THE MIND AND THE HAND: IMPLICATIONS OF RECENT RESEARCH ON MONTESSORI THEORY AND PRACTICE

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A Greeting from Jane Healy

"Welcome to this exciting and important conference! I regret I am unable to be there with you, but I am confident that you will return home re-energised in your efforts to do good things for children and re-affirmed in your professional expertise. As Maria Montessori understood so well, learning arises from body, mind, and emotions. Now brain research empasizes anew the dynamic linkages between these three. In the next two days, I hope each of you experiences stimulation for these aspects of your own learning. Don't forget, adult brains can continue to grow and change through a lifetime — perhaps teachers' most of all! Best wishes."

My brief today is to look at the link between the mind and the hand. How is the developing intellect intertwined with movement?

We know from our practical experience that "help me to do it myself" is the optimal way for young children to learn.

Why is that so, and how does it happen?

We will revisit the astute observations of Dr. Maria Montessori on this subject; she placed such emphasis on movement didn't she?

We will also give a nod to the educational psychologists of 30 and 40 years ago, and then spend some time reviewing the complex current research of the 1990's. At the conclusion, it is only valid that we ask how does this knowledge impinge upon our daily classroom activities?

However, this morning should not be one full of inward looking questions. Doubt plays no part here today. The purpose of this session is one of validation, affirmation, and optimism that what we hold true of Montessori philosophy is reinforced in writing and research of today.

We should come away with a refreshing satisfaction, and an obligation to try even harder, and stick more firmly to our dearly held beliefs of child development. For those of us who work in classrooms across Australia as guardians of young human beings, we must be reassured daily by those same trusting children, full of potential, and deserving the best we adults can offer. For surely, the child is the very reason we keep on searching – trying to affirm in research that which is before our eyes every day.

Maria Montessori believed that "the hand is the instrument of the mind". What did she mean?

The human hand serves such a unique function. It is astonishing to count the number of phrases in general speech giving reference to the actions of the tactile hand. It obviously reflects the dominance of our hands in our every day practical life. Consider the phraseology, when mastering a task:

"I have a grip of it" or "to grasp a subject" or "to take hold of an idea". "Can you handle it?" we ask. "I am going to tackle a problem", "grapple with difficulties", or even "what a touching story".

The hand is also such a social tool. Our social gestures are almost a language of their own (particularly when driving in Sydney). Our hand is an organ of expression. We carry, bathe, eat, offer, and greet according to the customs of our society. Our hands are instruments of our social behaviour, clearly expressing the temperament of the owner.

Historically, man's hand has followed his intellect, his spiritual life, and his emotions, and the marks it has left throughout civilisation betray his presence – in artefacts, temples and in art.

Changes in man's environment are brought about by his hands. All our implements, from the most primitive to the most delicate, are made for manual use; almost every machine is built to be worked by hand. If man had only used speech to communicate thought, if all wisdom had only been expressed in words alone, no traces would remain of past generations. It is thanks to the hand – the companion of the mind – that civilisation has arisen. The hand has been the organ of our gift of inheritance.

We are unique among the animal kingdom in having 4 appendages and using only 2 for locomotion. Our arms and legs develop independently and serve different functions. The power to walk and balance develop so regularly that all humans resemble one another in the way we use our feet, but noone can tell what any given human will do with his or her hands! Who can predict the skills of a baby?

What does guide development? From **The Absorbent Mind**,

> *"The child has an internal power to bring about the creation of himself. He goes on perfecting this by practice."*

Man is like a person born to enormous wealth. By force of will, the mind can propose and direct development. Nothing is pre-ordained, but everything is possible!

In broad terms, culturally, man has always used his hand to express himself, from cave dwellers to you and I. All art forms stem from the use of the hand and are prized in all cultures. The work of the hand reveals much about that culture. Consider the strength and technology of the pyramids, or the fine sensitivity to detail of wood carvings.

In individual child development, the development of the cerebellum is essential for achieving balance to enable the child to be upright on two legs, thus freeing the hands from crawling. The hands are now able to concentrate on manipulating everything in the environment. This work of the hands gives accomplishment to the commands of the mind.

So the child, through manipulation, offers his brain awareness of softness, hardness, warmth, cold, smoothness, roughness, pressure and weight, sharpness, stickiness, fineness, thickness, geometric form and shape and so much more. From E.M. Standing (1957):

> *"The unconscious impressions gathered in the first three years are the stuff out of which is woven consciousness itself, with all that it implies of reason, memory, will and self knowledge. The work of the hands plays an essential part in building up conscious intelligence."*

Through this intelligent purposeful movement of the hands, the child is able to classify, order, and learn abstract concepts through concrete materials. During the absorbent mind, that specific period from birth to six years, the child sends *every* impression to his mind which indelibly records it. Our sensations of the world around us are thus *the idea of it as conveyed to us* by the tactile hand.

It is tempting to only consider this obvious gathering of impressions through the senses as assisting cognitive development, but the value of movement goes deeper than just helping in the acquisition of knowledge. It is the basis for the development of personality. It is not enough that the child should *see* the things we wish to teach him, we must present them in a form that solicits movement. It is not enough for her to *hear* the things that we wish her to learn; it must be followed by a creative movement.

We take our hands so much for granted! Prof. David Katz in 1925 wrote, "The versatility of the human hand corresponds to the free movement of the human intellect."

We possess in our hand an organ that can distinguish thick from thin flexible surfaces with an amazing subtlety. We take a piece of paper between finger and thumb, and use it like a pair of callipers for measuring thickness. Many people can discriminate with astounding accuracy differences in one hundredth of a mm. between the very thinnest of papers.

Our hand acts as an efficient thermometer. Metals are recognised by their coldness, wool by its warmth. Does this bring to mind the thermic tablets with their subtlety of sensation?

Should you be unable to determine the material of which an object is made, are we not able to tap it with a finger nail? The resulting vibration will supply our tactile sense with the desired information even if our ears have been blocked to the sound.

The following is almost a poem to the hand.
Gerhart Hauptmann wrote:

> *"the hand can fill the place of every instrument, and by its unison with the intellect, it renders the latter everywhere supreme."*

No wonder Maria Montessori regarded the deprivation of any one of the child's senses being as a lesser obstacle than deprivation of the use of the hands.

No wonder the principle of movement or activity is included within every area of the Montessori prepared environment.

But people still question. How does bodily movement come into the concept of mental development? Aren't we talking about the mind? And when we think generally of intellectual activity, don't we always imagine people sitting still, almost motionless?

For the answer we look to the child.

In childhood, a boy or a girl is building the conception of self and surrounding life on his perceptions and on her responses to stimuli. They are developing their intelligence through powerful activity and organising the content of their experience according to the order they find in their environment. In order to know the world, we must project upon it our touch, the self-involvement which can only be accomp-lished through movement.

I quote Maria Montessori (1917) on the relationship between movement and cognitive development:

> *"The beginnings of the development of intelligence are dependent upon the infants ability and motivation to put itself in relationship with the environment. As this relationship is established it brings about self-realisation."*

And from E.M. Standing (1957):

> *"The child works to perfect himself – using the environment as the means. The child is in a constant state of transformation. He is progressing, step by step, towards a more advanced state of being, each new stage of development is marked by a new phase of this inwardly creative commerce with the environment, which we call work. So profoundly does the adult notion of work differ from the work of the child, it is only the limitations of language that obliges us to use the same word."*

The essence of independence is to be able to do something for one's self, whether you are 18 months or 80 years.

Recently, I was with a not-quite-2-year-old Evie trying to take something out of a drawer way above her head, all the time warning me off by saying, "I can do it myself". After quite a while she turned around and said very matter of factly, without a trace of frustration, "In fact, I can't do it myself". What learning, and self-awareness! Children achieve independence by making effort! Our natural inclination is toward helping this effort, but our philosophy teaches us never to give more help than is absolutely necessary. In this quest for independence, the adult who keeps on helping, becomes an obstacle!

Dr. Montessori based her pedagogy upon the fact that any learning situation must include the principle of movement as an essential factor. Within our prepared environments – be it in practical life, sensorial, maths, language, and the cultural areas, the idea of activity, freely chosen by the children, is an inviolate rule. Movement cannot be and is not, set apart from cognitive function. I borrow these words from Constance Corbett. She says, "All direct and indirect learning situations, formal and informal, provide means for the children to move, to be active, in order to sustain interest and internalise knowledge." Free choice, that is intelligent direction of movement, is decision making. This choice strengthens the will.

During the learning process this movement, essential for intellectual development, must be purposeful and goal directed. "If there is no intelligent aim to the movements of children, then they are without internal guidance and soon become tired and disinterested."

Of course, the way to keep children interested, is to satisfy their needs. Discerning observation will alert us to those emerging sensitive periods, pointing us to the critical need of the moment. The essence of a sensitive period in human development is a "burning intellectual love between the child and his environment. As such, it is an animating psychic factor leading to immense mental activity." If the environment provides sufficient stimuli, actively sought by the child at a specific time in their development, cognitive growth will flourish. Conversely, obstacles put in the way of any sensitive period will not only result in a loss of potential, but in psychic damage. Remember the dropped stitches? "With each sensitive period that we miss, we lose an opportunity of perfecting ourselves in some particular way – often forever."

Montessori challenged the educational thought that viewed man as divided into two parts. The intellectual and the physical. She stated that the full development of psychic powers is not possible without physical activity:

> *"One of the greatest mistakes is to think of movement by itself, as something apart from the higher functions. Mental development must be connected with movement and dependent on it…If movement is curtailed the child's personality and sense of well being is threatened. Movement is a part of mans very personality and nothing can take its place."*
> (Paula Polk Lillard, 1972)

Broadly stated, intelligence equals activity, and it is activity – purposeful movement – that produces cognitive growth.

At this stage let us quickly review:

What do we have?

We have an upright child equipped with two inbuilt tools of learning, with amazing properties, and all the other senses to boot. We have a stimulating environment.

Will optimal learning take place?

“Not good enough!” said Maria Montessori.

The encounter with the stimuli must be active, purposeful and full of effort.

Not enough! Repetition must occur.

Still not enough! It must be at an optimal time for full potential, and this is what the research confirms.

And yet still! It must be spontaneous and freely chosen.

We all know that it is easy enough to keep a child’s hands busy, but to draw out the spontaneous action of the child is our aim. If we substitute our will by suggestion or coercion, we have robbed the child of the right to construct his own personality. The question of spontaneity, whether a child acts freely in choosing his own work, goes right to the root of Montessori education.

Literature from 30 and 40 years ago including Piaget 1952, Benjamin Bloom 1964, Bruner 1964, Hunt in the 1960’s and Dewey 1956 – all in various ways affirm the notions of:

- learning accomplished through ‘doing’ in an enriched environment;
- developing consciousness expressed through movement ; and
- matching stimuli of the hand with the child’s position on the cognitive growth continuum.

What of more recent research in the 1990’s?

It is with optimism that we find in recent scientific and technical research validation of Maria Montessori’s theories and practice from 80 years ago, which was then drawn directly from her acute observations of children.

When we are confronted with theories and recent research, we are amazed anew at Maria Montessori’s discoveries and deep understanding of the child. As we shall see, Montessori theories gain support from research in the areas of cognitive or neuro-psychology, developmental psychology, animal physiology and neuro-anatomy. But then again, this is not really surprising as Montessori’s view of intelligence was gained through her own training in philosophical anthropology, biology and psychology.

We come to Jane Healy. In her 1990’s book **Endangered Minds – Why Our Children Don’t Think** she registered areas of discontent from teachers ranging from lack of perseverance, impulsiveness, inability to listen and carry ideas forward, lack of motivation and disorganisation – all areas essential for children’s futures, and she asked are we valid in suggesting that this may be due to inadequate cognitive pathways set down in early childhood. Jane Healy writes. “experience and environments change child-ren’s brains. Part of the brain’s very physical structure comes from

the way it is used." There is little definitive proof of these subtle neurological changes, but there is plenty of circumstantial evidence.

Jane Healy suspects, as we do, greater television viewing associated with less time spent reading and less time in active hands-on learning, is a negative influence. Early brain development, she says, needs quality interpersonal interact-ions and correct stimulation to establish cognitive pathways. Children need someone to show them how to work with paint, clay and musical instruments, someone to nurture them and read stories to them, to walk in nature, and care for their pets. Sadly, "we are looking at an absence of these things in many children's lives."

Although cultural and generational change is inevitable, "environments remain the sculptors of growing minds both before and after birth."

What makes people different?

- in the words we comprehend;
- in our differing abilities to read a map; or
- in our capabilities to remember a telephone number or figure out change at the shop?

Plomin and DeFries in 1997 worked with actual children, rather than animals, in their field of behavioural genetics. Their research helped confirm the significance of environmental factors which count for as much variance in human behaviour as genes do. These men studied identical twins and adoptive children and their parents looking at heritability; that is, the genetic contribution to differences among individuals. If intelligence is about 50% heritable, then environmental factors must be just as important as genes in generating differences among people. Moreover, when genetic factors have an especially powerful effect, as in mental handicaps, environmental interventions can often fully or partly overcome the genetic determinants. Jane Healy talks of 're-potting the seedlings'.

Theorists, researchers and educationalists all acknowledge "The basic genetic architecture for our brains lies at the heart of all learning and much of our emotional behaviour. When these inherited patterns interact with the child's environment, plasticity or changeability of the human brain guarantees the variation in children that we see. The final pattern is determined by the way each individual uses that unique brain." Scientists and teachers alike know that "what children do, the ways in which they think and respond to the world, what they learn, and the stimuli to which they decide to pay attention, shapes their brains. Not only does it change the ways in which the brain is used (functional change), it also causes physical alterations (structural change) in neural wiring systems…" In an experiment to illustrate this, a rat who ran over textured stimuli to get to his food each day had a greater brain size, 11% larger cortex, than another rat with the same food, but in impoverished conditions for mental growth. Further, when the rat was challenged with problem solving to get to his food, his cortex size was 25% greater. The experimenters discovered changes in gross weight of the brain and thickness of the cerebral cortex due to stimuli and active use of neural circuits. "So environments shape brains….there are profound differences in the structure of the brain due to the stimuli taken in by the senses."

To help us make sense of some of this research, and being no expert myself, I will refer to Dr Montanaro and Richard Gregory's **Oxford Companion to the Mind**. The brain is continually at work receiving, processing and storing information. This enables us to relate and communicate with the environment and with ourselves. Even when we are asleep or unconscious, the brain operates at low amplitude. Now, there are around 16 billion brain cells, and here is a little background detail on these nerve cells or neurons. Neurons are the largest cells in our body and are considered to have three parts, the cell body, the dendrites and the axon. The short and

intertwined parts like the branches of a tree are called dendrites; the long extended ones, axons. Some of these can be as long as the distance from the brain to the foot. Axons enable the interchange between nerve cells and all parts of the body. Every part of the body is reached by the axons which are capable of bringing messages from the periphery to the centre (the brain), or from the centre to the periphery. Nerve cells also share information through the dendrites which reach out to many other cells, establishing networks of information which allows for more accurate and rapid work. Dendrites meet other cell connectors at points called synapses, where major exchanges of information or energy take place. It is astounding to see the number of dendrites (indicating inter-relationships and shared information) at birth and then compare the brain cortex after several months.

All the neurons in the central nervous system of man are present at birth. As the baby grows, they enlarge and grow, the dendrites spread further, and the axon lengthens; but neurons, unlike most cells, do not divide, or reproduce. So they are irreplaceable; and any neurons that we lose from accident, disease, substance abuse or pruning are lost forever and we are so much the poorer.

Our brain works by neural fields – that is a group of up to a million or so linked neurons operating on the same frequency. We have a near infinite number of neural fields available and no end of potential states to draw on. Like an engine idling, our neural fields are abilities ready to fire into action when called on.

Every cell works by emitting electrical voltages or currents. Chemical transmitters in the cell, drive information along electrical pathways, sending information where it is needed. These pathways are not mystical. I have it on good authority they can be seen under a microscope. Especially in the first years of life, the brain shows a great capacity for developing very specialised functional circuits. Montanaro says many educators are not yet sufficiently aware of those 16 billion nerve cells present in the newborn brain, and tend to be unconvinced about the urgency of letting them (the cells) get to work immediately. The dendrites and the axons, as we have seen, grow rapidly after birth. They constitute the basic structure needed to process all future information. This explains why different environments produce human beings with different basic brain structures.

Here is a new idea to think about: Most neuro-psychologists (working with brain structure and function) believe that at certain times in the development of the brain there is great competition for neural connections.

Let us go back to the foetal brain for a moment.
In the months before birth, the first cells form the ‘hard wired systems’ which will be responsible all our lives for:

- our reflex movements;
- our physical drives;
- our balance; and
- our instinct for self preservation.

Later developing areas of the cortex (but still before birth), are the control panel for:

- processing information;
- receiving sensory stimuli; and
- organising and association.

These later areas, so important for planning, reasoning and using language to express ideas, are the most pliable or impressionable of all. Their development depends upon the way a child uses his or her brain at different stages of development. These abilities of reason, planning and problem solving, and creativity, emerge as a result of violent competition for neural connections. We have more than we use. The brain literally 'prunes out' and disposes of its excess neurons.
It may seem logical that the more neurons the better, but this is not the case. Because there is a limited number of available connection sites, the mortality rate for neurons is staggering.

Even before birth, 40 to 60% of cells die off because they can't find a home. As the brain forms, the cells which develop first arrange themselves in the inner layer of the cortex – later arrivals must go beyond to form the outer layers. These final layers of the cortex hold the potential for the highest order – latest developing mental abilities, but these cells have the hardest job finding available connection sites.

The cells that do not connect are lost, and this is part of the reason that we are unique individuals and why all children do not learn the same way. As an offshoot here, consider this malleable, growing foetal brain, and, armed with the knowledge that toxins can cross the placenta: what damage then, can be caused by lead and heavy metals, solvents and pesticides, alcohol, smoke and drugs – all capable of causing neurological changes before birth!

Back to Jane Healy. She writes, "In develop-ment it is now well known that there are certain critical times when an organism is ready to deal with certain stimuli." Surely she speaks of sensitive periods! "If the stimuli is not available at the critical time, the brain structures that would have mediated them will not function and will die." You've all heard of 'use it or lose it'. How does the brain naturally hone itself into an efficient processing unit? The researchers call it 'synaptic pruning' – for us it is: what gets shaved and what gets saved!

"A major task during the years of childhood is to prune the mass of potential neurons into networks of connections that are useful and automatic for the mental skills that the child is being encouraged to develop.

In a simple analogy, a neuro-anatomist, Dr Scheibel, described an immature brain as somewhat like a large tree, crowded with many little birds singing weakly at the same time, so that no individual song may be heard. As the brain matures, gradually eliminating some of the connections and retaining others, the tree contains fewer but larger birds with strong clear songs, well separated so that each can be distinctly heard.

The adults task is to make a variety of stimulation available, at the same time putting careful consideration into which choices children are encouraged to make." Jane Healy is validating our prepared environment.

I found this idea of synaptic pruning so relevant to our discussion of cognitive pathways laid down in childhood by active learning.

The neural pruning idea was repeated again in Joseph Chilton Pearce's 1992 book, **Evolutions End – Claiming The Potential of Our Intelli-gence**. He says, several times in a child's development the brain 'cleans house'; it releases a chemical that dissolves all unproductive or unused connections, leaving the productive, developed neural fields in tact.

The trimmed-up neurons will put forth new dendrites and axons as needed to establish new fields for stimulus responses. (Remember the role that the hand is playing in feeding in stimuli.)

A neural field's imperviousness to this house cleaning chemical seems to involve a fatty protein called myelin. As learning takes place, myelin forms an insulating sheath around long axon connections of the neural fields and muscular nerves. Myelin is impervious to the chemical used in house cleaning; its sheathing somehow helps preserve that particular network, making the ability permanent.

And, it seems to assist in conducting the energy being exchanged between neurons, which speeds up the information flow. The more myelin, the more efficient that neural field.

At first many connections may be necessary, requiring great concentration on our part. As learning develops, fewer connections can do the same job. An initially slow, clumsy operation becomes smoother and goes on 'automatic pilot' when the many neural fields involved have myelinated enough to become new intelligence or ability at our disposal, ready to fire into service when needed.

Marjorie Wollacott, a professor of neural physiology and Chairman of the Department of Exercise, Movement and Science in Oregon, writing about neural pathways said, "We literally mean that during an action, a specific set of neural circuits is stimulated; and every time the circuit is stimulated, the connections, or synapses between the neurons in that circuit, become stronger." So, if we perform a particular action every time there is a certain stimulus, a particular habit is born. Repetition may stimulate myelination. Researchers have shown that in the earliest language development a baby in utero moves the same muscle in response to the same phoneme in the mothers speech. The more frequent the response, the more myelin forms. The thicker this myelin sheathing – the quicker the information can be relayed, requiring less energy for its conduction – the more firm and lasting the learning, and the more efficient and compact that particular neural network becomes.

That is why our primary language, though always more powerful, takes up far less room in the brain than a secondary language. It is also why practice makes perfect, and why when once locked in, or myelinated, a learning is generally life-long Ð like riding a bike or as my dad said, "Milking a cow, you don't forget how."

So we see that neural fields are brought into play by usage and are made permanent by the extent of that usage.

Or in Jane Healy's words:

> *"Each baby brain comes into the world uniquely fitted out ready to pursue knowledge, but how well that happens depends on the mental traffic that trains the brain to think and learn. For children, habits of the mind soon become structures of the brain, and they gain their habits, directly or indirectly, from the adult culture that surrounds them. Learning environments both at home and at school can partially rearrange neural diagrams."*

In our belief that the hand is the instrument of the mind, we must agree.

Our very sense of self is naturally 'embedded' in a learning, until that learning becomes autonomous, or partly so, by myelination of the neural fields. Any serious learning requires 'all hands on deck', total attention and energy, and our self ego, which directs the energies of the mind, temporarily identifies with the task, or is embedded in it. Once maturation of the learning process is achieved. our personal awareness is freed. We can stand back from the new ability, use it at liberty and move onto other things. This cycle of psychic embedded-ment and then freedom from it, plays a critical role in our lifelong development. So long as we are still caught up and embedded in learning, as in childhood, we can't grasp the possibility of any higher stage of learning.

Before we become quite bamboozled, let us do a quick retake:

- we begin with many neurons;
- use creates connections;
- neural fields are strengthened by use;
- myelin forms with repetition; and
- myelin protects neural networks from the brain's regular house-cleaning (or synaptic pruning).

Our brains evolve individually according to what is useful and adaptive for our own particular environment.

But this does not mean we are victims of whatever stimuli comes along! The individual has to "do something with it", be active, for brain function to occur and connections to be made. Active involvement rather than passive response is the brain food to develop new synaptic connections.

For Example, Dr Jane Holmes Bernstein (a clinical neuro-psychologist) tells us of a famous experiment with identical twin kittens: which demonstrates the relationship between brain function and activity.

Imagine this: The two kittens were each put in a large circular container, painted with black and white vertical stripes. This was their only visual stimulation during their sensitive period for visual development – just as their eyes opened after birth. One kitten rode in a small basket which was attached to one end of a revolving balance beam. The other kitten was in a second basket attached to the opposite end of the beam. His legs, however, protruded from the basket. As he walked around, the beam revolved, and his brother had a free ride. Both, of course, has the same visual stimulation of the vertical stripes. But, later it was discovered that visual receptor cells in their brains had developed differently, even though they had experienced the same scenery. The kitten who merely rode along was functionally blind for vertical stripes. Only the kitten who had his feet on the floor, knowing where he was, aware of his position on the floor relative to the vertical lines, developed the brain connections. So, experience shapes brains. But you need to interact with the experience – it is not enough just to be in a stimulating environment.

Physical manipulation with their hands is one of the main ways in which children interact with experiences.
Of course here we are, back to where we began – the link between the mind and the hand.

There is a huge amount of research reinforcing not just an enriched stimulating environment, but activity in it. Unfortunately, much of it is animal research, for example the rat and the kittens. And much is not only unsavoury, but I would have thought unethical. It repeatedly shows that merely making visual experience of a complex environment, and not allowing them to interact with it, has little behavioural effect.

Watching is not enough. Jane Healy asks of herself when she is struggling to 'make' a student learn something, "Who's brain is growing today? Who is interested, curious and touching?" Children need stimulation and intellectual challenges, but they must be actively involved in their learning, not responding passively while another brain, (the teacher or parent) laboriously develops new synapses on their behalf!

Joseph Chilton Pearce says, "Nature's imperative, her developmental rule, is that no intelligence or ability will unfold until given the appropriate environment." We are born into the world like a garden

that has been sown, but the seed must be nurtured and nourished by activity in the appropriate environment.

Pearce says the character, nature and quality of the model environment determines the character, nature and quality of the intelligence unfolding in the child.

Do we think then that large doses of passive television watching aids brain development? Jane Healy devotes an excellent chapter to this end. Good language and good problem solving require active involvement and persistence and television in early childhood produces passive learners and reduces vigilance.

For all those parents who ask you why we don't have computers in our preschools, read Jane Healy.

Computers do offer instant gratification, individual attention promptly reinforcing children with a sense of mastery, BUT the problem is that tender young brains need broad horizons, not over-built neural pathways in one specific area. The main job of the brain of the preschooler is to learn the principles by which the real world operates and to organise and integrate sensory information. This brain needs much more emphasis on laying the foundations in attention and motivation than on jamming the storehouse full of data that makes it look smart to adults. The last thing that today's children need is more bits of learning without the underlying experiential framework to hang them onto.

Dr. Phyllis Weikart, an American expert on motor development, warns that physical learning must take place before children start dealing in abstractions. One must precede the other. How well this reinforces Maria Montessori's observation, which we put into practice daily, that much concrete manipulation is the essential grounding for abstract learning.

We have placed a lot of emphasis on the activity of the hands. C. Best, a researcher, in hemi-spheric function, suspects that that the ability to activate and coordinate the work of both hemispheres of the brain, may be even more important than developing individual systems in either side. Visual stimulation must not replace physical hands-on activity like running, kicking, throwing, building, climbing, working with clay, sewing, folding and cutting. Two sides of the body, and hence two sides of the brain, are used in these activities creating connections across the hemispheres. "The corpus collosum, the thick bridge of fibres connecting the hemispheres, is one of the brains latest maturing parts. It helps us with flexibility of ideas, creativity, and analytical thinking. Poor development of this critical link between the hemispheres may result in learning and attention problems." To summarise, it is physical activity that develops the fibres bridging the two hemispheres.

We all understand the importance of capitalising on sensitive periods. Jerome Bruner talks of readiness to learn, Piaget of critical periods. Once the critical period is lost, it may be very difficult to learn the skill with full effectiveness. In the case of missed sensitive periods, the right stimulation may be unavailable when the brain is ready for it. What of the reverse? What of the wrong stimulation before the brain is ready? It is a symptom called the 'hurried child'. Doctor Sandra Scarr warns that timing is the issue. Sets of neurons in the human brain get ready for some types of learning at different points of development. "Too much, too early may be as detrimental as too little, too late."

This applies to people who would wish to hurry the learning of their children along – you know the ones, holding academic expectations for which their children's brains are not yet prepared.

One of the first essentials for any adult wishing to help small children is to learn to respect the different rhythms of their lives. It is futile to hustle the work of the child. Nature has fixed his

program. He cannot be 20 before he is 20. To become a woman of 20 must take 20 years. Remember, "process, not the product".

There is even talk of experimental stimulation of the brain, artificially whilst still in the womb. Well, to the latter we must reply that the foetus receives a great amount of stimulation from its mother's and its own movement, the sound of voice and heartbeat. Nature created a perfect environment, and to try and engineer pre-natally, could have disastrous consequences.

External pressure to produce learning or intelligence, violates the premise that a healthy brain stimulates itself by active interaction with what it finds challenging and captivating in its environment.

Jane Healy summarises:

> *"The quiet spaces of childhood have been disrupted by media assault and instant sensory gratification. Many children have been yoked to hectic adult schedules and assailed by societal anxieties. Many have been denied of time to play and work with their hands, and the opportunity to pursue mental challenges that are the real building blocks of intellect. Schools must lead the way, acknowledging children's developmental needs as they guide them firmly into personal involvement with the important skills and ideas that will empower them for the future. We can't slow the pace of adult life. Preschools and primary schools can't alter changing family patterns or eliminate media influences. We can accept that brains learn in different ways and on different schedules and be sensitive to the fact that we need diversification of learning and flexible timetables of mastery. We adults can stand firm as advocates of mental growth."*

In 1993 Annette Haines, an AMI teacher trainer in Missouri, presented a paper looking at numerous studies of brain function. Neuro-scientists using PET scans (Positive Emission Tomography) and Magnetic Resonance Imaging are mapping the brain. Their research, Annette Haines concludes, "seems to substantiate what Montessori could only intuit from her observations of children."

A wide range of evidence now places Maria Montessori's thoughts in the centre of current theory. Both Neuro-biologist Mark Rosenweig (University of California 1965) and Wolf Singer's 1990 research at the Brain Institute in Frankfurt suggest that "early primary learning is an experience-dependent process of self-organisation, which serves an adaptive function." Surely this is the 'absorbent mind' to which they refer!

Singer confirms that a child's mind is different from that of an adult and that different learning processes are in effect during the first five years.

> *"During pre-natal development, the infant's brain grows as much as any other organ. After birth, however, brain development differs radically from the development of other organs because, with the activation of the sensory-neuron network, electrical activity is added which results in a self-organising dialogue between the genes and their environment."*

Citing countless more studies in the fields of bio-social science, neuro-biology and artificial intelligence, Annette Haines concludes that in the areas of the absorbent mind, sensitive periods and planes of development, Maria Montessori's ideas remain "neither outdated nor inaccurate and provide a coherent and plausible theory which has profound implications for education."

If we believe that the hand is the instrument of learning, then our educational theory and practice should reflect this.

Do our child rearing practices and our classrooms allow children the best chance to fulfil their potential?

If we adults close the paths of activity to children, we become the mightiest impediment to their development. We quelch the child's capacity of judging and acting according to his own personality. It's a form of stealing by us – domination by a stronger ego.

A final checklist of practical conclusions for us:

- take care not to equate good with quiet, or active with disruptive;
- take care not to hurry or force learning;
- practice acute observation – always be aware of the sensitive periods for learning;
- allow time for calm reflection;
- encourage repetition – it strengthens neural pathways;
- restrict yourself to being the presenter of work for the hands of the child;
- always active, concrete, broad activities precede verbal, abstract, specific work;
- I know it is often out of our hands, but, guard against over-regulation causing children's environments to be excessively safe, but unvaried in activity;
- Remember your vital role – early childhood patterns set life-long modes of learning;

It seems appropriate to close with the words of Jane Healy:

> *"The environments we provide for children, the stimuli with which we encourage them to interact, and the ways in which we demonstrate for them the uses of a human mind – these are the means at our command for shaping both their brains and our cultural future."*

We must give no more to the eye and the ear than we give to the hand.
Maria Montessori

There is nothing in the intellect which was first not in the senses.
Aristotle

The environments we provide for children, the stimuli with which we encourage them to interact, and the ways in which we demonstrate for them the uses of a human mind – these are the means at our command for shaping both their brains and our cultural future.
Jane Healy

It is in this period that he seizes things by his own activity, and lays hold of his mental world as if he were gathering it with his two hands.
Maria Montessori

There is not one general fixed intelligence. There are multiple intelligences and it changes with what you take from the environment.
Robert J. Sternberg 1998

The versatility of the human hand corresponds to the free movement of the human intellect.
David Katz 1925

The essence of a sensitive period in human development is a 'burning intellectual love – a drama between the child and its environment.

Maria Montessori

Process, not the product.

Maria Montessori

To have found one quarter of the answer to his own questions by his own effort, is of more value to the child than to hear it all, half understood from another.

Friedrich Froebel

The hand can fill the place of every instrument by its unison with the intellect; it renders the latter everywhere supreme.

Gerhart Hauptmann

The hands which he employs for work are more intimately connected with his intelligence than any other parts of the body. They are the instruments of man's intelligence.

Maria Montessori

Heritability describes what *is* rather than what *can* or *should be*.

Plomin and DeFries

It is as if the child, having absorbed the world by an unconscious kind of intelligence, now lays his hand to it.

Maria Montessori

The 'history' or expression of our individual experience feeds back into the general neural fields giving rise to that experience. Instant by instant, we reap what we sow, individually and collectively.

Joseph Chilton Pearce 1992

Movement is the secret for holding the attention of the child.

Maria Montessori 1939

The child is driven to touch, taste, smell, listen to and look at an event to "fill in" a visual stimulus. In this way neural fields organise as structures of knowledge.

Joseph Chilton Pearce

Nature's agenda for us is to participate in the creative process. Products, such as information, answers, thoughts and things, are cheap; process is priceless.

Joseph Chilton Pearce

Mans mind does not spring from nothing; it is built up on the foundations laid by the child in his sensitive periods.

Maria Montessori

We are really talking about how to teach them, not just how to unearth a wiring diagram.

Jane Healy

The adult community at large must decide to wrap up the growing brains of our children in mental garments of language, reflection and thought.

Jane Healy

Can we conceive of anything more sacred or more wonderful than the development of this essentially human movement of the hand of the child… expressing the inner life.

Maria Montessori

DISCLAIMER:

As my role is one of reviewer, I acknowledge that research matter presented in this paper is not my original work, rather it is in the form of re-statement of recent research and conclusions from the work of those authors represented in the bibliography. All credit lies with those authors. *Pamela Nunn*

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