A global view of strategies for visual spatial learners

I have been following the development of Linda Silverman's model of the visual spatial learner (as distinct from auditory sequential) since the article "Invisible Gifts, Invisible Handicaps "was published in April 1994. The model proposes that some gifted children show the characteristics of a gifted visual spatial learner but have problems that prevent them from being good auditory-sequential learners. The model has become well accepted because many parents of gifted children who were underachieving at school "recognised" their child from the characteristics listed by Silverman. As the model developed, so did the strategies used to overcome their problems.

This article identifies many other strategies that already exist by mapping the characteristics of Silverman's visual learner onto those identified in other educational models. By showing that some existing teaching/educational models are, at least partly, applicable to teaching visual spatial learners (VSL), parents and teachers instantly have a much greater choice of strategies.

Silverman's model

According to Silverman, the characteristics of an auditory limited visual spatial learner are:

- Whole part learner
- Learns concepts all at once
- Systems thinker
- Sees complex relationships
- Good at mathematical reasoning
- May be inattentive in class
- Needs to be shown
- Poor at phonics, needs a sight/whole language approach
- Poor at spelling, needs to visualize words
- Poor at rote memorization
- Excellent with abstraction
- Poor at timed tests
- Poor handwriting, should use a keyboard for assignments
- May be disorganised
- Learns complex systems easily
- Struggles with easy work
- Prefers to develop own methods of problem solving
- Learning usually permanent, -turned off by repetition
- Arrives at correct solutions without taking steps
- Good at geometry and physics
- Creatively/technologically gifted
- Late bloomer.

Recurring ear infections during the first two years of life were identified by Silverman to be the most likely ailment contributing to the development of a gifted VSL.

Silverman and her followers have explored a number of strategies to teach these children. Some of these appeared in Lesley Sword's article "I Think in Pictures, You Teach in Words: The Gifted Visual Spatial Learner", (*Gifted*, Issue 114, June/July 2000) and Linda Silverman has published a book "Upside-Down Brilliance: The Visual Spatial Learner" (Paperback - November 2002).

The psychologist's approach adopted by Silverman and Sword was limited by its focus on individuals and individual tasks and I delved into other models. Initially I was struck by the similarity of Silverman's VSL to the cognitive functions said to occur primarily in the right hemisphere of the brain. There was also a good match between Silverman's auditory sequential learner and the cognitive functions

attributed to the left side of the brain (see chart 2). Having seen the similarity, I research "right brain/left brain" theories, including the neurological evidence.

I have for a long time been impressed with Howard Gardner's analysis of how we learn and have researched extensively the neurological and developmental evidence on which his theory was based. His educational model, multiple intelligence, was a must for my melting pot of strategies: the neurological evidence closely matched both Silverman's and right brain/left brain models: the visual spatial strategies were designed to show educators how to teach children who learnt most effectively using the visual spatial part of their brain: employing the linguistic strategies would help strengthen and develop their auditory sequential abilities. There was also a body of knowledge that seemed to suggest that some visual spatial learners perform better in language and arithmetic-type activities, if they start with a visual spatial activity.

But how was I to express these relationships in a way that made them accessible to both educators (typically auditory sequential learners) and parents of gifted visual spatial learners (typically visual spatial themselves)? Firstly, I drew up chart 1, in which I compared the characteristics of the different models with the Silverman model. I then drew up a "mind map" of what I wanted to say. This was very difficult due to lack of experience but clarified my thoughts enormously. I then charted the characteristics of Krebs' neurological model (chart 2) and the whole brain model as the source information for both these models is difficult to locate (chart 3). Finally, I strung the idea together in words.

Having established that these models were comparable, it was time to examine the type of strategies that each model employs. There emerged four different approaches to helping auditory limited VSLs learn more effectively:

1. Teach using their most effective learning method: visual spatial
2. Improve communication between the hemispheres of the brain
3. Teach VSLs how to approach language/analytical problems through a "back door" e.g. through visualisation, music, demonstration
4. Employ strategies that improve/develop/strengthen auditory sequential learning

Teaching your child through their strengths

I strongly believe that gifted visual children should be given strategies to develop their gifts in much the same way as gifted linguistic children are given opportunities to develop their gifts. Under the current system there is no celebration of your visual spatial gifted child's gifts, only a struggle to improve their achievement.

If a VSL is encouraged to understand that the strategy they naturally use - the visual spatial strategy - is powerful and effective, they will learn to employ it more effectively. If they are taught how to develop their strategies further, they will learn more. If they are taught using visual spatial strategies, they will learn most effectively. Although this sounds obvious to us, the traditional educational system has not come to terms with believing that this can be a powerful way of learning. It has been seen as a useful back-up tool. (Use of multi-modality teaching is now thought to be contra-indicated for some auditory limited children - see later.) Yet adult education in the workplace is strongly biased towards visual spatial materials: videos, charts etc. What about "A picture is worth a thousand words"? When has an illustration been allowed as the answer to a problem, with words clarifying the picture? This is very similar to the first time this article appeared - the mind map, which was the visual representation of the ideas, was not published. Editors are very language-based sequential learners!

If your child is empowered to learn through their visual spatial abilities, they will not only improve their performance at school but their self-value will naturally improve (if only because they are achieving). They also improve in unrelated areas of school work (there are some subjects that are not easily taught through visual spatial techniques), possibly because of the improvement in self-value and possibly because they learn to approach the subject through a different neurological pathway *(see Gifted no. 118)*

Visual spatial models
The most powerful strategies are those found in educational models based on Howard Gardner's Multiple Intelligences. You can use strategies that teach through music, through visual or spatial aids or through doing (learning through experience), all of which are predominantly right brain functions. There are many websites and books that can be accessed for more information on these models. (for details see *Gifted* Issue 118, April 2001 or the article "Variety is the spice of life" on the NZAGC website)

I have also found appropriate strategies within books and articles aimed at the development of creativity and lateral thinking, both of which are right brain functions. Teaching strategies for use with the hearing impaired can also be used to effectively teach our VSLs, as they are based either on visual spatial or kinaesthetic (movement, touch etc - doing) strategies. Use these words in search engines on the Internet or your library catalogues to find possible literature. Lesser-known keywords you can try are "gestalt" (whole brain) thinking and "visual meditation".

A neurological model
The role that ineffective communication between the brain's hemispheres plays in education has been known for a long time (e.g. "Overcoming Dyslexia" by Dr Beve Hornsby, 1984). Some children do not change naturally from one side of the brain to the other and some flitter between the two. Other children function as though there is a blockage to certain areas of the brain or as if the messages get "confused". Today, integration deficit is classified as a primary central auditory processing disorder. (This is what an audiologist would call Silverman's auditory limited learner).

The most common cause is thought to be stress and early childhood experiences. Fortunately, the neurological network in children's brains is very plastic. (For the latest information, refer to Scientific American, September 2003.) This means that children can be taught either to use other pathways to access the function or to use strategies that implement or build a more efficient (or faster) pathway than the ones they have developed. The neurological evidence shows that different parts of the brain can take over control of functions (both physical and cognitive) when damage occurs.

Krebs, an Australian scientist, suffered extensive nerve damage from diver's bends. As a consequence of his research and subsequent exploration of the techniques (and theory) of applied kinesiology, he wrote a book in 1988 in which he describes his journey of recovery, research and development of programmes that physically remediate learning disabilities.

Chart 2 lists the cognitive functions of the left and right hemispheres given by Krebs.

Krebs believed that communication breakdowns occur usually in the main neural links that connect the left and right hemispheres of the brain, the corpus callosum. When this occurs, a child may be restricted to either left or right hemisphere functions. If a child is restricted to right hemisphere functions (an auditory limited VSL) according to Krebs (1988) they are:

- Impulsive.
- Inattentive in a classroom or subject to daydreaming. Some use their creative minds to cause disruptions.
- Unable to see the relation between cause and effect.
- Unable to or has difficulty in budgeting time. This means organisational skills are poor and projects are often left incomplete.
- Unable to or has difficulty in concentrating. Concentration being defined as "paying attention over time". (Time not being a function of the right hemisphere.)
- A poor speller, unable to use phonetics.
- Poor in mathematics, especially in learning their times tables or fractions.
- Usually a fluent reader but demonstrates poor comprehension. Symbols are interpreted easily but assigning meaning to words is difficult. Whilst the child can decipher each word in sequence, word-by-word, by the time they finish the sentence, the stress of attempting to keep the rate of assigning meaning synchronised with symbol decoding will often result in the omission of meaning. The child then goes on to word processing (not assigning meaning) to the words. Often there is a patchy recollection of the story or

a filling in of the gaps to produce a story. Quite often this is not the story that they have read.
- Often well co-ordinated because gestalt functions control body awareness and orientation in space.

This type of dominance usually occurs when the corpus callosum is "blocked" at about two or three years of age before the logic (or left hemisphere) functions have developed, resulting in the child being restricted to right hemispheric functions.

At the other extreme, a child restricted to the left hemisphere of the brain (a visually limited auditory-sequential learner):

- is usually good with verbal language and early mathematics (arithmetic and algebra).
- often can't clap in time to a tune.
- is often clumsy.
- usually can't spell well and is restricted to using only phonetic strategies.
- is unable to read well out loud as they stumble over words. However, they usually comprehend very well.

Gifted children develop their own strategies to "get around" problems, thereby making it difficult to make them fit any typical list of characteristics that identify a child with learning problems. Often they don't even know they learn differently to other children. It is rare to come across a good example that illustrates some of the strategies a gifted child uses to compensate for disabilities, but Krebs (1998) gives a case study of Susan. Susan, while gifted in the functions of the left hemisphere, had little or no integration with her right hemisphere. As an adult she managed her own successful computer programming company, but at school, she did not do well in exams. She could easily demonstrate that she understood concepts but was unable to memorise dates, names and equations. To get around her "problems" she made use of a very good digit span memory and memory for sounds to memorise the auditory pattern of words rather than the word pictures (the usual mode of encoding words into memory). Thus she could spell well, which is not usual for someone restricted to one hemisphere. As she was unable to access images of times tables, she made up algorithms that she used to calculate answers as required. However, she was unable to effectively memorise a long piece of work such as a poem.

There is a very much smaller connection (called the hippocampal commissure) that connects the right and left hippocampi, two of the underlying structures in the brain through which the integration of visual and auditory short-term memory occurs. It is also the site of access to long term memory. The functions of the left and right hippocampi are different. The left hippocampus is mainly involved in symbolic digital processing and auditory short-term memory. The right hippocampus is largely involved with visual-spatial processing and visual short-term memory.

If the left hippocampus is not accessible a child will go "blank". This is usually when stressed such as during an exam. The auditory section of the child's brain repeats the question over and over again. However, the child cannot access the visual long-term memory to obtain the facts that he studied. Poor integration in this area is picked up by a low "digit span" test result on standard IQ tests. Generally, a child with a low digit span will have poor spelling or will forget multiplication tables after a few days. The information is becoming lost because it is not getting to long-term memory. Blockage in this connection is usually spasmodic and therefore difficult for teachers to understand. Krebs **(**1998) gives an example of a 13-year-old gifted child, Aden, who had an uneven maths performance. Aden could complete abstract problems one day and not be able to add or subtract the next. He knew how to perform a lot of higher maths functions but he couldn't express them. This is similar to being unable to verbalise the name when a person's face is seen. If, like forgetting a name, the "drop out" is temporary, often changing subjects or relaxing can remove the stress that caused the lack of integration.

In the above, "left" or "right" brain refers to the hemisphere in the brain in which the cognitive functions commence. Subsequent processing occurs in the underlying structures of the brain that are common to

all cognitive functions. The left or right hemispheres become relevant again only when processing is complete and the result of the activity is to be expressed.

Krebs' method of solving the problem was through the physical sciences. Firstly, he followed the latest events in neurology, then the latest therapies and their theories. He quickly moved into early kinesiology, which was, at the time, a therapy programme for treating the disabilities resulting from polio and other nerve-damaging medical conditions. From there he moved into applied kinesiology and travelled the world (literally and figuratively) to learn from researchers or practitioners whom he learnt were having success with treatment of nerve damage. He himself became an applied kinesiologist. His programme, like other applied kinesiology programmes, is heavily influenced by the inter-relationship of the anatomical, lymphatic, vascular systems with acupressure and other reflex points. The programme he designed specifically to bring benefits in an educational setting was LEAP. LEAP (Learning Enhancement Advance Programme) involves brain formatting, among other protocols. It involves an in-depth understanding of neurology and respects the uniqueness of characteristics that reflect underlying learning problems. It requires a trained therapist.

From this neurological model we learn that physical therapies can help our children assess both sides of their brain. It does not take much independent research to learn that ineffective communication between the brain's hemispheres has been thought to be the cause of many learning disabilities, particularly dyslexia, and that many programmes already exist. They can be found in the allied health area of occupational health/therapy and also in programmes of sensory integration, perceptual movement, and kinesiology (including applied kinesiology). There are now some very reputable "remedial" programmes that have been developed specifically to help learning disabilities. These therapies can be very effective, even if your child is gifted, although they are generally used for very slow learners. The characteristics relating to learning disabilities that can be observed in gifted children are just the tip of the iceberg. Quite often the gifted child has already learnt to learn differently, and consequently masks many of the usual learning difficulties (LD) characteristics. I suggest that parents and teachers extract the exercise routines, particularly the cross-hemisphere exercises, and make them part of your child's life. At the very worst they are good exercises and at the best they can radically improve your child's ability to learn. I have been most impressed with the results obtained using Brain Gym, an applied kinesiology programme. It has an advantage over individual programmes in that it is easy to implement in the classroom or at home. As always, it is best to have any allergies, food intolerances and nutritional deficiencies treated before undertaking higher-level therapies. Ensure your child has lots of water, restrict the amount of sugar in their diet and try to remove stress (see no. 4 below - Kinesiology).

In Silverman's model we are told that visual spatial learners can solve more difficult problems easier than they solve simple sequential problems. I compared this to the results of brain activity studies made while gifted children attempted to solve difficult problems: the right side of the brain became active first and then activity moved to the left side. Therefore, cross-hemisphere interaction can and does occur in VSLs when difficult problems are solved, but it did so only after activity had occurred in the right hemisphere. I then formulated a hypothesis:

In a VSL, if thinking begins in the right side of the brain, switching to auditory-sequential or logic functions of the left brain is much easier than if they try to commence thinking logically

Reports back from schools based on Multiple Intelligence record that children improve in all subjects in that environment. This suggests that a successful strategy for problem solving for some VSLs might be to commence a learning activity with a visual spatial activity and then move on to evaluative or analytical acts. It also suggests that improving (or bringing into consciousness) the child's ability to move from right brain to left brain: from visual spatial to auditory sequential: from global thinking to detailed thinking will improve the VSLs access to left brain functions. It also poses the question of whether for some VSLs the auditory sequential "problem" is a problem of access rather than neurological dysfunction.

……review of the literature shows us that auditory/sequential abilities in our gifted visual spatial learners can be accessed and developed if visual/spatial function is initiated first.

Whole brain (or left/right brain model)

12/11/03

Most gifted children shift rapidly from one side of the brain to the other. For example, imagine a child in the classroom waiting for the teacher to be ready. While waiting, the child looks at a friend crossing the playground outside. The child feels the sunlight warming their face through the window and smells the unwashed hair of a classmate. The teacher interrupts with the command "Open your book at page 12. Listen carefully while I take you through the first part." As the child's thoughts and senses jump to the everyday world of the teacher's command, they have just moved from right brain to left in an appropriate fashion. So long as shifts can be made between the two, being dominantly left or right brain is acceptable and appropriate. However, some children "flit" between the two hemispheres, some have trouble switching between them and others have trouble initiating activity in either one of the hemispheres.

The "whole brain" strategists believe that whole brain thinking leads to a process that is greater than the sum of each separate hemisphere. The major strength of left brain is that it allows construction of detailed models that have predictive value. Logical linear models make it possible to deduce what will happen next. However, the major drawback of Logic is that the model is always based on the facts, the facts as they are known *right now*. As with the rational belief that the earth was flat, new facts can make what was rational, appear irrational. It is the right spatial creative brain thinkers who advance science by paradigm shifts. They, like Einstein, either conceptualise something new or combine old ideas in a new and different fashion. However, without Logic Brain to test and prove, the ideas generated by Creative Brain are quickly lost.

Reference to Chart 1 and Chart 3 will show you how similar the list of characteristics of the VSL given by Silverman (1989) is to the list of characteristics of a person who, in the vernacular of the 1980s right brain/left brain models, is right brain dominant.

Whole brain thinking is not new. Many of the examples given of accessing logic or of creative thinking processes are based on books written in the 1980s for the workplace. The strategies are different to the educational strategies because they utilise the more general characteristics of the hemispheres. For the right hemisphere, for example, this means emotion, automatic motor functions, big picture, and non-verbal communication. Many of the strategies are similar to that used in education to "teach" creativeness.

I like the use of the more general characteristics for parents because these are the characteristics that they see in their child at home. They are not always aware of the details of how their child approaches school work.

There is an underlying assumption that by "using" the techniques/strategies, they will become second nature. This strategy is the basis of many successful self-assertive courses. Children who are right brain dominant (visual spatial learners) can be asked to "act" the role of the left brain learner. It is not threatening and often brings success.

Strategies to move between hemispheres

- Begin writing with "setting the scene". Use emotional and evocative word pictures (evoking the right brain) then give facts and analysis (move to left). If too much emotion is evoked it becomes difficult to make the shift.
- Breathing. This is based on Yogi techniques and is now practiced on biofeedback machines. Breathe through the more congested nostril. To assist a move to the left hemisphere, breathe through the right nostril.
- Strategies that the literature suggest help the brain to shift between hemispheres:

RIGHT **TO LEFT**	LEFT **TO RIGHT**
Take notes. Write key points.	Visualise. Daydream. Write in very large flowing letters.

Organise. Set priorities. Review.	Discover visual patterns. Look for the big picture. Find connections. Look with "soft eyes". That is, do not focus rigidly. Do not look for details but for an overall impression.
Evaluate. Eliminate extraneous ideas. Set goals.	Open up to irrelevancies.
Analyse body language or tone of voice.	Respond to body language or tone of voice. Hug. Smile. Laugh.
Practice your rational opinions and presentations.	Talk to yourself in a positive, supportive way, using colourful, playful, childlike language.
Take mental practice runs. Compare. Judge.	See through others eyes. Try to "feel" their point of view.
Make decisions. Recall. Question. Check progress, goals and time.	Move. Exercise. Repeat. Experience. Play. Enjoy.
Shift phone to the right ear.	Shift phone to the left ear.
Write. Outline. List. Work crossword puzzles. Solve maths problems.	Doodle. Draw.
Ask questions. Make puns.	Sing. Hum. Recall. Joke. Chuckle.
Stride purposefully. Touch your toes or perform some other callisthenic function. Count out loud until you have completed a prescribed number of counts.	Breathe deeply saying or thinking "maaaaa" with each exhale until relaxed. Take a stroll.
Go off alone. Write a note describing anger or concerns.	Take a mini-vacation at work desk by leaning back, relaxing, closing eyes and daydreaming.
Connect with time, schedule or historic moment. Looking at watch, and mentally plan trip or day's activities.	Make eye contact with others to feel their point of view.
Estimate value of precision, economies and foresight.	Relate to someone or something known or experienced.
Break problem into separate parts. Revise policies until consistency prevails.	Be aware of colours, space, aromas, sounds and emotion.
	See the whole situation. See how each person and element is related.

The following analysis of problem solving or "brainstorming" suggests when brain shifts are appropriate. Children can use any of the strategies to assist them in the shifting process. Practiced techniques allow for appropriate shifts.

1. Access the left brain. The first step is to define the problem. This is a critical step and can be the hardest part of solving a problem. However, for schoolwork it is usually relatively easy. Extract the keywords, the verb and the subject. Then list specific details that need to be covered. If the specific details are not given in the problem and the project is general, such as "lions", then the easiest approach is to find a book on lions and copy out the keywords the book implements. Use the contents pages or the index to determine what lions look like (appearance and place in the animal kingdom), where they live (habitat), what they eat (nutrition), or what sort of babies they have (reproduction).
2. Switch to the right brain. Evoke every possible connection or pattern that can be imagined. Do not censor any thought. Jot down keywords or phrases (without trying to make the words make sense). If desired, make a rough sketch. Whilst doing this, children should make themselves as comfortable as possible and close eyes (if this is not possible, the "soft" focus technique may be implemented). If ideas slow down, the child should focus on one of the cues already recorded to see if any thing else comes to mind.

3. Switch back to the left brain. Delete stupid, extraneous and incorrect cues. Highlight those cues that both left and right brain liked. Leave the others as "maybes". If the project is simple, children can number each cue in the order that they will write about them in the project.
4. If the problem is complicated or difficult the child may need to group similar cues together by using circles or arrows. (This is the same technique as used in mind maps which utilise the right brain.) or cues may be listed under a heading. A heading may be "Where they (lions) live" or "Habitat" for the older student (employing the left brain).
5. The child can switch to the left brain if further research is required
6. Stay in the left brain to write the project. Each group must have at least one paragraph.

(It is worth noting that if the problem is very difficult, the right brain would be needed in the initial analysis.)

If this method of brain switching is to be used during exams, it must be practiced. Exams almost always require left brain output. Getting stuck in the right brain mode during an exam guarantees a poor test result. Getting stuck in the left brain may lead to a mediocre result. To successfully use these techniques it is necessary for the child to become conscious of how they feel when in one mode or the other. The child needs to know what works for them. For example, before writing an answer a child may need to draw a detailed picture of what is going to be written about.

Other strategies to improve "whole-brain thinking" that can be applied to school aged children are:
Developing the right brain:

- Cinematics, a step-by-step visualisation technique progressing from spontaneous viewings to programmed mind pictures that serve specific purposes such as goal-setting and invention. The child learns to visualise full sequences by following a "what if" to its conclusion rather than the predictable "snapshot". The problem is therefore followed until a visual answer is located which can then be translated into language.
- Suspending the left brain by overloading it with details (watching mindless TV) or starving it until it lets go out of boredom through such activities as running, chanting or marching. In school projects this technique can be used after the problem has been defined and the facts collected. Suspending the left brain at that point allows the child's right brain to come up with a whole brain approach that will show the child how to connect the individual elements that compose the project.

Developing the left brain (which can be practiced in all aspects of a child's life):

- The impression a child creates on others depends mainly upon how they look and act. The interaction they receive in return is an indication of the perception others have of them. How others treat them, in turn, influences how a child feels. To make this work positively for a child they should be encouraged to act the part of a "left "brainer". Suggest to the child that they dress and act alertly, that they be positive, optimistic, incisive, efficient and energetic. Encouragement to stand and sit straight with a positive pleasant look on their face enables others to see them as logical and rational (left brain) and treat them accordingly. Thus the child feels efficient. Soon, the theory goes, the child won't need to pretend any more because it will be naturally occurring.
- After obtaining "the big picture", focus on detail. Do this by breaking the big picture into smaller and more detailed sub-pictures.
- Focus on time, numbers and money.
- Encourage research. When a child consults various sources of information, they begin to weigh up conflicting opinions and draw original conclusions.
- Encourage analysis and evaluation with anything and everything, even junk mail. "Why have I been sent this? What is the message they want me to get? How have they gone about doing it? Are they successful?" This is a variation of the "What, when, who and why" method.
- Speaking is very left brain, so encourage speaking even if the child is not very good at it. A good avenue to explore is perhaps to join a debating club. However, this should only be one where they can learn to do better or one that is not attended by their peers.

- Encourage setting of daily challenges or goals. Have a child use time tables, which are very left brain.
- To improve spoken language have children read aloud whenever possible, practicing volume control, articulation and modulation. Have the child listen to a tape of their voice explaining an opinion, then constructively listen to it. Encourage children to rehearse by speaking in front of a mirror or recording a video of themselves. Have the child check for irritating or negative body language. Then encourage the child to try the same speech again standing straight, speaking confidently and smiling. Then compare how *they* would feel about both speakers. Do not remove the colourful and emotive language. This style of language, the intonation, the rhythm, the metaphors and the gestures originate in the right brain. Incorporate it. Try to remove the "I" from every sentence.
- To improve written language, encourage use of a prescriptive guide to help with organisation of words. Still include, if appropriate, the visual, emotional and sensory descriptions, the metaphors and the emotive words. These aspects make language a balance of left/right influences. Visual spatial learners may achieve better results if essays are started with description, thus "setting the scene". After this description the child can be analytical, engaging their left brain to organise the remainder of the essay. Communicate to the child that the inclusion of right brain visions add "flavour" and character to an essay or story which will be valued and respected.

The visual spatial learner (with an auditory/sequential problem) and giftedness

Each model has an explanation as to why children develop either with visual spatial abilities, without auditory sequential abilities or without adequate communication between the two abilities. However, one of the significant reasons for the recent dramatic increase in the number of child visual spatial learners is our current lifestyle. Most young children, as part of their upbringing, are exposed for long periods of time to visual stimuli (television, videos, computers). They experience very few situations that involve them in sequential problem solving or meaningful auditory medium. (Auditory input from TV is not processed by children who passively learn via the visuals.) The consequence is that these children start school with highly-developed visual functions and relatively poorly developed auditory functions - almost the opposite to their teachers. It is in the classroom that they first experience difficulty with auditory learning. (refer Hannaford, 1995)

Fortunately, the neurological network in children's brains is now known to be "plastic" and children can be taught to develop immature existing pathways (or to bypass a damaged function). (This is more effective if, at the same time, they are not also made to feel failures or always rewarded for small improvements in work they do badly and rarely praised for what they can do well.) New evidence suggests that constraint-induced therapy is effective in building new neurological pathways (Scientific American Sept 2003). This is the basis for some new remedial language programmes where intensive repetitious practice of basic movements (e.g. sounds) is thought to result in an area of the brain "taking charge" and is effective even when the original problem was a lesion in the brain.

We need to implement educational approaches that firstly recognise that children can be unevenly gifted and secondly give these children a chance to develop their gifts by using their strengths. (Giftedness (or intelligence) has, for a long time, been equated with a single factor (known as "g").) Recognising that children can be unevenly gifted is a relatively new idea and recognising that gifted children can also be learning disabled is an even newer concept. As soon as our VSL children begin school that they should be taught reading and writing using visual methods and they should also participate in a developmental auditory sequential programme so they can learn/develop auditory sequential learning ability. Supporting the cognitive development there should also be a planned physical exercise programme that encourages appropriate neurological development.

A note on "auditory limited"

This article is not concerned with why a child is auditory limited but I cannot escape the scientific research that shows that the cause will affect the strategy that will be successful with your child. This is, however, not a universal concern.

If you are being guided by a speech therapist rather than an audiologist, you will be told that the "building blocks" of language is not a concern. It is the student's ability to use what strategies they have to make language comprehensive and comprehensible.

The two approaches, neither of which are wrong, cause the apparent confliction in advice given.

Diagnosis of an auditory limited learner by an audiologist will be CAPD (Central Auditory Processing Deficit. This is where a child with good hearing does not process sound appropriately and is consistent with an undeveloped auditory or left brain.

Various sub categories of CAPD have been proposed; the most common being called "auditory decoding deficit" when the primary (left) auditory cortex is involved, and "integration deficit" when the corpus callosum is involved. (In the models discussed in this article, an auditory decoding deficit would equate with a visual spatial learner where auditory processing has not been developed or is damaged. A child with integration deficit would equate to a visual spatial learner who cannot access auditory processing.) Different strategies are required for each subcategory and a strategy recommended for one subcategory may be contra-indicated or ineffective for another. For example, FM transmitters or sound field are effective for auditory cortex deficiencies but ineffective for integration deficiencies. Visual clues are useful in auditory cortex deficiencies but contra-indicated for integration deficiencies.

While traditional educational management strategies have been assigned to the various subcategories of CAPD, neurological retraining of the auditory pathways (a physical remediation based on the assumption of neuro-plasticity), is gaining acceptance. Parents interested should investigate SOMONAS or sound therapy. Audiologists, as well, are using a neurological approach: they are developing computer games and educational software programmes that are said to develop specific neurological pathways they believe are needed for language.

Speech therapists who diagnose your gifted VSL with CAPD may recommend a different set of strategies. This occurs because audiologists and speech therapists approach CAPD from different directions: audiologists use therapy programmes that are stimulus driven and intended to improve encoding of the auditory signal through adaptive stimulation: Speech therapists recommend programmes that focus on improving ability to use metalinguistics/metacognitive strategies and enhance the student's experiences and expectations to allow the strategies to be used. Both approaches have a large amount of evidence supporting them, but neither have "cause and effect" evidence. It is likely that some children will benefit from bottom-up therapy programmes (audiologist's approach) and some from top-down therapy programmes (the speech therapist's approach). My own bias, given my science background, is a bottom-up approach but I recognise that gifted children are usually helped more by a metacognitive approach*. (see bibliography for articles on CAPD)*

There are two other sub categories of CAPD that, on the balance of evidence so far, appear to be more suitable to a top-down approach. They are auditory associate deficit, which is primarily an inability to apply the rules of language to incoming auditory input and output/organization deficit, which is an expressive language/executive function disorder, difficulty acting on incoming auditory information, deficit in the ability to sequence, plan, and organize responses.

It is also important that parents of gifted children who are both visual-spatially gifted and auditory-limited should be aware that the psychological test pattern of their child will show attention deficit. This is not necessarily ADD and it is advised that a diagnosis of ADD in a VSL gifted child is confirmed by neurophysiologic testing.

Remember: There are three important ways to help a visual spatial learner improve their performance in the classroom: Teach them through their strength (use visual-spatial strategies), teach them techniques to move from visual spatial to auditory sequential thinking as required, and improve their auditory sequential skills.

Most of the models have substantial amounts of supporting evidence, but none have cause and effect data. In all probability, different categories of a VSL will emerge and the different models will turn out to be appropriate to different categories. Until there is more definitive data, pick and choose according to which meets the needs of your child.

Annotated Bibliography

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Hannaford,C. (1995) *Smart Moves: Why learning is not all in your head.* Great Ocean Publishers, Virginia

Examines the role of movement in learning. It contains a lot of neurophysiology. An excellent section on the application of Brain Gym in helping learning disabled children.

Krebs, C & Brown J. (1998). *A Revolutionary way of thinking*. Hill of Content, Melbourne.

Krebs's journey through the research of neurophysiology on his way to discovering and developing uses of kinesiology in healing. Some of the best overviews (and interpretations) of neurophysiology available.

McPhillips.M., Hepper,P.G., Mulhern,G. (2000). Effect of replicating primary-reflex movements on specific reading difficulties in children: A Randomised, double-blind controlled trial. *Lancet*, 355, 537-541.

Pittelkow,K & Jacob,A. (2000). *Discover the gifts and talents in your child*. Simon& Schuster, Sydney.

Discusses the use of brain gym (an educational kinesiology) for encouraging children's ability in English. Also advocates its use in the classroom to allow children to learn more effectively. This particularly concerns gifted children who have uneven cognitive profiles.

Pittelkow (2001) *"Variety is the spice of life* , *Gifted, 118*

Discussion of how Howard Gardner's theory of Multiple Intelligence can be applied to great advantage in the education of our gifted children, in Issue 118 of Gifted or refer the NZAGC website

Pittelkow, Kay

- "CAPD and the gifted child: The relevance of central auditory processing deficit to gifted education"
- "Auditory Re-Training - a personal experience"

These articles appear on the website for NSW Gifted Association (under Article Index). www.nswagtc.org.au

Silverman, L.D. (1989). Invisible gifts, invisible handicaps. *Roeper Review, 1 2(1), 37 – 42.*

This was the article that, for the first time, described VSL children in such detail that many parents referred it to teachers.

Springer, S.P. & Deutsch, G. (1993). *Left brain, Right brain*. 4th ed. W.H. Freeman and Co, New York.

This cognitive neurophysiology reference book reviews the scientific studies that show (or purport to show) differences between the left or right hemispheres of the brain. They don't always find it and certainly not the way popular literature has interpreted it. An excellent book for obtaining a "scientific" understanding.

Sword, Lesley. (2000). I think in pictures, you teach in words: the gifted visual spatial learner. *Gifted. 114, p1, 27-30*

Wonder, J and Donovan. (1984) Whole-Brain Thinking. Working from Both Sides of the Brain. W. Morrow, New York.

This book is full of workplace strategies for engaging creative or analytical functions and moving between the two to obtain better use of the mind. Provides many examples that could be translated into strategies for visual spatial learners or sequential learners.

Reference Books

Beetlestone,F. (1998) *Creative children, imaginative teaching*. Open University Press, Buckingham US.

A teacher's guide to enriching primary school education by incorporating creativity into the curriculum.

Dennison, P.E. and G.E. Dennison. (1994). Brain Gym: Teacher's edition (revised), Switched On Publications, Sydney.

A practical self-help manual allowing teachers (or parents) to implement a series of movements or actions which activate or unblock connections in the brain. (Brain Gym is known an edu-kinesiology programmes)

Kranowitz, C.L. (1998). *The out-of-sync child: Recognising and coping with sensory integration dysfunction.* Berkley, New York.

Outlines the characteristics of children with this disorder and what to do about it using sensory integration techniques.

Marks-Tarlow, T. (1996). *Creativity inside out.* Learning through Multiple Intelligences. Addison-Wesley,USA.

Packed with practical and different ways to challenge students to interact with the world. Designed to be used sequentially, through a well thought out lesson plan, indices allow access to activities by subject, learning style, student grouping, function duration, special populations and grade level. Developed for educators of students in grades 4 - 9.

Pheloung, B. (1997). *Help your class to learn. effective perceptual movement programmes for your classroom.* Barbara Pheloung, Manly, NSW.

A very valuable resource for parents trying to find NSW schools that provide perceptual movement programmes. Also useful for the overview which describes children that require these programmes.

Technical Assistance Paper 10967 (2001)- Florida Department of Education. "Auditory Processing Disorders".

A very good review of CAPD including questionnaires and applicable tests. (available on-line)

CHART 1 Characteristics of Silverman's visual spatial learner explained in terms of Multiple Intelligences theory, whole brain model and brain research

Spatial learner (From Silverman)	**Neurological (brain) studies**	Whole Brain	Multiple Intelligence (MI)	**Comments & Explanations**
Whole part learner Learns concepts all at once Systems thinker - Sees complex relationships	Too complex to be examined. However, all evidence would point to both hemispheres being involved. *	A right brain function	The ability to see relationships between diverse parts across domains is characteristic of visual spatial and advanced logic mathematics intelligences	Refer to note below chart.
Good at mathematical reasoning	Males do better generally on mathematical reasoning tests and females do better at calculations. Extreme mathematic ability is linked to bilateralisation and not specialisation of the hemispheres.	Arithmetic is a left brain function.	Logic/ Mathematical intelligence. This involves mathematics as well as deductive and inductive reasoning. However, complex reasoning involves visual spatial intelligence.	
May be inattentive in class Needs to be shown	The right frontal lobe is active in tasks requiring attention	Attention is a left brain function. Inattention implies Right brain function	Inattention to maths or language in class implies weakness in logic and linguistic intelligences.	Attention is concentration over time and since right brain has no concept with time, right brain dominants are erratic in their concentration. In multiple intelligence theory attention is focus and occurs in all intelligences
Poor at phonics: Needs a sight/whole language approach	Verbal, including phonological memory is primarily accessed via left hemispheric routes. Word recognition is an activity that occurs in the right brain.	Language is a left brain function. However, recognising words as a shape without meaning is a right brain function	Poor at phonics implies a weakness in Linguistic intelligence. Being able to use visual intelligence to compensate implies strength in this area.	Using sight/whole word techniques to learn spelling because phonics is inefficient, is, in multiple intelligence theory, teaching through the child's strong intelligence which in this case is visual spatial.
Poor at spelling- Needs to visualize words	Left and right hemispheres are both necessary for good spelling. The left brain is active in detailed visual analysis but the right brain is active in symbol recognition.			
Poor at rote memorization Excellent with abstraction	Verbal, including phonological and sequential memory are primarily accessed via left hemispheric routes.	Rote memorisation of verbal material is a left brain function. Creative problem solving is a right	Abstraction implies the ability to see relationships between diverse parts (see whole part learner) and is a	If you try but still have difficulty memorising then it unlikely that you will learn however many times it is repeated "in the same manner". Abstraction, as a learning method usually involves lateral thinking or similar right

Spatial learner (From Silverman)	**Neurological (brain) studies**	Whole Brain	Multiple Intelligence (MI)	**Comments & Explanations**
		brain function Abstraction is a right brain function	visual spatial characteristic (visual – spatial or logic intelligences)	brain approaches
Poor at timed tests. These should be avoided		Right brain: see inattention above		
Poor handwriting - should use a keyboard for assignments		This characteristic is not concerned with why the handwriting is poor but that keyboard skills are a way around the problem. Writing seems to be an extension of the language function and therefore presides in the left brain although in practice it is not so straightforward. However, touch-typing is a new motor skill and as such the learning will be in the left brain, Once the motor skills are automatic) they become a right brain function which is why it is recommended here.		
May be disorganised	Too complex to be studied. Frontal lobe is usually involved.	Disorganisation is a characteristic of a right brain dominants	Organization is only relevant in the sequential intelligences of linguistics and logic. This characteristic implies a weakness in these intelligences	
Learns complex systems easily Struggles with easy work		See 1 above. “Easy work” is typically sequentially based and difficult problems incorporate spatial concepts. Thus this characteristic is implying weaknesses in the sequential linguistic and /or logic intelligences and strengths in spatial or right brain functions.		
Prefers to develop own methods of problem solving		Silverman assumes, correctly, that the usual strategies employed in problem solving in schools are analytical or evaluative and are therefore sequential based. If the problem is in maths it is logic intelligence that is involved, if it is expressed in words (English, history etc), then the problem solving involves linguistic intelligences. All of these are left brain functions. However, brainstorming, lateral thinking, mind mapping and many other visualisation and “creative” strategies (some of which are discussed in strategies from whole brain models) are all recognised problem solving strategist. If they are not taught at your child’s school then your child develops a version for himself. These alternative strategies are right brain functions and, in the school setting usually use visual spatial intelligence.		
Learning usually permanent -turned off by repetition		As mentioned above: repeating a method that has been correctly used and yet has failed cannot succeed as nothing has changed. When it is repeated your child is bored and is placed in a situation where he already knows he will fail. A turn off! Repetition is a sequential oriented technique and works only when for some reason the information was not received the first time or when presenting content that is inherently sequential such as logic or linguistics.		
Arrives at correct solutions without taking steps		A right brain function	Implies use of an intelligence that is not sequential based: i.e.	

Spatial learner (From Silverman)	**Neurological (brain) studies**	Whole Brain	Multiple Intelligence (MI)	**Comments & Explanations**
			visual spatial.	
Good at geometry and physics		The visual and transformation aspects of geometry and physics are right brain functions	Geometry and physics have large components of visual-spatial as well as logical functions. Therefore it is reasonable to assume your child will do better at this than other logic based school subjects. (Note: while typically poor at any subject involving language, visual spatial learners can learn languages that are "picture" based).	
Creativity/ technologically gifted		As above + the control of body movement in space (as required for engineers etc) is a right brain function.	Visual spatial, logical (technology) & kinaesthetic (technology) intelligences are all required in various combinations depending on the domain.	
Late bloomer	Could not be studied.	This characteristic is discussed in the note below which relates to the whole part learner		

- "Whole part learner" is a term loosely applied to a child who, to understand, must see the parts in relationship to the whole. They need to know where the teacher is heading and the significance of the current lesson in terms of the concept in its entirety. This ability to see relationships between parts is a right brain or visual spatial characteristic. However, primary school teaching is dominantly sequentially (mathematical and language) based. Children who learn principally via the right hemisphere or children with sequencing or left brain disabilities will underachieve in this setting. However, when very difficult or creative problems are introduced in late high school or university, the right hemisphere plays a much more significant part and your spatial learner performs relatively better than their sequential learners for this type of problem. In addition, at university or some senior high schools, sequential learning methodology is no longer compulsory and your child (or young man or woman, now) can use/develop learning strategies that make use of their advantages.
- Repetitious learning. The comments above relate to complex tasks. There is a lot of evidence that suggests that repetition (particularly if the alternative is constrained/limited) of (neurologically) simple tasks will result in changes in the brain. The reading programme "Fast for Words" is premised on this.

Chart 2: Cognitive Functions of the left and right hemisphere
(adapted from Krebs's book)

LEFT HEMISPHERE	**RIGHT HEMISPHERE**
LINEAR	SPATIAL or GESTALT (holistic learning)
DETAIL	CREATIVITY
Proof	Making it up
Facts	Imagination
Order	Fantasy
Consistency	Spontaneity
VISUAL CONSTRUCTION	VISUAL
Creating images of words from letters	Recognition of faces
Spelling words	Word recall for spelling
Learning x tables	Recall of times tables
ASSIGNING MEANING	INTERPRETING SYMBOLS
Gives words their meaning (eg cat = furry animal)	Recognition of alphabet
Reading comprehension	Recognising words when reading
WRITING	WRITING
Printing	Large flowing (cursive)
LANGUAGE (Verbal)	LANGUAGE (Non verbal)
Speech	Guttural utterance
Editing thoughts to say	Sound (music)
Saying things	Noises (grunting)
Written language	Gestural language
ARITHMETIC	GUESSES
+,-,÷,x	BELIEFS
Mathematics (not necessarily geometry)	
LEARNING CO-ORDINATED MOVEMENTS or ACTIONS	AUTOMATIC CO-ORDINATION
Sequencing physical actions (eg a child trying to throw his first ball)	Balance
	Running
SENSE of TIME	NO SENSE of TIME
Ordered	Easily distracted
Organizational	Attention deficit

Chart 3: WHOLE BRAIN MODEL Characteristics of children (or adults) who are left or right brain dominant

Characteristic	Left		Right	
	Dominant	Moderate	Moderate	Dominant
Problem solving	Lefts are more likely to solve a problem by following an organised approach; by defining the problem, researching and recording possible solutions, by eliminating impossibilities.	Moderate lefts will check the record and repeat strategies that were previously successful. From these solutions they will assign priorities to the most viable, and then implementing the plan.	Moderate rights will get a feel for what will work and proceed. They need frequent support from others.	Wait to see what happens (this is in response to a life problem not a school problem). In school they will use mind mapping and brainstorming if they have been taught.
Reading	Prefer analysis, tables, and written or verbal directions		They prefer maps, charts, diagrams, pictures and photographs	
Listening	Focus on words and the message		Take a more general approach that incorporates body signals, emotional tone and other subtleties. Can usually tell you about what they heard, particularly the emotional content, but often short on details.	
Verbal skills	Good and usually talk to express a point. They are more structured and their language is more precise. They are often persuasive speakers because they have confidence in their well-defined logical opinions. Jokes are usually puns. Can be boring as they lack colourful and emotive language.	Mixed dominants often speak slowly because they have an internal debate between left and right brain thoughts. Rhyming and using metaphors require left and right brains.	Are usually vague about what they want to express. Sometimes they can picture what they want to express but cannot find the words to do so. Favour colourful, emotional, sweeping terms. Have trouble keeping on subject when giving talks. Use personal examples and often fail to conclude. Humour is seen in funny or unusual juxtapositions or other visual rearrangements. (Often Lefts don't understand what Rights see that is funny.)	
Visual spatial skills	Need detailed instructions ("Turn left at the first street, proceed two blocks and turn right"). They have trouble putting names to faces unless they use memory techniques to recall them. Particularly a problem if the name is mumbled - that is, they have poor visual recognition of faces and have to rely on remembering the "name".		Easily recognises faces and usually can recall what the person wore, whom the talked to and if they drank red or white wine – all visual clues. Directions are usually visual. They only need directions such as "It is in that street that comes out at zone 3". Can always show you how to get there, but often can't give directions (that a left brain can follow)	

Organisational skills	Good and usually neat. Craftsmen. They like order and stability and are willing to adhere to rules and adapt themselves to structure. They analyse and compare society's standards Time and schedule conscious. Impatient with time-consuming aspects of meetings, committees (or co-operative learning situations) Always plan to go or do some function. Will not take risks until everything has been evaluated. Wants to see the evidence or research before they accept new ideas. Are often unaware of people's feelings because they don't listen to voice tones or read body language. Boys will tackle model kits by following instructions one by one.	Sloppy and like change because they are visually and physically oriented. Like the unusual, the discordant and different. They "know" what is proper for them. Unaware of time because they lose contact with the here and now. Enjoy meetings for personal contacts (not concerned with waste of time). Tend to be impulsive and like impromptu occasions. Do not plan, or if they do, they visualise the result. "Read" other people's body language and "feelings". Will take risks (they like change and don't like to plan so they are more easily involved in new ideas and projects). Boys will tackle model kits by looking at diagram and assembling. (Girls tackle dress-making the same way.)
Sports and work	Like sports that invite comparisons and evaluations They play competitively. They employ goal setting and will not undertake a task that has no result (product).	Like freedom and dread comparison. They play because they like the feeling. They will walk with no destination. The thrill of doing is enough.
Attitude and personality	Thinks intuition is amusing or rubbish. Happy. Tend to be controlled and disciplined with fewer mood swings.	Place trust in daydreaming and hunches. Sad. Have more obvious mood swings and tend to vocalise their moods.
Eye position	Are usually "right-eyed" and look to the left side of a picture or page. (If you are left brain dominant and are left eye dominant you are likely to be in a special needs class - USA research.)	Are usually "left-eyed" and will look first to the right side of a picture or page.

No 4 - Kinesiology

Applied kinesiology originated because of the analysis of disabilities resulting from polio and other nerve-damaging medical conditions. Treatments are heavily influenced by the inter-relationship of the anatomical, lymphatic, vascular systems with acupressure and other reflex points. Many of the early work was purely medical but now some of the protocols have been so well developed that non-medical therapists can be trained. Kinesiology has therefore obtained an undeserved reputation of "mumbo jumbo". Medical uses are well documented but its usage for learning disabilities has not been statistically studied. However, there are some very powerful case studies on the subject (Krebs, 1998 and Hannaford,1995). Results from some indirect studies are emerging. For example, the removal of primitive reflexes has been shown in a scientific trial published in the journal *Lancet*, to significantly improve reading ability. Applied kinesiology can remove primitive reflexes in a child with one treatment session. This is instead of weeks using standard techniques.

There are many versions of kinesiology with some being more confronting than others:

- Touch for Health was originally aimed at creating better community health and wellness and was available to anyone who applied. It is not specifically related to educational needs but is a prerequisite for many of the other kinesiology modalities.
- Educational kinesiology (or Edu-K) aims to re-educate your child's whole body/brain system to function and learn in a more effective and resourceful way. It is a movement based programme that offers you understanding of how learning occurs and what motivates and blocks learning. Brain Gym exercises are an essential part of Edu-K and can be, and are used as a self-help programme or can be used in classrooms. There is more about Brain Gym outlined below. Some techniques are also outlined in books written by Krebs (1998), Hannaford (1995) and Pittelkow and Jacob (2000).
- NOT (Neural Organisation Technique) involves reorganising the neurological system to free the body of chronic pain and other imbalances related to accident and illness. Practitioners of this branch of kinesiology believe that they resolve problems at the most basic level. They believe that many of the observable problems (such as learning disabilities) will be solved as a consequence of curing the underlying problem. (This must be carried out by a qualified therapist.)
- LEAP (Learning Enhancement Advance Programme) is Krebs's (1988) programme and involves brain formatting, among other protocols. It involves an in-depth understanding of neurology and respects the uniqueness of characteristics that reflect underlying learning problems. It requires a trained therapist.

Strategies from Brain Gym

Brain Gym exercises are best described visually and readers are best to refer to texts listed at the end of the article. I have included two examples of physical movement techniques and two based on acupressure:

- Cross-crawl for general brain integration. Cross-crawl is walking on the spot: moving your feet and knees up and down, in co-ordination, while moving your arms back and forth. The right arm must be coming forward when the left leg is coming up and the left arm has to be coming forward when the right leg is coming up. As with all brain gym exercises, cross-crawl must be done consciously and slowly. Movement must be free and easy. Cross-crawl works by creating considerable flow across the corpus callosum. Done regularly, cross-crawl stimulates the development and myelination of neural network that makes up the corpus callosum.
- Lazy-8s for integrating hearing, known as "the elephant". Place your ear to your shoulder and extend your arm like an elephant's trunk. (In this way your neck, shoulder and eye are engaged as a unit.) Start slowly with the right hand, move up to left and slowly inscribe the letter 8 in the air. (Check that both loops of the 8 are equal.) Start with large muscle movements to relax the muscles of the hands, arms and shoulders and later reduce the scale. Switch to the other hand and shoulder. As the elephant relies on the core muscles involved with posture, it stimulates the vestibular system and as eye-body co-ordination is involved, it also stimulates the

vestibulo-ocular reflex. The elephant should be done before any left brain activity is started. It is particularly useful for children who have been diagnosed as having Attention Deficit Disorder.

- Acupressure for auditory integration, known as “thinking caps”. Place your index finger behind the top of your ear, then take your thumb and gently unroll the curl of your ear while simultaneously pulling the ear out and back. Continue to do this right along the curl of the ear from the top to the lobe. Doing this three times will activate reflexes that allow you to suddenly hear and listen more effectively. There are some 140 acupressure points on the ear.
- Acupressure for right/left switching. Hold your navel with one hand, then take your thumb and index and middle fingers and locate the twin depressions on the chest below the end of the collarbones at the sternum. Press gently and note any tenderness. Massage them gently in a circular fashion. This simple acupressure stimulation appears to reinstate the neurological flow through the corpus callosum and other left/right connections