.	*Concerto in D minor for 2 Violins*
Beethoven, L.	*Concerto in D for Violin and Orchestra* (Op.61) *Concerto in E flat for Piano and Orchestra* (No.5, Op.73)
Brahms, J.	*Concerto in D for Violin and Orchestra* (Op.77)
Chopin, F.	*Waltzes*
Haydn, J.	*Concerto in C for Violin and Orchestra* (No.1) *Concerto in G for Violin and Orchestra* (No.2 *Symphony in F* (No. 67) *Symphony in B flat* (No.68)
Mozart, W.A.	*Concertos for Violin and Orchestra* (Nos.1, 2, 3, 4, 5) *Concertos for Piano and Orchestra* (Nos.18, 21, 23) *Concerto in A for Clarinet* *Symphonies* (Nos.29, 32, 39, 40) *String Quartets* *Sinfonia Concertante Contradances*
Tchaikovsky, P.	*Concerto in B flat for Piano and Orchestra* (No.1)
Vivaldi, A.	*Concerto in D for Flute* (No.3) Concerto in C for Piccolo

Music for overcoming inhibition or awakening courage

Beethoven, L.	*Piano Concerto No.5* *Choral Fantasy for Piano and Orchestra*
Berlioz, L.	*Harold in Italy* (third and fourth movements)
Brahms, J.	*Symphony No.2*
Chopin, F.	*Etudes Op.10 and Op.25*
Copland, A,	*A Lincoln Portrait* *Suite of old American Songs*
Debussy, C.	*Claire de lune*

Delibes, L.	*Coppelia*
Dvorak, A.	*Symphony No.8*
Grofe, F.	*Grand Canyon Suite*
Handel, G.F.	*Water Music* *Music for the Royal Fireworks* *Choruses from Messiah and Israel in Egypt*
Humperdinck, E.	*Prayer and Dream Pantomime* *La Marseillaise* (arr. by Berlioz)
Mendelssohn, F.	*Symphony No.4* (Italian)
Mozart, W.A.	*Concertos for Piano and Orchestra* (Nos.26,27)
Parry, H.	*Jerusalem*
Prokofieff, S.	*Piano Concerto No.3* *Symphony No.5*
Sibelius, J.	*Symphony No.2*
Strauss, R.	*Sunrise* (Also sprach Zarathustra)
Tchaikovsky, P	*Dance of the Reed Flutes* (Finale to Symphony No.5)

Music to celebrate achievement

Bach, J.S.	*Toccata and Fugue* (organ)
Beethoven, L.	*Chorale Fantasy for Piano, Chorus & Orchestra* *Symphony No.9*
Haydn, J.	*The Creation* *The Seasons*
Rachmaninoff, S.	*Concertos for Piano* (Nos.2, 3)
Sibelius, J.	*Finlandia*
Verdi, G.	*Grand March* (Aida)
Wagner, R.	*Overture to the Meistersinger* *Ride of the Valkyries* *Dawn and Siegfried's Rhine journey* (Götterdämmerung)

Appendix C

A summary of factors influencing the development of the Musical Intelligence

The following factors influencing the development of the Musical Intelligence have been listed according to the page numbers of the thesis:

2-18 Where pregnant mothers are **undernourished**, the babies are born with up to 50% fewer neurons.

A **healthy diet** in infancy is necessary for the process of **myelination**, which facilitates the **speedy conduction of information**.

Behavioural differences between the sexes cannot be attributed to social conditioning:
Diversity - Biological fact
Equality - Political/ethical/social precept.

2-21 There are certain physical differences in the brain structure of males and females:

Cerebral cortex	- right side is thicker in males
	- left side is thicker in females
Corpus callosum	- larger in the female than in the male brain.

2-21 Hormonal **brain sexing** fixed at eight weeks after conception, and cannot be altered.

The menstrual cycle in females can result in **'withdrawal symptoms'**.

2-23 As seen on page 2-18, social conditioning cannot determine the **sexual mind-set**, which is a product of biology and **cannot be altered**. In other words, the brain is 'pre-wired'. Certain biological biases are merely reinforced by social conditioning.

2-24 **Sex-specific hormones** do have an effect on the brain's transmission system, **affecting verbal skill, muscle co-ordination, and spatial relationships.**

2-26 **Accelerated learning** makes extensive use of **alpha** brain waves.

From **birth to adulthood**, the brain waves develop from:
Slow **delta** waves to slightly faster **theta** waves, to faster alpha waves, to fast beta waves.

2-28 The **development of faster brain wave rhythms**, moving from the **slow delta waves at birth,** through **theta waves** at about **3-6 years**, to slightly the faster **alpha waves** at about **7 years**, to **beta waves** which become fully functional at about **14 years**, roughly coincide with the landmarks of cortical development (see 4-15).

2-30 The ear is not limited to **hearing**, it plays a crucial role in **energising** the brain and body.

2-31 Learning is not all in the head: **movement** is essential to learning.

There is a societal bias to **physical achievements**: cultural tradition separates mental and physical activities. **Movement** is necessary to **anchor** thought

2-33 Cross-lateral movement is crucial to activating the development of the corpus callosum. A lack of this development can lead to learning difficulties.

The body plays an integral part in **all** intellectual functions, including abstract thinking, due to the role of the cochlear-vestibular system.

2-34 The biological **pre-wiring of the brain** is an indication of **the greater importance of nature** as opposed to nurture. The **environment** has little or no influence on the development of the sensory and motor systems of the child. **The brain's ability to re-organise itself in response to new experiences makes it possible for humans to learn.**

2-37 The RAS system, which is responsible for the 'fight or flight' reaction, can restrict the flow of information to the cortex. There are more neural connections from the limbic system to the cortex than vice versa. Also see 3-43: negative emotions have greater power than positive emotions.

3-3 **IQ, EQ, SQ, memory and recall, brain profiles/dominance, brain waves**, and **evolutionary psychology** all have an impact on learning.

3-8 "**Flow**" as the neurobiology of excellence is induced by **intense concentration**, and impacts on education in general and **music education** in particular.

3-9 **Challenges**: it is vitally important **to match (musical) challenges with the learner's ability**.

3-11 A learner's **social incompetence** (inability to organise/negotiate, or poor use/interpretation of body language), amounts to a **learning disability.**

3-12 **Criticism** can have a profound effect on **motivation**, **energy**, and **confidence**.

3-13 Serially connected **neural tracts** form the basis of IQ
Neural networks form the basis of EQ
Neural oscillations form the basis of SQ.

3-16 **Without memory there can be no learning**. The *hippocampus* in the brain is involved in the storage of information, and **does not degenerate with age**.

Alpha and **theta** waves play an important role in the memory-process.

Music (with rhythm, patterns, dynamics etc.) acts as a prime 'carrier' for memories.

3-19 Learning that is **distributed over time**, produces better recall than 'cramming'. The brain is **unavailable for new input during sleep** as it is busy replaying, registering, and storing information. Information can be organised and rehearsed during sleep, however.

3-23 **Locale** memory can be stimulated by '**mind-mapping**'.

3-27 **Cross-laterality** is essential for learning.

Learning preferences are based on **lateral dominance of the brain, hands, feet, eyes, and ears.**

Stress results in **unilateral brain processing**.

3-40 In the case of **ADHD pupils**, the brain functions mainly on slow **theta** brain waves, and **physical movement** is required to access the fast **beta** waves necessary for learning. **Neurotherapy** can facilitate the 'switching' from theta to beta waves without medical intervention.

3-44 On average, **people avoid risk**, **except when threatened**.

3-45 The message of **evolutionary psychology** is that there is **a limit to how much the mind can be remoulded** (see 3-46).

People respond to **status recognition**.

3-46 **Leadership** cannot be acquired: it is necessary to have **the 'right' brain profile and testosterone level**.

3-46 **Heredity** plays a vital role in development.

4-5 A **specific pre-wiring** of the brain (a specific brain profile) is necessary for the brain to flourish **in a particular environment**.

4-6 **Foveal vision** plays an important role in early childhood education. Hannaford makes particular reference to rural African children who have well-developed three dimensional vision, but have not yet developed two dimensional 'foveal' vision required for reading. **Foveal vision usually matures between the ages of seven and eight years.**

4-7 **Limiting beliefs** in an individual's ability to succeed has **a negative inf**luence on development of confidence.

4-8 Vitally important facets of **communication** are: **body language** (55%), voice (38%), and **verbal content** (7%). Educators usually focus on the verbal content of lessons, while attaching little or no value to **how** it is communicated.

4-9 The **emotional impact** of communication will affect the **long-term storage** of information.

Learning and teaching are **more effective** when left and right hemispheres of the brain are **both** involved in all information processing.

4-11 Educators should be aware of **their own brain dominance** or hemispheral preference, as well as that of the learner.

4-15 According to Hannaford's "**Landmarks of cerebral neo-cortical development**", whole brain processing only starts taking place from about 9 to 12 years of age. **Gestalt processing** starts at approximately 4-and-a-half years of age, and **Logic processing** at about 7 to 9 years. The landmarks of cortical development roughly coincide with the **development of faster brain wave rhythms** (see 2-28).

4-16 The **first sensory system** to develop (at about four-and-a-half months in utero), is the **vestibular system** which controls movement and balance, as well as 'vestibular hearing'. The ***rhythmic* dimension of music** corresponds to the **functioning of the vestibular system**. According to Madaule (1998:37) rhythm induces and conveys movement. Deaf people are able **to 'hear' or perceive rhythmic vibration**.

4-17 The connection between the **vestibular system and neo-cortex**, and **eyes and core-muscles** is vitally important to the learning process.

4-18 **Cochlear** hearing develops in utero, and provides the alertness that comes with **higher vibrations that assist the learning process**.

The **integration** of cochlear and vestibular hearing is crucial to the learning process: without movement the mind does not grow.

Smell is strongly linked to **memory** (hippocampus).

4-19 **Touch** stimulates **sensory motor growth** and **nerve network development**. The development of more complex nerve networks increases learning potential. Appropriate supportive touch is valuable in development and learning.

4-20 **Vision** is a very **complex phenomenon** with less than 10% of vision actually taking place in the eyes. Touch is particularly important to the young child **to 'understand' vision**. Proprioception (the body's sense of itself in space), and touch make up the remaining 90% of the sense of vision. **Much of vision is 'learned'**.

4-21 The use of **NLP** (a group of psychological techniques based on how the brain codes learning and experience) can be particularly beneficial in a **musical performance** situation.

4-27 **Nutrition** has a profound effect on the **number of neurons** in the brain, and **the richness of their interconnections** (see also 2-18).

Polluted water and air **reduce** the amount of **oxygen** available to the brain. The brain needs large amounts of oxygen to develop and function, both before and after birth. **Candida albicans** removes **oxygen** from the blood, and could be responsible for learning problems.

4-28 "**Poor health**" usually leads to "**poor academic performance**".

4-29 There are **structural differences** between male and female brains in learning ability with respect to **brain-sensory intake** and **thought processing** (Jensen).

4-30 Educators and learners should remain constantly aware of the powerful influence **sex hormones** have on certain learning tasks (see 4-31).

4-31 **Educational content** should not be presented in the same way for everyone. However, **equal opportunities** should be provided.

4-37 Teaching and learning cannot thrive on only one or two of **the three basic neural systems**. The serial tracts reflect IQ, the parallel neural networks reflect EQ, and the 40 Hz across-the-brain oscillations reflect SQ, with the latter providing the means to bind experience together and place it in a wider frame of meaning (see 3-13).

4-38 **Disaffection** is affecting growing numbers of young learners, and has become a significant problem, in particular with respect to underachievement by children from **ethnic minority groups**.

4-39 'Culture' – both **'high art'** (sometimes referred to as 'elitist') and **popular culture**, should be included in education.

4-43 It is important to note the following:

- The brain changes physiologically as a result of experience
- The environment in which the brain operates can influence the functional ability of the brain
- IQ is not fixed at birth
- Some abilities are acquired more easily during certain sensitive periods
- Learning is strongly influenced by emotion..

Poverty, low levels of nutrition, inadequate access to health care and education, and the lack of basic community and household resources, all undermine the development of children (see 2-18).

4-44 **Learning** is the process of acquiring information.
Memory is the process of retaining/storing the information.

5-4 According to Shaw, there are indications that **music** will be recognised as a "window into **higher brain function**":

- counting rhythms and organising fingering point to basic mathematical operations
- playing an instrument involves body movement in three dimensional space, and is linked to developing spatial abilities.

5-5 Musical intelligence cannot be *increased* by music education: an existing musical intelligence can be developed/improved/enhanced/optimised.

In group music the interpersonal intelligence needs to develop.

There are indications that music education and instrumental playing influence and improve many of the cognitive domains of human intelligence.

5-6 A musician is involved in **thinking and feeling**, leading to a form of **spiritual experience**.

Cognitive, **affective**, and **psychomotor** attributes play an important role in the development of the musical intelligence.

5-7 **Musicians** and non-musicians process musical information differently.

5-8 Music education impacts on **brain activation patterns**. Changes in these patterns depend on the applied teaching strategies used.

5-9 Music is a unique way of **knowing.**

5-10 The **ear** is designed to energise/re-vitalise the body. The human vertical posture allows the human to have maximum control over the listening process, which in turn stimulates the brain to full consciousness.

5-11 Music with a predominance of rhythm and little or no pitch differentiation (music with a heavy beat such as rap or rock) **stimulates primarily through the vestibular system**.

Music with emphasis on **melody** stimulates the **cortex** via the cochlea, and can stimulate the mind/flow of thought.

The richer the music is in **harmonics**, the **more energy** it provides.

Music educators have a major role to play in developing children's **listening ability**.

5-12 Music is a combination of **rhythm** and **melody**, stimulating the **vestibular** and **cochlear** systems separately as well as in an **integrated** manner.

Music with a predominance of **melody**, with little or no rhythm ('**cochlear music**'), is effective for meditation and spiritual matters.

Music with a predominance of **rhythm**, and little or no pitch differentiation ('**vestibular music**') such as rap or rock, stimulates the body primarily through the vestibular system.

Music offers a unique **space-time** dimension.

Music with the emphasis on **melody**, stimulates the cortex via the **cochlea**, and can contribute to organising and clarifying the **mind/flow of thought**.

Musical sounds energise the brain: **the richer the music in high harmonics, the more energy** it provides – implication for acoustic vs electronic instruments.

5-16 **All** individuals respond to, and participate in music of their environment. Music is not reserved for the talented few, or only for those that can afford it, or for those whose caregivers consider it important.

5-17 Musical involvement can help adults remain **more alert at any age**, including the later years.

Knowledge of **bi-lateral brain function** can greatly **enhance** effective teaching.

Those who study music, particularly at an early age, show neurological differences compared to those who have not received any musical training.

Music is **processed in widely diffuse areas of the brain**.

5-18 Those with **disabilities or illness** are also able to have **meaningful musical experiences**.

5-20 Humans are well able to learn **to choose** whether they wish **to process information globally or analytically**.

Listening to music can be enhanced by **musical learning**.

Negative emotions are associated with musical **dissonance**, whereas **positive** emotions are associated with softer **pop**, **baroque**, or **classical** style music.

5-21 A **good sound source** is necessary to develop **listening skills**.

5-22 By **walking upright**, the upper limbs of humans are no longer required to support the body, making it possible to develop **refined movement** of the upper limbs.

5-23 The more music is treated as a **language**, the more important the **written notation/verbal descriptions** of sound become in the study of music. By concentrating on *analytical* processing of music (to the detriment of *global* sound processing), the result could be an action that may be **profoundly unmusical**.

5-24 Instrumentalists are commonly categorised into "sight reader" or "player-by-ear". There has to be an **interaction** between the two to produce **musical** playing.

5-25 **Refinement of muscle movement of the hands and face** takes place at approximately **age 30** (of particular importance for pianists, violinists, and vocalists).

Human **awareness of personality profiles/emotional preferences, brain dominance profiles/eye-ear-hand-foot preferences, and the ability to select hemispheric processing**, could assist in:

- selecting **emotionally suitable compositions** for a learner
- **solving technical problems** arising from a specific brain dominance profile
- **clearing misunderstandings** resulting from different modes of hemispheric processing.

5-26 The **impact of high-level performing** on the **mental and physical health** of the performer must be given consideration.

5-27 It is the **instrumentalist** / **musical performer**, rather than the musical composition, that **conveys** and **induces** the emotion of the music to the listener.

5-30 Instrumentalists should be made aware of **the important role of body language in communication**, and the impact of how they dress and move when 'on-stage'.

5-31 To establish a learner's goals and aspirations, a **feeling of 'one-ness'** between the **student** and **instrument** should be cultivated, so that playing becomes second nature.

Focus on **sound** during a lesson.

Teachers should be up-to-date with information concerning possible **medical problems** associated with the playing of their instrument.

5-32 In well-founded early musical training, the brain processing will be fundamentally **from the emotional to the analytical**.

5-34 Music plays a vital role in **producing and cementing society**.

'Musicality' is **an inherent part of brain function**.

Music can be used **to co-ordinate human emotional states** (weddings and funerals).

5-35 Wilson suggests that the **parents** of music learners should also be educated musically.
Active music-making influences **brain development**
Passive listening **cannot be considered sufficient** for enhancing music learning.

5-36 There are certain **critical stages of development** for music education (see 5-37).

5-37 Fifty percent of the brain's neural connections are effected during the first **five or six** years of life, and form "**the foundation upon which all learning will be based**".

The appropriate time **to stimulate cochlear-vestibular hearing**, is from the fetal age of four–and-a-half months to about nine years of age.
For **musical memory stimulation**, the critical age is from eight to eleven years.

In the fetal stages of hearing development, the **mother's voice** creates the vital desire to **listen and communicate**.

5-38 **Hearing** music elicits physical changes (heart-beat, blood pressure, etc.).
Making music is a bodily-kinesthetic experience, putting musicians in the category of "small muscle athletes".

Virtually everything people experience in life, depends in some way on a **transformation of brain activity into muscular activity** (thought into action). The mind cannot grow without bodily movement.

5-39 **Cross-lateral** movement is **critical** to human learning.

Therapy is fundamental to all people, and not only to those with a special need.

5-39 There appears to be a link between **musical taste** and **intellectual function**.

There are also indications that the innate human musical talent, usually associated with the **right** hemisphere of the brain, may be **constrained** by the less musical **left** brain.

5-40 For many people **'musical function'** is more important than considerations of **musical quality**, and they remain unaware of the limitations of the genre of music they listen to. They are unskilled at listening to complex music, and **prefer music that is easy to listen to**.

5-41 Music is claimed to provide **balance**, **proportion**, **rhythm**, and **pleasure** to educational experience, as well as to **accelerate the process of fixing information in short and long term memory.**

5-42 Technology has provided society with **an abundance of music**.

5-43 Music has many **non-musical** benefits:

- providing **relaxation**
- reducing **stress**
- fostering **creativity**
- stimulating **imagination/ thinking/ motor skills/ speech and vocabulary**
- reducing **discipline problems**.

5-44 Approximately 80% - 90% of the brain's motor control capabilities register stimuli from the **hands**, **mouth**, and **throat**. By **developing highly refined control of these areas in early childhood**, almost the entire brain can be stimulated.

5-48 The human body responds to sound **whether it can be consciously heard or not**. Cymatic sound environments that are in harmony with the natural vibrations encoded in the body are able to provide a greater sense of well-being, energy, and happiness.

5-50 According to Eagle's Theory of Quantum Musichanics:

music is energy - energy is music
people make music - music makes people
music matters - music **is** matter.

5-52 **Noise** can be harmful or therapeutic (white noise).

5-53 Music can be selected **to meet specific needs**. The three main categories are:
Music to **calm**, to **energise**, and/or to **focus**.

Factors influencing the development of the Musical Intelligence can be grouped under the following headings:

1. **Pre-natal and Early childhood**

2. **Gender differences**

3. **Pre-wiring / Environments / Nature vs nurture**

4. **Nutrition and the brain**

5. **Emotions in Learning**

6. **Memory and recall**

7. **Cochlea-Vestibular System**

8. **Communication**

9. **Intelligence / Development / Learning / Movement**

10. **Music / Musical Intelligence / Music Education**

The ten categories have been tabulated as follows:

1

Pre-natal and Early Childhood
Where pregnant mothers are **undernourished**, the babies are born with up to 50% fewer neurons
A **healthy diet** in infancy is necessary for the process of **myelination**, which facilitates the **speedy conduction of information**
Foveal vision plays an important role in early childhood education. Hannaford makes particular reference to rural African children who have well-developed three dimensional vision, but have not yet developed two dimensional 'foveal' vision required for reading. **Foveal vision usually matures between the ages of seven and eight years**
According to Hannaford's "**Landmarks of cerebral neo-cortical development**", whole brain processing only starts taking place from about 9 to 12 years of age. **Gestalt processing** starts at approximately 4-and-a-half years of age, and **Logic processing** at about 7 to 9 years. The landmarks of cortical development roughly coincide with the **development of faster brain wave rhythms**
The **first sensory system** to develop (at about four-and-a-half months in utero), is the **vestibular system** which controls movement and balance, as well as 'vestibular hearing'. The ***rhythmic*** **dimension of music** corresponds to the **functioning of the vestibular system**. Rhythm induces and conveys movement. Deaf people are able **to 'hear' or perceive rhythmic vibration**

2

Gender Differences

Behavioural differences between the sexes cannot be attributed to social conditioning:

Diversity - Biological fact
Equality - Political/ethical/social precept

There are certain physical differences in the brain structure of males and females:

Cerebral cortex - right side is thicker in males
- left side is thicker in females

Corpus callosum - larger in the female than the male brain

Hormonal **brain sexing** is fixed at eight weeks after conception, and cannot be altered

The menstrual cycle in females can result in **'withdrawal symptoms'**

Social conditioning cannot determine the **sexual mind-set**, which is a product of biology and **cannot be altered**. In other words, the brain is 'pre-wired'. Certain biological biases are merely reinforced by social conditioning

Sex-specific hormones do have an effect on the brain's transmission system, **affecting verbal skill, muscle co-ordination, and spatial relationships**

There are **structural differences** between male and female brains in learning ability with respect to **brain-sensory intake** and **thought processing**

Educators and learners should remain constantly aware of the powerful influence **sex hormones** have on certain learning tasks

Educational content should not be presented in the same way for everyone. However, **equal opportunities** should be provided

3

Pre-wiring / Environments / Nature vs Nurture
The biological **pre-wiring of the brain** is an indication of the greater importance of nature as opposed to nurture. The **environment** has little or no influence on the development of the sensory and motor systems of the child. The **brain's ability to re-organise itself** in response to new experiences makes it possible for humans to learn
The message of **evolutionary psychology** is that there is **a limit to how much the mind can be remoulded**
Leadership cannot be acquired: it is necessary to have **the 'right' brain profile and testosterone level**
Heredity plays a vital role in development
A **specific pre-wiring** of the brain (a specific brain profile) is necessary for the brain to flourish **in a particular environment**
The brain changes physiologically as a result of experience
The environment in which the brain operates can influence the functional ability of the brain
IQ is not fixed at birth
Some abilities are acquired more easily during certain sensitive periods

4

Nutrition

Where pregnant mothers are **undernourished**, the babies are born with up to 50% fewer neurons (see 1)

A **healthy diet** in infancy is necessary for the process of **myelination**, which facilitates the **speedy conduction of information** (see 1)

Nutrition has a profound effect on the **number of neurons** in the brain, and **the richness of their interconnections**

Polluted water and air **reduce** the amount of **oxygen** available to the brain. The brain needs large amounts of oxygen to develop and function, both before and after birth. **Candida albicans** removes **oxygen** from the blood, and could be responsible for learning problems

"**Poor health**" usually leads to "**poor academic performance**"

Poverty, low levels of **nutrition**, inadequate access to **health care** and **education**, and the lack of basic **community** and **household resources**, all undermine the development of children

5

Emotions in learning

The RAS system, which is responsible for the 'fight or flight' reaction, can restrict the flow of information to the cortex. There are more neural connections from the limbic system to the cortex than vice versa

Negative emotions have greater power than positive emotions

A learner's **social incompetence** (inability to organise/negotiate, or poor use/interpretation of body language) can activate the fight or flight reaction

Criticism can have a profound effect on **motivation**, **energy**, and **confidence**

On average, **people avoid risk**, **except when threatened**

Limiting beliefs in an individual's ability to succeed has **a negative inf**luence on development of confidence

The **emotional impact** of communication will affect the **long-term storage** of information

6

Memory and recall

Memory is the process of retaining/storing information

Without **memory** there can be no learning

The *hippocampus* in the brain is involved in the storage of information, and does not degenerate with age

Alpha and theta waves play an important role in the memory-process

Music (with rhythm, patterns, dynamics etc.) acts as a prime 'carrier' for memories

Learning that is **distributed over time**, produces better recall than 'cramming'. The brain is **unavailable for new input during sleep** as it is busy replaying, registering, and storing information. Information can be organised and rehearsed during sleep, however

Locale memory can be stimulated by '**mind-mapping**'

Smell is strongly linked to **memory** (hippocampus)

7

Cochlea-Vestibular System

The body plays an integral part in **all** intellectual functions, including abstract thinking, due to the role of the cochlear-vestibular system

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The **first sensory system** to develop (at about four-and-a-half months in utero), is the **vestibular system** which controls movement and balance, as well as 'vestibular hearing'

The ***rhythmic*** **dimension of music** corresponds to the **functioning of the vestibular system.** Rhythm **induces** and **conveys** movement

Deaf people are able **to 'hear' or perceive rhythmic vibration**

The connection between the **vestibular system and neo-cortex**, and **eyes and core-muscles** is vitally important to the learning process

The **integration** of **cochlear** and **vestibular** hearing is crucial to the learning process: without movement the mind does not grow

8

Communication
The **emotional impact** of communication will affect the **long-term storage** of information
The use of **NLP** (a group of psychological techniques based on how the brain codes learning and experience) can be particularly beneficial in a **musical performance** situation
Vitally important facets of **communication** are: **body language** (55%), voice (38%), and **verbal content** (7%).
Educators usually focus on the verbal content of lessons, while attaching little or no value to **how** it is communicated
The **emotional impact** of communication will affect the **long-term storage** of information

9

Intelligence / Development / Learning / Movement

From **birth to adulthood**, there is a **development of faster brain wave rhythms**, moving from the **slow delta waves at birth,** through **theta waves** at about **3-6 years**, to slightly the faster **alpha waves** at about **7 years**, to **beta waves** which become fully functional at about **14 years**, roughly coincide with the landmarks of cortical development (see 1)

Accelerated learning makes extensive use of **alpha** brain waves

IQ, EQ, SQ, memory and recall, brain profiles/dominance, brain waves, and **evolutionary psychology** all have an impact on learning

Teaching and learning cannot thrive on only one or two of **the three basic neural systems**. The serial tracts reflect IQ, the parallel neural networks reflect EQ, and the 40 Hz across-the-brain oscillations reflect SQ, with the latter providing the means to bind experience together and place it in a wider frame of meaning

Vision is a very **complex phenomenon** with less than 10% of vision actually taking place in the eyes. Touch is particularly important to the young child **to 'understand' vision**. Proprioception (the body's sense of itself in space), and touch make up the remaining 90% of the sense of vision. **Much of vision is 'learned'**

Foveal vision plays an important role in early childhood education. Hannaford makes particular reference to rural African children who have well-developed three dimensional vision, but have not yet developed two dimensional 'foveal' vision required for reading. **Foveal vision usually matures between the ages of seven and eight years (see 1)**

Touch stimulates **sensory motor growth** and **nerve network development**. The development of more complex nerve networks increases learning potential. Appropriate supportive touch is valuable in development and learning

"**Flow**" as the neurobiology of excellence is induced by **intense concentration**, and impacts on education in general and **music education** in particular

Learning is the process of acquiring information

Learning is not all in the head: **movement** is essential to learning

There is a societal bias to **physical achievements**: cultural tradition separates mental and physical activities. **Movement** is necessary to **anchor** thought

Cross-lateral movement is crucial to activating the development of the corpus callosum. A lack of this development can lead to learning difficulties

The body plays an integral part in **all** intellectual functions, including abstract thinking, due to the role of the cochlear-vestibular system

9 (continued)
Challenges: it is vitally important **to match (musical) challenges with the learner's ability**
A learner's **social incompetence** (inability to organise/negotiate, or poor use/interpretation of body language) amounts to a **learning disability**
Cross-laterality is essential for learning
Learning preferences are based on **lateral dominance of the brain, hands, feet, eyes, and ears**
Stress results in **unilateral brain processing**
In the case of **ADHD pupils**, the brain functions mainly on slow **theta** brain waves, and **physical movement** is required to access the fast **beta** waves necessary for learning
Neurotherapy can facilitate the 'switching' from theta to beta waves without medical intervention
Learning and teaching are **more effective** when left and right hemispheres of the brain are **both** involved in all information processing
Educators should be aware of **their own brain dominance** or hemispheral preference, as well as that of the learner
'Culture' – both **'high art'** (sometimes referred to as 'elitist') and **popular culture**, should be included in education

10

Music / Musical Intelligence / Music Education

According to Shaw, there are indications that **music** will be recognised as a "window into **higher brain function**":
- counting rhythms and organising fingering point to basic maths operations

playing an instrument involves body movement in three dimensional space, and is linked to developing spatial abilities

Music is a unique way of **knowing**

Music with a predominance of rhythm and little or no pitch differentiation (music with a heavy beat such as rap or rock) **stimulates primarily through the vestibular system**

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Music is a combination of **rhythm** and **melody**, stimulating the **vestibular** and **cochlear** systems separately as well as in an **integrated** manner

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Music can be used **to co-ordinate human emotional states** (weddings and funerals)

Musical sounds energise the brain: **the richer the music in high harmonics, the more energy** it provides – implication for acoustic vs electronic instruments

All individuals respond to, and participate in music of their environment. Music is not reserved for the talented few, or only for those that can afford it, or for those whose caregivers consider it important

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10 (continued)

Technology has provided society with **an abundance of music**

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According to Eagle's Theory of Quantum Musichanics:

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Cognitive, **affective**, and **psychomotor** attributes play an important role in the development of the musical intelligence

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References

Literature

ALTENMÜLLER, E. 2001a. Wozu Musik in der Schule? In: *Ansichtssache* (HAZ), (2001:Feb.15th).

ALTENMÜLLER, E. 2001b (in press). *How many music centers are in the brain?* New York: Annals of the New York Academy.

ALTENMÜLLER, E., BANGERT, M.W., LIEBERT, G. & GRUHN, W. 2000a. Mozart in us: how the brain processes music. In: *Medical problems of performing artists* 15 (2000:99-106). Philadelphia: Hanley & Belfus.

ALTENMÜLLER, E., GRUHN, W., PARLTZ, D. & LIEBERT, G. 2000b. The impact of music education on brain networks: evidence from EEG-studies. In: *International journal of music education* (2000, No.35, 47-53).

ARMSTRONG, T. 1994. *Multiple intelligences in the classroom.* Alexandria: ASCD.

ARONOFF, F.W. 1988. Reaching the young child through music: Howard Gardner's theory of multiple intelligences as model. In: *International journal of music education* (1988, No.12, 18-22).

BARBE, W.B. & SWASSING, R.H. 1979. *Teaching through modality strengths: concepts and practices.* Columbus: Zaner-Bloser Inc.

BECK, D. & BECK, J. 1987. *The pleasure connection: how endorphins affect our health and happiness.* San Marcos: Synthesis Press.

BEGLEY, S. 1996. Your child's brain. In: *Newsweek* (1996:Feb.19th).

BENSON, D.F. & ZAIDEL, E. (eds.). 1985. *The dual brain: hemispheric specialization in humans.* London: Guilford Press.

BLOOM, F.E., LAZERSON, A. & HOFSTADTER, L. 1985. *Brain, mind, and behavior.* New York: W.H. Freeman and Co.

BLOOM, S.B. (ed.). 1984. *Taxonomy of educational objectives: cognitive domain*. New York: Longman.

BODEN, M.A. 1990. *The creative mind: myths and mechanisms.* New York: Basic Books.

BOGEN, J.E. 1985. The dual brain: some historical and methodological aspects. In: BENSON, D.F. & ZAIDEL, E. (eds). *The dual brain: hemispheric specialization in humans.* London: Guilford Press.

BONNY, H.L. & SAVARY, L.M. 1990. *Music and your mind: listening with a new consciousness.* New York: Stanton Hill Press.

BREWER, C. & CAMPBELL, D.G. 1991. *Rhythms of learning.* Tucson: Zephyr Press.

CAINE, R.N. & CAINE, G. 1991. *Making connections: teaching and the human brain.* Alexandria: ASCD.

CALVIN, W.H. 1990. *The cerebral symphony.* New York: Bantam Books.

CAMPBELL, D.G. 1992 (second edition). *Introduction to the musical brain.* St Louis: MMB Music.

CAMPBELL, D.G. 1997. *The Mozart effect: tapping the power of music to heal the body, strengthen the mind, and unlock the creative spirit.* New York: Avon Books.

CAMPBELL, L., CAMPBELL, B. & DICKINSON, D. 1996. *Teaching and learning through multiple intelligences.* Needham Heights: Simon & Schuster.

CLARKE, J.H. 1990. *Patterns of thinking: integrating learning skills in content teaching.* Boston: Allyn and Bacon.

CLEMENTE, C.J. 1987. *Anatomy: a regional atlas of the human body.* Baltimore: Urban & Schwarzenberg.

DEACON, T.W. 1997. *The symbolic species: the co-evolution of language and the brain.* New York: Norton & Company.

DE BONO, E. 1988. *Six thinking hats*. London: Penguin.

DE BONO, E. 1993. *Serious creativity: using the power of lateral thinking to create new ideas.* New York: Harper-Collins.

DEMOREST, S.M. & MORRISON, S.J. 2000. Does music make you smarter? In: *Music educators journal* (87(2):33-39).

DEPARTMENT FOR EDUCATION AND EMPLOYMENT (NATIONAL ADVISORY COMMITTEE ON CREATIVE AND CULTURAL EDUCATION). 1999. *All our futures: creativity, culture and education. Suffolk: DfEE Publications*.

DEPARTMENT OF EDUCATION. 1999. *National strategy for further education and training 1999 - 2001: preparing for the twenty-first century through education, training and work.* Pretoria: DoE.

DEPARTMENT OF EDUCATION. 2001. *The nationwide audit of ECD provisioning in South Africa*. Pretoria: DoE.

DUFF, J. & BRAITHWAITE, K. 1999. *Neurotherapy for ADHD.* http://www.adhd.com.au/Neuro.html

DUFF, J., SILBERSTEIN, R.B. & JARMAN, F.C. 1999. Project title: *Effectiveness of neurotherapy in the treatment of attention-deficit/hyperactivity disorder (ADHD) using SSPT.* http://www.adad.com.au/research.html

DUNN, R. & DUNN, K. 1978. *Teaching students through their individual learning styles: a Practical approach.* Reston: Prentice-Hall.

DU TOIT, P. 1995. *Essential thinking skills.* Cape Town: Kagiso Publishers.

EAGLE, C. 1991. The quantum reality of music. In: HAUPTFLEISCH, S. (ed.). *Music education: Why? What? How?* Pretoria: HSRC.

ECHO GLOSSARY. 2001. http://www.echoes.org/de.glossary.html (accessed 15.5.2001).

ELLIOTT, D.J. 1994. Music, education, and musical values. In: *ISME conference proceedings.* Florida: Tampa.

ELLIOTT, D.J. 1995. *Music matters: a new philosophy of music education*. New York: Oxford University.

ELLISON, L. 1993. *Seeing with magic glasses.* Arlington: Great Ocean.

ENCYCLOPAEDIA BRITANNICA. 2001. Rock, grunge, new age. www.Britannica.com (accessed 15.5.2001).

FAIRBANKS, D.M. 1992. Basics of accelerated learning. In: DARRAUGH, B. (ed.). *Info-line: practical guidelines for training and development professionals* (Issue 9209, September 1992). Virginia: ASTD.

FLOHR, J.W., HODGES, D. & MILLER, D.C. 2000a. Current research on music and the brain. In: *Proceedings of the International Society for Music Education* (2000:127-133).

FLOHR, J.W., MILLER, D.C. & deBEUS, R. 2000b. EEG studies with young children. In: *Music educators journal* (87(2):28-32).

FOX, D.B. 2000. Music and baby's brain: early experiences. In: *Music educators journal* (87 (2):23-27).

GANONG, W.F. 1997 (eighteenth edition). *Review of medical physiology.* Connecticut: Appleton & Lange.

GARDNER, H. 1982a. *Developmental Psychology: an introduction.* Boston: Little, Brown & Co.

GARDNER, H. 1982b. *Art, mind, and brain: a cognitive approach to creativity.* New York: Basic books.

GARDNER, H. 1987. Symposium on the theory of multiple intelligences. In: PERKINS, D., LOCKHEAD, J. & BISHOP, J. (eds). *Thinking: the second international conference.* New Jersey: Erlbaum.

GARDNER, H. 1993. *Multiple intelligences: the theory in practice.* New York: Basic Books.

GARDNER, H. 1998. Are there additional intelligences? The case for naturalist, spiritual, and existential intelligences. In: Kane, J. (ed.). *Education, information, and transformation: essays on learning and thinking* (1998: 111-131). New Jersey: Merrill.

GARDNER, H. 1999. Multiple approaches to understanding. In: *Intelligence reframed: multiple intelligences for the 21st century*. New York: Basic Books.

GAUTENG DEPARTMENT OF EDUCATION 1998. *Curriculum 2005*. http://www.education.gpg.gov.za/Curr2005/Curr2005_000.asp (accessed 31.12.1998).

GOLEMAN, D. 1996. *Emotional intelligence: why it can matter more than IQ.* London: Bloomsbury.

GOLEMAN, D. 1998. *Working with emotional intelligence.* London: Bloomsbury.

GORDON, E.E. 1990. The nature and description of developmental and stabilised music aptitudes: implications for music learning. In: ROEHMANN, F.L. & WILSON, F.R. (eds). *Music and child development, Denver Conference 1987.* St. Louis: MMB Music.

GRUHN, W. 1998. *Der Musikverstand: neurobiologische Grundlagen des musikalischen Denkens, Hörens und Lernens.* Hildesheim: Georg Olms Verlag.

HALPERN, S. & SAVARY, L. 1985. *Sound health: music and sounds that make us whole.* San Francisco: Harper & Row.

HANNAFORD, C. 1995. *Smart moves: why learning is not all in your head.* Virginia: Great Ocean.

HANNAFORD, C. 1997. *The dominance factor: how knowing your dominant eye, ear, brain, hand and foot, can improve your learning.* Virginia: Great Ocean.

HAUPTFLEISCH, S.J. 1997. *Transforming South African music education: a systems view.* Pretoria: University of Pretoria. Unpublished D.Mus. thesis.

HEALY, J.M. 1994. *Your child's growing mind: a practical guide to brain development and learning from birth to adolescence.* New York: Doubleday.

HERRMANN, N. 1989. *The creative brain.* Lake Lure, NC: Brain Books.

HODGES, D.A. 2000. Implications of music and brain research. In: *Music educators journal* (87(2):17-22).

HOLLINGSWORTH, S. (ed.) 1997. *International action research: a casebook for educational reform.* London: Falmer Press.

JABUSCH, H. & ALTENMÜLLER, E. 2001. Apollos Geissel – wenn die Finger nicht mehr spielen wollen: Die fokale Dystonie bei Pianisten. In: *Piano News* (2/2001, 22-27).

JAMES, C. 2001. *Sounds wonderful*. http://www.chrisjames.net (accessed 6.1.2001).

JENSEN, E. 1995a. *Brain-based learning and teaching.* North Riding: Lead the Field Africa.

JENSEN, E. 1995b. *The learning brain*. North Riding: Lead the Field Africa.

JOURDAIN, R. 1997. *Music, the brain, and ecstasy: how music captures our imagination.* New York: William Morrow.

KANDEL, E.R., SCHWARTZ, J.H. & JESSEL, T.M. 1991 (third edition). *Principles of neural science*. Connecticut: Appleton & Lange.

LAWLOR, M. & HANDLEY, P. 1996. *The creative trainer: holistic facilitation skills for accelerated learning.* London: McGraw-Hill.

LAZEAR, D. 1994. *Multiple intelligence approaches to assessment: solving the assessment conundrum.* Tucson: Zephyr Press.

LEEDY, P.D. & ORMROD, J.E. 2001 (seventh edition). *Practical research: planning and design.* New Jersey: Prentice Hall.

LEHR, M.R. 1998. The brain building subject. In: *Teaching music* (1998, Vol.6/No.3 December).

LINDEN, A. 1997. *Understanding how you think can help change your behaviour.* lizhill@indra.com (1997.11.03).

LINKSMAN, R. 2000. *The fine line between ADHD and kinesthetic learners.* http://www.latitudes.org/learn01.html (accessed 18.5.2000).

LOZANOV, G. 1978 (translated by HALL-POZHARLIEVA, M. & PASHMAKOVA, K.). *Suggestology and outlines of suggestopedy*. New York: Gordon and Breach.

McCARTHY, B. 1987 (revised edition). *The 4mat system.* Barrington: Excel.

McCARTHY, B. 1990. Using the 4MAT system to bring learning styles to schools. In: *Educational leadership* (Vol.48 no.2, Oct. 1990).

MADAULE, P. 1998. Listening training and music education. In: *Early childhood connections: journal of music- and movement-based learning* (Vol.4 No.2, Spring 1998, pp. 32-41).

MAGUIRE, J. 1990. *A guide to your gray matter: care and feeding of the brain.* New York: Doubleday.

MARTINI, F.H. 1998 (fourth edition). *Fundamentals of anatomy and physiology.* New Jersey: Prentice Hall.

MERRITT, S. 1990. *Mind, music and imagery.* New York: Penguin.

MEYER, B.J., MEIJ, H.S. & MEYER, A.C. 1997 (second edition). *Human physiology*. Cape Town: Creda Press.

MICHELS, P. 1996. *Developing the pre-school child's musical intelligence by means of a comprehensive music programme focused on age-controlled auditive development.* Pretoria: University of Pretoria. Unpublished M.Mus. dissertation.

M.I.N.D. INSTITUTE. 2001. *What is the M.I.N.D. Institute (MI)?* www.MINDinst.org (accessed 3.9.2001).

MOIR, A. & JESSEL, D. 1992. *Brain sex: the real difference between men and women.* New York: Delta.

NATIONAL ADVISORY COMMITTEE ON CREATIVE AND CULTURAL EDUCATION 1999. *Consultative report one: pre-16 education*. London: NACCCE.

NATIONAL FOUNDATION FOR EDUCATIONAL RESEARCH 1998. *The effects and effectiveness of arts education in schools.* London: NFER.

NELSON, C. & BLOOM, F. 1997. Child development. In: *Child development and neuroscience* (68(5), 970-987). Chicago: University Press.

NICHOLSON, N. 1998. How hardwired is human behaviour? In: *Harvard business review* (1998, July - August).

O'CONNOR, J. & SEYMOUR, J. 1993 (revised edition). *Introducing neuro-linguistic programming: Psychological skills for understanding and influencing people.* London: Aquarian Press.

ODAM, G. 1995. *The sounding symbol: music education in action.* Cheltenham: Stanley Thornes.

ORMROD, J. E. 1995 (third edition). *Human learning.* New York: Prentice-Hall.

OSTRANDER, S., SCHROEDER, L. & OSTRANDER, N. 1994. *Super-learning 2000.* New York: Dell.

PEASE, B. & PEASE, A. 1999. *Why men don't listen and women can't read maps*. Victoria: Australian Print Group.

PEERY, J.C., PEERY, I.W. & DRAPER, T.W. (eds). 1987. *Music and child development*. New York: Springer.

PERSAUD, R. 2001. Mind over music: how your brain dictates your musical taste. In: *BBC music magazine* (July 2001).

PHILLIPS, E. M. & PUGH, D.S. 1987. *How to get a PhD: managing the peaks and troughs of research.* Milton Keynes: Open University.

PLUTCHIK, R. 1980. *Emotion: a psychoevolutionary synthesis.* New York: Harper & Row.

PRIMOS, K.M. 1996. *Music education and the concept of holism in a South African context, with special reference to the Johannesburg region.* Pretoria: University of Pretoria. Unpublished D.Mus. thesis.

QUALIFICATIONS AND CURRICULUM AUTHORITY. 1998. *Maintaining breadth and balance at key stages 1 and 2.* London: QCA.

REIMER, B. 1999. Facing the risks of the "Mozart effect". In: *Music educators journal* (86(1):37-43).

ROSE, C. 1991 (fifth edition). *Accelerated learning.* Gosport: Ashford Colour Press.

ROSE, C. & NICHOLL, M. J. 1997. *Accelerated learning for the 21st century: the six-step plan to unlock your master-mind.* New York: Dell.

RUSHTON, J.P. 2000 (2nd special abridged edition). *Race, evolution, and behavior: a life history perspective*. Port Huron: Charles Darwin Research Institute.

SCHNEIDER, W. 1993. Varieties of working memory as seen in biology and in connectionist/ control architectures. In: *Memory and cognition* 21.2 (1993: 184-192).

SCHUPPERT, M., MÜNTE, T.F. & ALTENMÜLLER, E. 1997. Störungen der Musikwahrnehmung nach einseitiger Grossgehirnschädigung. In: *Musikphysiologie und Musikermedizin* (1997, 4.Jg., Nr.2.)

SCHÜRMANN, K., PARLTZ, D. & ALTENMÜLLER, E. 1997. Brain activation patterns during music processing reveal emotion related hemispheric differences. In: ELSNER, N. & WÄSSLE, H. (eds.). *The Göttingen Neurobiology Report, Thieme, Stuttgart* (pp 1007).

SHARP, C., BENEFIELD, P. & KENDALL, L. 1998. *The effects of teaching and learning in the arts: a review of research.* London: QCA.

SHAW, G.W. 2000. *Keeping Mozart in mind*. San Diego: Academic Press.

SINGER, W. 1999. Neurobiology: striving for coherence. In: *Nature* (1999.02.04, Vol 397).

SKINNER, B.F. 1971. *Beyond freedom and dignity*. Harmondsworth: Penguin.

SPERRY, R.W. 1985. Consciousness, personal identity, and the divided brain. In: BENSON, D.F. & ZAIDEL, E. (eds.). *The dual brain: hemispheric specialization in humans.* London: Guilford Press.

STERNBERG, R.A. 1998 (second edition). *In search of the human mind.* New York: Harcourt Brace.

STERNBERG, R.J. & LUBART, T.I. 1995. *Defying the crowd: cultivating creativity in a culture of conformity.* New York: The Free Press.

SYLWESTER, R. 1995. *A celebration of neurons: an educator's guide to the human brain*. Alexandria: ASCD.

TERVANIEMI, M., KUJALA A., ALHO K., ILMONIEMI R.J. & NAATANEN R. 1999. Functional specialization of the human auditory cortex in processing phonetic and musical sounds: a magnetoencephalographic (MEG) study. In: *Neuroimage* (March 1999, 9 (3):330-6).

TOMATIS, A.A. 1991 (translated by LUSHINGTON, S.). *The conscious ear: my life of transformation through listening.* New York: Station Hill.

TOMATIS, A.A. 1996. *The ear and language*. Ontario: Moulin.

VAN DEN BORRE, J. 1998. A critical view on the influence of music and noise on modern society and on its music education. In: VAN NIEKERK, C. (ed.). *ISME conference proceedings.* Pretoria: Unisa.

WALKER, R. 1996. Book review: George Odam, *The sounding symbol.* In: *International journal for music education* (1996:27, 58-59).

WEBB, T.W. & WEBB, D. 1990. *Accelerated learning with music.* Georgia: Accelerated Learning Systems.

WEINBERGER, N.M. 1998. Music increases social interaction in preschoolers. In: *MuSICA Research Notes, Volume V, Issue 1, Winter 1998.* http://musica.cnlm.uci.edu/mm/V511W98.html (accessed 24.1 1999).

WEINBERGER, N.M. 2001. Feel the music! In: *MuSICA Research notes, Volume VIII, Issue 1, Winter 2001.* http://musica.cnlm.uci.edu/mm/VIIIW01.html (accessed 10.8.2001).

WHITE NOISE HOME ORDER INFO. 2001. *Information on white noise.* whitenoiseCD.com.

WESTERLUND, H. 1998. Universal against contextual thinking in multicultural music education – Western colonialism or pluralism? In: VAN NIEKERK, C. (ed.). *ISME conference proceedings.* Pretoria: Unisa.

WILCOX, E. (ed.) 1999. Straight talk about music and brain research. In: *Teaching music* (Vol.7 No.3, December 1999).

WILSON, F.R. 1985. Music as basic schooling for the brain. In: *Music Educators Journal* (1985, May, 39-42).

WILSON, F.R. 1991. The importance of music in childhood experience. In: HAUPTFLEISCH, S. (ed.). *Music education: Why? What? How?* Pretoria: HSRC.

WOLFE, P. & BRANDT, R. 1998. What do we know? In: *ASCD* (1998, Vol.56, 8-13).

ZAIDEL, E. 1985. Roger W. Sperry: An appreciation. In: BENSON, D.F. & ZAIDEL, E. (eds). *The dual brain: hemispheric specialization in humans.* London: Guilford Press.

ZOHAR, D. & MARSHALL, I. 2000. *SQ – spiritual intelligence the ultimate intelligence.* London: Bloomsbury.

Interviews

ALTENMÜLLER, E. Prof.Dr.med., Head of Department, Institute of Music Physiology and Performing Arts Medicine, Hannover University of Music and Drama. 2001.06.28, including discussions with post graduate students at the Institute.

GALLEY, N. Prof.Dr.med., Institute of Psychology and Psychotherapy, University of Cologne 2001.07.02.

LIEBENBERG, S.W. Neuroanatomy, Basic Medical Sciences, University of Pretoria. 2000.01.07.

ODAM, G. Prof., Co-ordinator of research and staff development, Guildhall School of Music and Drama, London. 2001.06.19.

Seminars

Brain dynamics. Presented in Midrand, 2000.03.27 by Kruger, J. (Human performance technologies).

Leer jou brein ken. Presented at UP Conference Centre, Pretoria, 1999.07.24, by the Medical Faculty, University of Pretoria.

Musiek, die brein, die klein kind. Presented by the Centre for Music Education, University of Pretoria, 1999.08.21, at the University of Pretoria.

NLP for musicians: Neuro-linguistic programming workshop/seminar. Presented in Johannesburg, 1999.09.24/25, by Hofmeyr, T. (Salon Music).

Whole-brain learning to achieve outcomes-based education. Presented for the National Dept. of Education at Laudium (Pretoria), 1996.07.08 – 1996.07.12, by Launa Jean Ellison (Director of Whole Brain Learning Consortium, USA).

Whole-brain seminar. Presented at UP Conference Centre, Pretoria, 1998.08.08 by Vermeulen, A. (Destinatum).