Evonne Bennell info@evonnebennell.com

Listening, Auditory Processing, Reflex links and support with RMT

> *Everything we do requires movement of one kind or another. Without movement we cannot take care of ourselves, go where we want or express ourselves to others (Ayres, 2005).*

Babies are born ready to hear, hearing the sounds of their internal world from as early as 12 weeks after conception.

Later, they can distinguish between sounds and patterns of speech and music. While key auditory structures like the cochlea are fully developed in utero, the skill of listening will develop as the brain matures.

The auditory system forms a baby's first line of defense, an interactive 360° surround sound system, which provides a continuing stream of information to monitor, and orientate as they move, interact and engage with the world around them.

The child's brain development is shaped through the continuous repetition of sound, influencing her cognitive and emotional development.

The process of maturing and myelination of the auditory pathways having begun, will take well beyond her infancy to process sounds, interpret the actual words and their meaning, and respond in speech.

This process of hearing the words, hearing the meaning, and hearing the implications is Auditory Processing. This important developing ability is the foundation for future effective oral and written communication: listening, speech, reading, writing and spelling.

Processing of sound relies on the efficiency of an individual's brain organisation to receive, orientate, filter/discriminate, interpret, plan and initiate a motor response/reply in correlation with other sensory input, in particular the vestibular and vision senses.

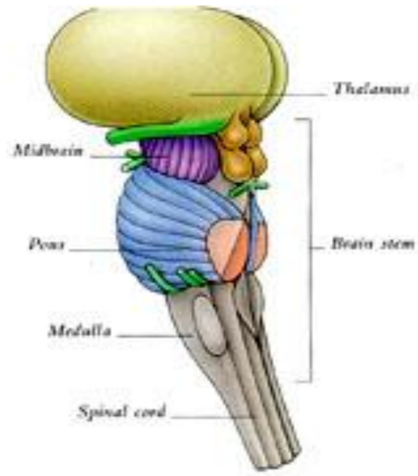
Sound processing begins within the ear by the conversion of sound into electrical impulses. These impulses are carried along a series of brain structures forming the auditory neural pathway to the cortex.

A number of these structures are critical to the process of interpreting the signal in particular the cochlea, reticular formation, inferior colliculus, thalamus and the auditory cortex. Sound signals travel through three hierarchical afferent pathways: the reticular activating formation, the thalamus and the cortex.

Sound Processing and Auditory Neural Pathway

→ → **Ear Canal→Ear Drum→Otoliths oscillate→Oval Window →Cochlea hair cells converts to vibrations→synapsis along auditory nerve →Brain Stem- Medulla Oblongata- Pons- Cerebellum - RAS → Superior Olivary Complex → Midbrain (Inferior Colliculus) →Thalamus→Amygdala→Primary Auditory Cortex**

Each level has a specific role in creating a precise and clear "auditory picture" by filtering the signals, removing extraneous information and linking with information from the other senses. The Reticular Formation (RAS) is the initial filter of the central nervous system. When the RAS is working efficiently, it applies a coarse filter to all sensory input, to prevent overload and avoid inundating the brain with information[1].



The Thalamus is a sensory and motor relay centre connecting with many different areas of the brain including the cerebellum, brain stem and cortex. It also evaluates and modulates the auditory input, by sharpening the perceived meaningful sound and dampening 'noise', then forwards signals on to both the sensory cortex and the amygdala (limbic system). The amygdala has a role of oversight by alerting the nervous system to any potential threats, if no apparent threat messages are sent to the hippocampus and the cerebral cortex.

Actual perception of sound begins in the cortex where sound is decoded interpreted and meaningful acoustic pictures are created stored and responded to.

http://163.178.103.176/temas/temab2n/aportal/fisonercg/fisonerob9/clay/internas.html

Development of the Auditory System

The Auditory System begins its development in tandem with the vestibular system just 4 weeks after conception with both the semicircular canals of the vestibular system and the cochlea emerging on the embryonic brainstem.

- 4 weeks – cochlea emerges, ossicles begin formation
- 6 weeks - auditory nerves, cochlear nuclei and superior olive recognisable.
- 8 weeks - cochlea has completed 2.5 turns, and grows to adult size by 20 weeks.
- 20 weeks hair cells mature and begin to relay with brain stem (inferior colliculus) and neurons in the auditory system begins to relay sound impulses.
- By 24 weeks gestation the foetus' inner ear is fully functional

By 24 weeks after conception the baby responds to the tone and rhythm of the mother's voice. Initially responding to low sound frequency, over time sensitivity to higher tones develops and a broad spectrum of sound waves can be detected and processed.

Researchers have completed numerous studies of hearing and sound in utero. A study of 400 foetuses illustrated their movement in response to low frequency sound stimulation at 16 weeks[2]. Sound at this stage of development is processed through the receptors in the foetus' skin and skeletal framework.

[1] Schneck & Berger; *Music Effect*

[2] Shahidullah & Hepper 1992

In another study[3] mothers read the "The Cat in the Hat" twice a day for the last 6 weeks of gestation. At testing, following birth the babies demonstrated a preference of the familiar text by sucking faster to hear their mothers' voice. Tis signaled recognition by their behavioural response, and a preference for the story read by their mother to another's.

By birth the lower neuronal relays between the ears and brain stem are myelinated.

After birth the eustachian tubes begin to dry out and hearing sound of higher frequencies and discrimination establishes.

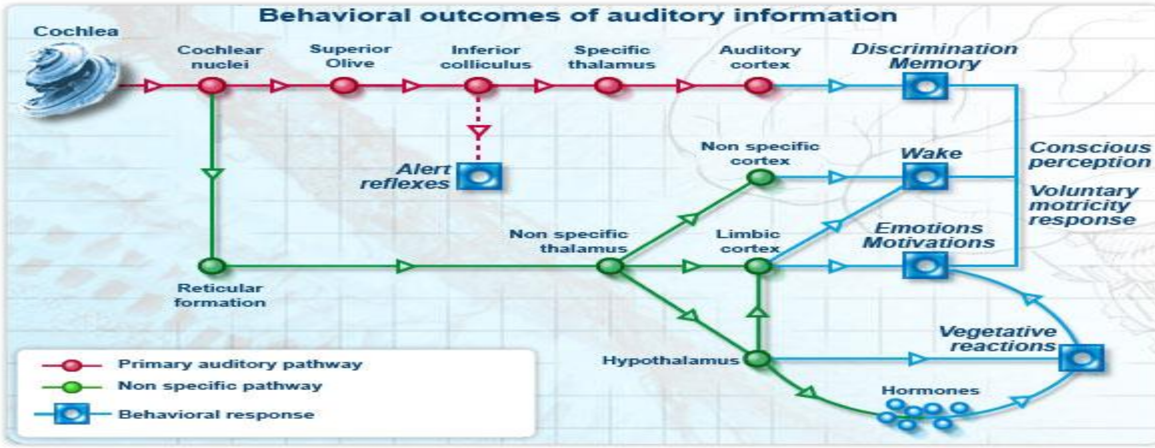
Orientation of the eyes and head to sounds on the horizontal plane continues to develop further over the coming months. Over the 12 months the relays to the thalamus myelinate, while, the maturation of the entire auditory pathway continues alongside language until about age 6-10.

The Inferior Colliculus, orienting and modulation of sound

The Auditory sense is closely linked to the vestibular and visual systems. The auditory and vestibular systems are housed within the same structures and both process information regarding our position, our internal GPS systems. The vestibular system provides the brain with positional information of the head and the head when in motion. The cochlea provides the reference for understanding our environment our own body map, a 3D sense of time and auditory 'images' of the space around us in any given moment.
The inferior colliculus, is the integrating synaptic point in the mid brain for sound. It has associations with over 20% of the brain, including the cerebellum and other vestibular related structures, the superior colliculus (vision), thalamus and basal ganglia. The integrated sound (orientating) data provides the spatial and tonal information to blend with our kinesthetic/proprioception awareness of our body maps.

The auditory system is always on, subconsciously alerting us to ongoing changes within our environment and with the cortex orienting continuously refining our perceptions. This is in part the orienting response, part of the autonomic nervous system monitoring system. The Orienting response monitors both new (what is it?) and significant stimulation. If a loud sound is received (acoustic startle) the inferior colliculus signals the superior colliculus to direct eyes to the sound (vestibulo-ocular reflexes) for further monitoring.

[3] DeCasper & Fifer 1980



http://www.cochlea.eu/en/auditory-brain

The Acoustic Stapedius Reflex can dampen loud noises within 30 milliseconds by initiating a contraction of the stapedius muscle, reducing the movement of the stapes and the vibration to the cochlea. This reflex develops between 2-4 months after birth, at a similar time to the Moro reflex integration timeframe. Sally Goddard Blythe[4] suggests if this reflex is not developed fully hypersensitivity to sound and triggering of the Orienting Response, Moro and other reflexes can occur.

The ear dampens loud sounds and attempts to filter through sound discrimination[5] by reflexive adaptions in our posture and muscle tone. Contracting the small muscles in the middle ear (stapedius and tensor tympani), the jaw, and face/ head (Pterygoid, masseter, temporalis etc). Even cranial nerves, with their attachments on the tiny bones within the ear and face (Trigeminal, Facial and Vagas) can be involved in the response to minimise the effect of auditory hypersensitivity.

Sensory modulation refers to the ability to respond appropriately to sensory input, working on the 'goldilocks principle' just right, rather than a under or overreaction to normal levels of sensory stimuli. When the response is not the 'just right' response the autonomic nervous system (ANS) sets off a cascade of sympathetic and parasympathetic responses to react or to assist in righting the system.

Sensory modulation challenges respond with either hypervigilance, effectively hearing 'too much'. They are unable to filter selectively and may become auditory defensive. Paul Madaule says "the paradox of poor listening is hearing too much[6], a child ears wide open for language integration is also wide open and sensitive to noises." Alternatively, they present as hyposensitive, they tune out and under register, appearing distracted, unresponsive, seem unable to listen, and distract others by talking loudly.

---

[4] Sally Goddard Blythe; Attention, Balance Coordination pg. 64-65
[5] E Borg and S Allen The Ear Muscles Scientific Journal 1989
[6] Paul Maudale When Listening comes Alive

Auditory Processing and Listening

Listening is a whole body active experience. A good listener must work through a series of steps from attention, orient to sound, and then input and process that sound through the auditory pathway to decode i.e. interrupt both literal and inferred meaning, interpret non-verbal gestures and facial expressions the prosody and then plan and execute an appropriate response. All this within the expectation of a response within 4 seconds.

Children and adults with auditory processing challenges present with:

- Difficulty modulating auditory sensations
- Hypersensitive to noise, high-pitched sounds or low frequency sounds
- Poor auditory discrimination- difficulty locating sound, separating out sounds, or associating new sounds to visual symbols.
- Poor sense of timing and rhythm
- Difficulty with receptive and/or expressive language.

Nutritional factors, mineral deficiencies – magnesium, manganese, essential fatty acids, and oxytocin levels have been indicated in auditory processing. Within these multileveled processes there are many possibilities for a breakdown to occur and hamper the ability to filter, receive, attend, and respond in a timely manner and may result in education, emotional and social challenges.

Where RMT can support

RMT provides stimulation of three key senses linked to primitive reflex integration: the vestibular sense via input of head positioning and movement during exact movements, tactile input through the friction of the floor surface, clothes and skin; and proprioceptive input which gives body position from all cells in the joints tendons and ligaments of the body. It's these senses and the processing of their information that the auditory system must interface with.

Phillips-Silver and Trainor note "There are multisensory connections very early in life between movement systems and auditory systems. Not only does auditory stimulation make us move, but the opposite is true as well; the way we move actually affects how we hear"[7]

RMTi offers numerous movements, isometric and other activities, to assist more efficiency in the auditory processing and listen skills by:

- Integrate retained primitive reflexes and stabilise postural reflex foundations
- Enhance sensory processing and modulation (particularly vestibular system)
- Improving focus and attention with improved neural connectivity through the Brain Stem (midbrain inferior colliculus), Reticular Activating System and thalamus to the neocortex.

[7] Phillips- Silver and Trainor Feeling the Beat: Movement influences Infant Rhythm Perception;

- Maturation and calming of the central nervous system
- Improve muscle tone and postural control
- Ease muscle tension- especially neck shoulders for orienting
- Enhance sound therapy programs with RMT concurrently to enhance multiple sensory systems modulation.

Primitive and postural reflexes linked to aspects of auditory processing challenges.

Moro	• Hypersensitive to sudden or loud noises • Sound frequency trigger • Poorly developed auditory laterality • Reduced distance awareness • Anticipatory hypervigilance to sound(see balloon expect it to pop creates anxiety) • Delayed/ Weak acoustic stapedius reflex* supported by sound therapy • Muscle tension - hamper orient response • Auditory confusion – delayed orienting response • Possible difficulty discerning vowel sounds
Fear Paralysis	• Anxiety or stress response to sudden Noise • Sound frequency trigger • Repetitive loud noises experienced in utero
Tonic Labyrinthine Reflex	• Immature vestibular system mismatch Inferior Colliculus • Head control, muscle tone and postural control - Vestibulo-ocular reflex arc- spatial maybe impacted at midbrain Inferior Colliculus level • Tension in neck muscles reduces orienting response
Spinal Galant	• Hypersensitivity to sound • Low pitch sound 'felt' vibration in lumbar area • Higher pitch sound 'felt' vibration via hair follicles
ATNR	• Tension in neck, facial, jaw muscles reduces orienting response or dampens to much sound • Poorly developed auditory laterality –binaural ears
FPR	• Hypersensitive to sudden or loud noises • Sound frequency trigger

STNR	• poor posture and fatigue
OHRR LHRR	• reduced muscle tone /posture • Auditory confusion – delayed orienting response • Unstable postural control
Vestibular issues	• Tone challenges and poor posture • Mishear confusion with plosive sounds • cerebellum organisation and communication issues

RMT passive movements replicate the passive stimulation in-utero and in the early months after birth when babies are rocked, hugged and carried. They provide stimulus to enhance the neural connections of the brain stem to higher levels of the brain for improved auditory processing and help calm and organise the central nervous system.

RMT active movements are particularly beneficial for assisting with the maturation of neural networks between the cerebellum and numerous other parts of the brain generally helping brain organisation, muscle tone regulation, planning execution and control of muscles across the body.

Both passive and active (including kneeling movements) provide stimulus for the vestibular system to mature.

As the vestibular, auditory and vision sensory input is more efficiently processed and modulated, with less mismatch regarding head and body position there is an overall improvement in all sensory modulation, body schema and body mapping.

With this improved level of organisation, the orienting response can oversee the surrounding environment without unnecessarily triggering the autonomic system into an alert state.

RMT movement and Primitive Reflex integration techniques are very beneficial in the maturation of the nervous system by improving neural organisation and connectivity, enhancing sensory integration and modulation improving tone and increase focus and attention thereby supporting many areas of the auditory processing pathway.

References

Abrahams, P (2007) How the Body Works
Blomberg H Dempsey M Movements that Heal
Campbell, D Doman, A (2011) Healing at the Speed of Sound
Dempsey M RMTi course manuals Levels One Two Three

Eliot, L (1999) What's going on in there?
Frick, S; Young S; (2009) Listening with the Whole Body: Clinical concepts and Treatment Guidelines of Therapeutic Listening Program Course manual
Goddard, S. (2005). Reflexes, learning and behaviour: a window into a child's mind.
Goddard,S (2009). Attention Balance Coordination: the ABC of Learning Success
Herchkowitz N, Chapman Herchkowitz, E; A Good Start in Life
Lemer PS (2014) Outsmarting Autism
Rosinia, J. (2008). Sensory processing. In: Early Development of the brain: teaching resources for educators. Chapter 8, pp. 8-5 – 8-61. Washington D.C.: Zero to Three
Sasse, M. (2002). Tomorrow's children. Melbourne: Toddler Kindy GymbaROO.
Bluestone, J. Fabric of Autism
Schneck & Berger; Music Effect,
Small, R Building Better Babies second edition