Our brain

Understanding the basics of neuroscience

The importance of neuron survival

Being hard-wired for survival – meeting reptiles in the Forest!

Stress and relationships

Secure attachments
The Triune Brain

- The reptilian brain
  - lower brain/brain stem

- The mammalian brain
  - mid brain/limbic system

- The rational brain
  - higher brain/neo cortex
**Reptilian:** The oldest brain structures are the brainstem and cerebellum – that control our body’s vital functions of heart rate and breathing.

**Mammalian brain:** The limbic brain, consisting of the hippocampus, amygdala and hypothalamus, is responsible for emotions, values and other unique functions that control so much of our human behaviour.

**The Rational brain:** Is responsible for language, cognition, executive function, consciousness – in other words higher other thinking and imagination that influence individual learning and the development of culture and society more broadly.
The brain serves 2 functions:

First it controls all neurological (body nervous system) and physical functions – it keeps us physically alive.

Second it is a learning tool with a capacity in fact an inbuilt drive to grow.
The Basic Constituents

- Basic building blocks of the brain – nerve cells or *neurons* – *information processing cells*.
- Dense network of neurons, each one a mini eco-system taking in nutrients, generating energy, and adapting to environmental changes.

**Our brains:**
- Use up to 20% of the body’s oxygen supply
- And an incredible 60% of the body’s glucose supply

- Billions of neurons make up the nervous system. (100 billion – like trees in the Amazon)

**They maintain us as fully functioning human beings**

Everything you see, feel, think, and do is dependent on their ability to communicate with each other – making connections (60 trillion connections in the adult brain – like the leaves on the trees in the Amazon).
Neurons – the raw materials

- Neurons are by nature social entities and actively search out other neurons that connect together to produce neural networks
- Each neuron’s centre can carry an electrical impulse

**Important features:**
- **Dendrites**
  - receive messages from other neurons
- **Axons**
  - transmit messages to neighbouring cells

Axons are covered in white myelin – a protective sheath that acts as an insulator, enhancing the axon’s firing efficiency
The thicker the myelin surrounding the axons, the speed of action potential is increased, and the regeneration of axons. As cells are used, the myelin sheath is strengthened.
Babies are born with twice as many neurons and connections than adults! Connection production!

The neurons are there ready to be sculpted, some are strengthened and some are pruned. If you don’t use it, you may lose it!

Neurons survive when they send and receive information, when they make successful connections – if not they die.

Learning is about creating and strengthening pathways through these neurons for impulses of electricity to pass along. To learn something new the impulses need to jump across the gap (synapses!).

Balance is the first sensory system to develop – myelinised by time of birth. Myelin is an electrically insulating material surrounding the axon of a neuron. Without it, you couldn’t sit, crawl or stand, BUT a child needs years to learn how to use this system efficiently.
The Reptilian Brain......

- Connects to the spinal cord and thereby to the whole body
  - Central Nervous system

- A major component of the Central Nervous system is: Autonomic Nervous System: *Regulates bodily functions that occur beneath the level of conscious awareness e.g. heart and respiration rates and blood pressure*

- **Sympathetic Nervous System**
  - Stimulates functions associated with the stress response

- **Parasympathetic Nervous System**
  - Stimulates the relaxation response in the body
The Reptilian Brain..and children

- Deepest most ancient part of the human brain, largely unchanged by evolution - shared with all other vertebrates
- Responsible for instinctive behaviour related to survival (fight flight freeze and territorial instincts)
- At birth we are ‘hard-wired’ for survival.
- Our brains instinctively respond to threat and produce the response of flight freeze fight.
We all have an instinctive response to fearful and stress inducing experiences .... We

RUN

FIGHT/ATTACK

HIDE/WITHDRAW
Remember....

• When a child feels threatened or angry the reptilian brain takes over control from the cortex (rational brain)

• IQ plummets...appeals to reason just don’t work

• The child has to be calmed first. The use of play is better than a cognitive approach in these situations

_The reptilian brain returns the body to homeostasis: a securely attached child is both CALM and ALERT._
Comparison of the Developing Brain

Healthy Development
Development Affected by Environmental Stress


Human Brain Development
Neural Connections for Different Functions Develop Sequentially

Source: C.A. Below (2003)
Growing a Grown-up Brain

Scientists have long thought that the human brain was formed in early childhood. But by scanning children’s brains with an MRI year after year, they discovered that the brain undergoes radical changes in adolescence. Excess gray matter is pruned out, making brain connections more specialized and efficient. The parts of the brain that control physical movement, vision, and the senses mature first, while the regions in the front that control higher thinking don’t finish the pruning process until the early 20s.

Gray matter density: Gray matter becomes less dense as the brain matures.

More dense | Less dense

Age: 5 | Adolescence | 20

In the first 18 months – the learning is needed to establish neural connections concerned with relationships and the emotional ‘tag’ to those relationships.

Baby brain is an emotional organ ... it functions through relationship and learning is based on relationship.

For first 18 months of life brain learning is based on relationship. Underdeveloped or shrunken brains are due to poor relational experiences, and relational stress – so children don’t have the capacity to be socially appropriate, empathetic, self – regulating and humane.
Summary: In order to help us deal more rationally with fearful or stress-inducing experience we need to be helped from birth to **switch on** our higher thinking brains on:

- **Higher brain**
  - Rational processing
  - Logic, moral judgement
  - Imagination, language
  - Creativity

- **Lower brain - reptilian**
  - Flight freeze fight

- **MID - BRAIN:**
  - Emotional response to experiences - hard-wired for Empathy/relationship memory
Autopilot SYSTEM 1
INTUITIVE

Pilot SYSTEM 2
RATIONAL
DANIEL KAHNEMAN'S SYSTEMS OF THINKING

SYSTEM 1 THINKING
- Quick
- Little/no effort
- Emotional
- No sense of voluntary control
- Automatic

SYSTEM 2 THINKING
- Slower
- Conscious
- Effortful
- More logical
- More deliberative
- Complex decisions
Trauma & Brain Development

Typical Development
- Cognition
- Social/Emotional
- Regulation
- Survival

Developmental Trauma
- Cognition
- Social/Emotional
- Regulation
- Survival

Adapted from Holt & Jordan, Ohio Dept. of Education
The Stress Response

1. Nervous system perceives stress.

2. Brain sends signal to pituitary gland, which releases ACTH into bloodstream.

3. Adrenal glands release stress hormones cortisol, epinephrine, and norepinephrine.

4. Stress hormones travel through blood to target cells throughout the body, triggering the conversion of stored fat, protein, and carbohydrate to glucose, supplying the body with energy to respond to stressor.

5. Stress hormones prepare vital organs for “fight-or-flight” (see right).

STRESS MAKES US PHYSICALLY ILL
It negatively affects:
- Breathing
- Heart rate
- Glucose levels
- Digestion
- Release of urine
- Muscle tension
- Immune system
- Blood clotting increases

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Meet Your Happy Chemicals

Dopamine  Serotonin  Oxytocin  Endorphin

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Laughter and its Benefits On the Body

Laughter:
- increases serotonin and endorphins in the brain
- replenishes the lungs
- relaxes muscles and eases tension in the body
- reduces stress hormones in the body
- protects the heart
- increases immune system functioning
- is the best workout
Emotions & Chemistry of Hormones

- Mania
- Anxiety
- Happiness
- Curiosity
- Anger
- Excitement
- Stress
- Depression
- Autism
- Fear
- Apathy
- Euphoria
- Revelation
- Sadness
- Irritation

Hormones:
- Dopamine
- Serotonin
- Endorphins
- Oxytocin
- Noradrenaline
- Adrenalin
- Estradiol
- Testosterone
- Phenylethylamine
- Melatonin
- Vasopressin
- Progesterone
- Prolactine
- Acetylcholin
- Thyroxine
**Superintendent**: otherwise known as neocortex ... this brain thinks it is completely in charge however it is only a very small part of your whole brain. It is vital for helping us learn a language, make moral and complex decisions, do maths, show compassion for others.

**Foundation brain**: otherwise known as limbic system ... the biggest part of our brain includes the amygdala (emotion processing) cingulate cortex (connection to others and environment) hippocampus (memory).

**Survival brain**: otherwise known as REPTILIAN... it will react to STRESS FEAR signals sent from the emotional processing of sensory experiences and we will FIGHT FLEE OR FREEZE = argue/run away/hide.

**MEMORY BANK**
- sensor
- relationships
- emotion processing
- survival
- heart; the energy pump
SEEING
WHAT ARE YOU LOOKING AT?

Visual Processing is MUCH More Than Simply Seeing
- Seeing
- Retrieving images
- Hallucinating
- Visualizing
- Altering images
- Dreaming
- Analyzing

The voyage of discovery is not in seeking new landscapes but in having new eyes.
-MARCEL PROUST

We see with the eyes, but we see with the brain as well. And seeing with the brain is often called imagination.
- Steven Pinker
We all know that in space there is no medium in which sound can travel. There is no solid, no liquid and no gas. So, on moon we cannot hear any sound. Therefore, astronauts communicate to each other by signals or microphones in space even they are more closer.

HOW WE HEAR

1. Sound vibrations start.
2. Air vibrates.
3. Ear drum vibrates.
4. Tiny bones (ossicles) vibrate.
5. Tiny hairs in the cochlea vibrate.
6. Auditory nerve carries signals to the brain.

Normal Hearing

YOU FEEL VULNERABLE WHEN YOU HEAR THINGS THAT ARE NOT BEING SAID
Sense of touch

- The sense of touch is distributed throughout the body.
- Four kinds of touch sensations can be identified: cold, heat, touch, and pain.

- SKIN
  - Has two main layers: epidermis and dermis
  - The bottom layer is called subcutaneous tissue.

**Brain Fact #38**

The first sense to develop in the uterus is the sense of touch. The lips and cheeks can experience touch at about 8 weeks and the rest of the body around 12 weeks.
If a good enough relationship has been made between growing child and primary care giver then the infant learns that OTHERS can be trusted to make them feel safe and secure = loved

If the relationship with the primary care giver is not good enough ie the basic needs have not been met – then the child grows up to accept that OTHERS do not make them feel safe or secure and it = love
John Bowlby’s research (founder of child development theory of Attachment in 1950’s – 1980’s) current neuroscience and the results of brain scans shows that the part of the human brain switched on at birth is similar to all other mammals.

We all need to experience in our first year of life:

- Holding
- Mirroring
- Reflecting
- Feeding
- Mutual cueing

These are the basic needs which if met in the early years will establish a sense of well being that you are safe and your presence is welcomed.

IT IS ONLY WHEN WE HAVE ESTABLISHED A SENSE OF SECURITY THAT WE CAN BEGIN TO DEVELOP OUT FRONTAL CORTEX—THE HIGHER THINKING CAPACITY UNIQUE TO HUMANS.
How do we do this?

**Secure attachment:** relationship that is internalised that informs a person’s internal working model of self, other and feelings of being in the world.

Neuroscience of attachment: Attachment is a huge hormonal force that deeply affects the brain, mind, physiology and even how we lay calcium in the bones (Dr Margot Sunderland)

If the baby experiences consistent holding mirroring reflecting and feeding for at least the first 8-12 months of life. He/she will have foundations laid of feeling safe, a sense of belonging, optimistic outlook on life, my needs are met and will be met. Under 4’s have a need every 20 seconds (Lieberman, A 1995).

Examples: To soothe, to show you something, to say ‘wow’, to cuddle, to help her switch tap on, to get you to be delighted, to listen to her story.

Under stress: Brain scans of impulsive murderers – show poor impulse control in the frontal lobes similar to that of a toddler (Raine et al 1994).
The infant who has experienced lack of holding, feeding, mirroring, reflecting will be more fearful of new experiences – how could this show up at Forest School?

Stressed out children/teenagers function like threatened animals, unable to learn, attend, concentrate, enjoy friendships, play and problem solve. (Damasio 2001: Secret Life of the Brain).

They will have less brain connections to higher thinking and will instinctively respond to new situations with FFF....

They will sweat the small stuff.

Alarm systems in brain are activated, not the calm systems.

Minor stressors can elicit full-blown emergency reactions

Lower brain-reptilian flight freeze fight. Thinking narrowed down to defence or attack.
Secure attachment = Resilience

Impact on brain biochemistry: “In our brain each of us has his or her own finest drugstore available at the cheapest cost” (Pert, Molecules of emotion, 1997). The emotional chemicals in secure attachment include: Opioids, oxytocin, prolactin, natural valium (Benzodiazepines). They create feelings we humans call acceptance, nurturance and love.

In 2011 there were over 46 million prescriptions for anti-depressants (HSCIC 2013). There are only 63 million people in the country.


“The resilient kids observe other people very carefully, and think of relationships – as if they were greatly important. They pay attention to how they act in relationships, and to the effects of their actions on other people....They were interested in psychological experience and their ideas about themselves and other people were discerning and thoughtful.”

Non-resilient children rarely recognise themselves as the common denominator in all of their connections; and the way relationships work, seem to not interest them (importance of long-term relationships at Forest School).
Secure Attachment = Resilience

Resilience is key for: self-esteem, capacity to ask for help when troubled, development of effective stress regulatory systems in brain and body, capacity for deeply fulfilling relationships in later life, capacity for empathy, longevity.

What can we do at Forest School Practitioners?

• Calming the body down
• Understand the importance of play – it activates opioids.
• Being loving with safe boundaries.
• Relationships with others and the non-human world.
• Empathetic Listening e.g Sometimes it’s hard to share things, you look like you are upset; I know you are angry at me, I can see that... *(Link to effective communication).*
• The great outdoors - cortizol levels reduced, senses expanded.
• High ratios, increased relationships.
• Choices and consequences
• Child-led (attends, asks to play, attune, warm touches)

*The brain is plastic ... it has the capacity to keep growing through our lives*

The insecure child does have the potential to switch on higher thinking processes.
Evidence from Neuroscience

The outdoors and play together aid the release of opioids and oxytocin:

- You do not feel aggressive or anxious
- You feel calm and psychologically strong
- You have a feeling that everything is well in your world
- You have a deep sense of well-being
- You feel safe in the world
- The world has meaning
- Your immune system works better
- You are better able to learn

• Play builds new neural pathways by releasing chemicals in the brain
• It helps the formation of top/down networks – cortical to subcortical
• Anti-anxiety chemicals are released in the brain when a child/adult is helped to think about their feelings, trauma is modified
• Play acts as a ‘brain sculptor’ quietening the amygdala
It is now recognised that some stress is inevitable and can be positive – a challenge we can overcome and therefore our minds and bodies are not held in stress response too long.

IT IS THE FEELING OF SUPPORT WE RECEIVE FROM OTHERS THAT CAN MAKE THE DIFFERENCE TO HOW OUR MINDS AND BODIES DEAL WITH STRESS.
Bibliography

‘Play for Life’ Journal Summer 2007


IT IS VERY EASY FOR RELATIONSHIPS TO GET CAUGHT IN WHAT IS KNOWN AS THE DRAMA TRIANGLE.