Sensorimotor development and language,or the adventure of the human race

And man stood upright...

This is perhaps one of the most extraodinary episodes in the history of the human race, with man risking unsteadiness on both feet in order to further extend his field of observation and action, and his area of influence. Thus having discovered how to stand upright and having completely revised the relationship of his head to the rest of his body, the way was now open for man to produce articulate language, to develop his singing voice and to increase its range. No longer would man's language be restricted to making sounds or grunts to show his mood, or even his presence.

It would now become a highly complex tool used to establish connections between objects and events, to determine his own relationships with other humans, to determine other humans' relationship to them, to make relationships with others more sophisticated, to become organised, to communicate with each other, to become individuals.

One of the brain's functions is to produce language.

Language is therefore closely linked to the workings of the brain, but in order to produce language and meaningful speech, the brain needs an instrument, or rather a particular organ, namely the vocal apparatus, or glottis. It is here that the brain's messages concerning sound and intonation are articulated. In order to develop language, the brain must therefore have at its disposal an organ capable of responding to commands concerning phonation and articulation.

Can any parallel be seen between man's ability to stand upright and the development of the anatomical features necessary for the production of articulate speech ?

Attempts to teach chimpanzees to talk have proved futile. Admittedly, after many experiments the chimps managed to understand that "cup" meant a bowl containing drink, and they could express this with gestures. Nevertheless, it was still impossible for them to pronounce even such a simple word. They thus revealed themselves to be incapable of producing anything more than grunting noises. Therefore it is not an issue of the brain's abilities, since by their gestures the chimps showed that they could understand. It is rather a question of the unsuitability of the vocal apparatus, the instrument, and its inability to produce distinguishable sounds.

For monkeys, the vocal apparatus is not designed to produce a range of articulate sounds. This is not because the glottis is absent, but because it is positioned too high up in the throat. There is not enough space above the larynx to allow freedom of movement and articulation, restricting language to a series of inarticulate grunts or shrieks. The cervical vertebrae are either posteriorly convex, or very flat. The larynx and the hyoid bone (which enables us to locate the larynx) are situated very high up in the throat. The head is anterior to the central axis of the body. As a result of this very highly placed larynx, the monkey and Neanderthal man were able to simultaneously breathe through their nose and swallow, a feat impossible for modern man.

The position of the hyoid bone in relation to the spinal column and to the lower jawbone at the base of the brain determines freedom of movement for both the larynx and the tongue, and therefore determines the ability both to speak and to develop the higher functions of the brain. Numerous studies seem to show that although Neanderthal man's brain was larger than ours, modern man's brain is capable of far more. Even if Neanderthal man apparently had a wealth of facial expressions, gestures and technical abilities, he was incapable of

producing articulate language. Hence it was only with great difficulty that he could make new logical deductions, devise new schemes, and communicate his thoughts and ideas.

Therefore, it is indeed the lowering of the vocal apparatus in the throat and the opening up of a large supralaryngeal space, as well as the evolution of the brain, which have made possible the articulation of sounds and the development of human language as we know it today.
This new head position and the formation of the anteriorly convex cervical curve came about when man stood erect, in other words it was owing to an optimum organisation of the skeleton in the gravitational field, an organisation which offered the least resistance to gravity and freed lower and upper limbs, making the arms independent and agile, opening up man's field of vision and heightening his sensory perception of the space in which he lived and moved.
Thus, in the relatively flat savannahs he inhabited, his new speed and ease of movement, together with his wide field of vision and the fact that he now looked straight ahead (another consequence of the head's new position and the fact that he walked upright) gave him a distinct advantage over the animals around him (who moved slowly and were only aware of what was in their immediate vicinity) enabling him to follow a bird of prey's flight path so that he could reach the spot where the prey dropped before any other animal.
He could then dismember it and carry off chunks of meat (the birds of prey being unable to feast on prey until its skin softened).

However the ability to stand upright also made man genuinely unsteady on his feet, forcing him to make permanent reajustments to his balance. He had to develop sensorial and kinaesthetic sensors able to send messages to the brain at all times, including during activity, concerning the way movements are performed and the environment in which they occur.
Man's alertness and awareness level also increased as the central nervous system became highly flexible in order to adapt quickly to new situations, and to create motor responses which gave equal consideration to the reason for performing the action, the environment in which it occurred and the underlying emotions involved.
Modern man's brain has therefore moved towards a sensorimotor means of functioning, with differentiation and neuroplasticity being the principal determining factors in the adaptation process.

Let us return for a moment to the head's new position and how it is connected to the development of articulate speech.

In the big apes, as in the human infant, the cervical curve is posteriorly convex. A very flat inferior surface and a hyoid bone placed very high up in the throat eliminate virtually all supralaryngeal space and put the larynx in direct contact with the back of the nasal passages, separating the respiratory airways and the alimentary canal. This arrangement of the organs, which ensures that food cannot go down the wrong way, enables the animal or young child to eat and breathe at the same time.

When the human race took this last step towards standing upright the head was pushed backwards and raised and the cervical curve was altered. This led to the larynx dropping to below the level of the chin, thus opening up the supralaryngeal area (forming the pharynx, a crossroads between the oral, nasal, and laryngeal passages) and creating suspensors for this vocal instrument which continued, in a more supple and elastic way than previously, to be linked to the lower jawbone, to the base of the brain, to the cervical column, to the collarbone and to the sternum. These suspensors made it very flexible, enabling it to be rased and lowered, and allowing the vocal cords to be stretched quite significantly (thus giving the voice range and intonation). This suppleness also enabled man to modify the supralaryngeal space and the pharynx, allowing him in particular to produce sounds with ever more distinctive timbres and colours capable of expressing a whole range of emotions.

Similarly it can be seen that just like the larynx, the tongue, which inserts on to the hyoid bone and the epiglottis, moved further back into the mouth. The fact that the tongue's base was now in the throat also helped in opening up the pharyngeal space, which eventually became an area of free movement. This is what made it possible for the first back phonemes, produced using the base and the back of the tongue, and predominantly found in the so-called "primitive" languages, to be produced.

Each new experience enriched the central nervous system with further possibilities for coordinating movement. The range of articulate sounds increased, particularly since once man was capable of moving a particular muscle he was also capable of holding it still. Thus the suppler the back of the tongue became, the more it could be used as a support for movement elsewhere, firstly in the middle of the tongue, with the appearance of mid phonemes, and then similarly at the tip of the tongue with front phonemes, which are so commonplace in modern day language.
This tongue previously only been capable of backward and forward movements (which normally occurred when the head moved), was now able to move diagonally upwards and horizontally with increasing precision, thus laying the foundation for language, namely an increasingly controlled use of the tongue enabling it to produce distinguishable sounds.
So it can be said that the development of the tongue was a result of the head's upright position and the alteration in the shape of the cervical curve.

What is happening in infants?

We have seen that in the human infant the shape of the cervical curve and the position of the head are very similar to that found in the big apes, hence the high positioning of the larynx in the throat, and the ability to simultaneously eat and breathe. The cervical curve becomes anteriorly convex during the child's first year of life.
The larynx then moves to the position it will occupy for the rest of the baby's life, and the tongue moves slightly further back in the mouth uncovering the gums at the mouth's opening and developing freedom of movement at its base, thus facilitating free swallowing. It can be seen that in the infant too these developements only occur once he is upright, so there is clearly a parallel, a cause and effect relationship, between the ability to stand erect and the production of articulate language.

The human baby is born into the world with a brain which is already advanced and rich with the experience of the species, and yet he is totally dependent on others and physically very restricted. Therefore in order to be able to stand upright he has to develop his central nervous system through experience and sensorimotor learning. He follows a long process of motor development which, upon close examination, bears a remarkable resemblance to that followed by the human race, from its aquatic origins to modern day man. Starting with the use of flexors he produces his first cries, moves the head and the pelvis closer together and puts the vocal cords in place.
Then he uses the extensors to support eye movement and to open the mouth by lowering the lower jaw, thus freeing the soft palate. Next the child learns to turn round and to grasp objects, to make uncoordinated feet movements (with his ankles and toes) and to move his lips backwards and forwards (in relation to gravity). After this he combines all the different ways of crawling and starts to move his tongue mostly in response to movements in the cervical vertebrae, the limbs, and the pelvis. Thus his crawling becomes ever faster, freeing the head and widening this field of observation and movement, releasing the jaw and making the cervical and lumbar curves more pronounced as they are subjected to gravitational forces, bringing movement to the hip area and preparing for the time when the child will stand upright.
This process continues until the often eagerly awaited moment when the child stands on two feet, awkwardly at first, stumbling clumsily with undifferentiated movements, then gradually

improving until he achieves the simultaneously heavy and light balance of a man standing upright, or the "stable instability" of a head ready to use all its sensorial abilities.
In order to fully develop his nervous system the infant must go through all these stages. And the way in which he experiences them will condition his development.
These first sensorimotor experiences and the transition period while the central nervous system goes through the stages of maturity, which are related to the ancient evolutionary pattern, will determine how the child realises his potential. On the basis of these experiences the child, and later the adult, will organise his behaviour, his way of acting and reacting, and more particularly the way he moves from intention to action.

These first experiences will form the bases of a person's self-image. As Moshe Feldenkrais said "Each person acts and regulates his physical and psychological conduct according to his self-image" (conscious and unconscious image in his motor cortex). It is the image of his body, its contours, the relationship between different body parts, temporal and spatial relationships, spaces which will become areas of respiration, sound and movement. A person's self-image is also a representation of their feelings and thoughts, of their relationship to the space around them, to others, to the environment and to gravity.

When a child or adult is referred to you with some sort of disorder or limitation, the first thing to establish is the way he makes the transition from the intention to act and the actual performance of the action, in other words how the intention or thought materialises in a physical organ into "body and movement". Indeed every human function involves a physical organ and it would be foolish to think we could improve a function or alter a behaviour pattern without the organ being free, functional and differentiated in its movements.

From a pedagogical viewpoint

The way a pupil or patient moves (in other words their vocal, respiratory and articulatory behaviour for example) is always by definition the most appropriate way he has found within himself to react to a given stimulus and situation. It is dependent on a person's self-image. It is therefore not for me to say whether it is correct or incorrect but rather to hear, see and feel whether this function is in line with the singer's intention (in terms of producing the expression, colour of note and articulation desired) and whether this intention, whatever it may be, is clear.

If it is not, I examine how the different body parts and functions interrelate in order to determine where and why the limitation is taking place, causing the movement to be unsuccessful. What we can see as observers is often only the final result of a long string of uncoordinated processes which must be performed again if they are to be eliminated.
We then become guides in an experiment, in an adventure in a moving body, a nervous system, a mind, a voice. The work becomes an exchange of information between the pupil (who provides information through his behaviour and his outward appearance) and the teacher who, according to what he sees and hears, then also provides information at the right moment and in as clear a manner as possible. This occasions a new response, a fresh sensation...
Thus a richer and more complete self-image is created, enabling the pupil to more effectively and more expressively use his voice and body, and to make the most of his inexhaustible potential.

Let us also look at how to deal with a respiratory limitation

Firstly we must observe, without necessarily understanding, what is restricting the person, what it is in the physical organ where breath is produced which is stiffening and thus showing signs of constraint, what can be put down to habit, conditioning, and preconceived ideas...

Then it is our job to suggest contexts and environments to him (situations, postures, activities) and to restore free movement to the body parts which form part of the respiratory system (ribs, sternum, spinal column, shoulder blades, abdominal wall, nasal passages...). Finally awareness and differentiation games will enable the person to see their basic needs more clearly and to unconsciously modify their respiratory response - a response which is continuously being reinvented and recreated to correspond to his needs, intentions, activities and emotional state.

You can not therefore develop a person's respiratory system by conditioning it to act in a particular way, but rather by :
- restoring freedom to the physical organ, and specifically to our body and its movements,
- return the nervous system to a state where it is ready to receive information from inside and outside the body,
- giving an appropriate response to the restriction. This can be achieved by controlling those movements which are responsible for it.
In order to do this the respiratory system must be cleared of set habits which each person unconsciously acquires during the course of his lifetime, and also of emotional fixations and techniques learnt (such as the "correct" way to breathe, without considering that the respiratory system functions differently in different people and in different situations).

How can we get rid of limitations, redevelop muscle sense and restore flexibility to the nervous system ?

We have seen that in order to make his central nervous system reach a degree of maturity which will enable him to stand upright and to articulate, the infant uses movement as part of a development process similar to that of the human race. Therefore in order to eliminate a habit and the limitations of a self-image which has been restricted and damaged by a person's life experiences, we will use these movements, these ancient evolutionary patterns, these principles of somatic learning and education - reawakening a person's interest and curiosity in his own body and giving him the freedom to coordinate his movements.
During each session a movement and its many variations will be suggested as ways of differentiating attention, restoring choice, allowing a person to rediscover what freedom of movement, presence and sensorimotor coordination mean.

The human race's extraordinary adventure is an ever present wealth within us carrying freedom, choice and enthusiasm.