2. A few implications of Structured Water on Bodywork and Movement with respect to Muscles and Connective Tissue

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1. Introduction

This essay is an exploration of possible implications of Gerald Pollack's book "*Cells, Gels and the Engines of Life*"[1] with respect to the muscles of the body, with the net of interest thrown over a rather wide expanse of water. Much of the material in here is a speculative exercise in joining dots, and it would be interesting to see the results of well-designed experimental (or experiential!) forays into this territory.

It is a useful thing to be able to relate muscle action on a cell-by-cell basis to real experience of how muscles work – both as a user and as a bodywork therapist. Personally, on reading Pollack's book I immediately had a sense that I had stumbled upon something that bridged the gap between biological science and living experience. This is partly because of his pedagogical approach to writing – he conveys complex issues in a simple way, step by step, and gradually leads the reader to easily understand concepts that are remarkably profound and complex. But also, his revolutionary paradigm of the *phase-change of water* as a medium for all life processes at a cellular level brings about a model that has instantly recognisable behaviour.

Normally, in text-book science, we have learned that water exists in three *phases*. These are (i) solid ice, (ii) liquid water and (iii) (gaseous) water vapour. It has become apparent over the past 60 or so years, beginning with the scientific work of Albert Szent-Gyorgii, that water has a fourth phase. This fourth phase is semi-crystalline and structured, brought about by liquid water being in contact with a hydrophilic or hydrophobic ionically charged surface. Water molecules themselves are asymmetric, and so each water molecule exhibits a charge polarity, being more positive in charge on one side and more negative on the other. Normally it is thought that the thermal energy of each molecule is sufficient to prevent the water molecules binding to each other in chains or other structures for anything more than very short (less than microsecond) periods. However, it has been known for some time that water in rivers and shallow groundwater clumps together and remains in the form of at least hundreds or thousands of water molecules for much greater periods of time when in the presence of humic and fulvic acids – natural breakdown products of organic mater. Experientially, that water (also) has a much more viscous, soapy texture than water which is not bearing an organic load (and also interestingly, seems to make very good whiskey!)

More recently, the science of Gels has produced (amongst other more useful applications) weird squishy toys that feel remarkably life-like and that squelch without releasing any fluid.

1 Gerald H Pollack (2001) "Cells Gels and the Engines of Life" ISBN 0962689521

These strange materials may contain over 90% water, but the water is so closely bound to polymers with charged surfaces that is cannot flow in the way we normally expect water to behave. Instead of being a sponge that absorbs water and then can be squeezed to release the water, this ionic binding in a sponge-like matrix traps the water so effectively that in some cases it cannot even be removed by centrifugal force or exposure to salt/enormous osmotic potentials. The proteins and other molecules found in all lifeforms are remarkably good at binding to water in this way, and in fact, *it would seem as if their biological usefulness is defined by their ability to bind to water.*

When water is bound by a matrix that has a regular charge spacing (e.g. Actin) then the water itself takes on an ordered *quasi-crystalline* form. The exact form taken depends on the nature of the surface that it is bound to. If the surface is *hydrophobic* (i.e. like oil, it tends to repel water), then the water structures itself into a pentagonal relatively open crystalline lattice called a Calthrate[2]. If the surface is *hydrophilic* (the surface and the water are attracted to each other, as is the case for most molecules in living organisms), then the water molecules order themselves like a set of soldiers on parade, in uniform rows that are more densely packed than normal liquid water. The ordering of this water in rows is so uniform and capable of maintaining its molecular relationship in a range of conditions that the water is said to be *structured*. Also, the structuring of the water stores energy, which is then released when the water becomes de-structured. This de-structuring (return to a fluid state where the water molecules move freely under Brownian motion and are randomly distributed) releases/ discharges the stored energy. Thus, it seems as if almost every low-level function of cells - and possibly some larger scale physiological processes involving many cells in complex interactions – are initiated by a change of the bound water from structured to fluid phases. And one of the main initiators of this phase change is ATP, due to the very high charge density (12^{+}) associated with three quadrivalent Phosphorous cations (P^{4+}).

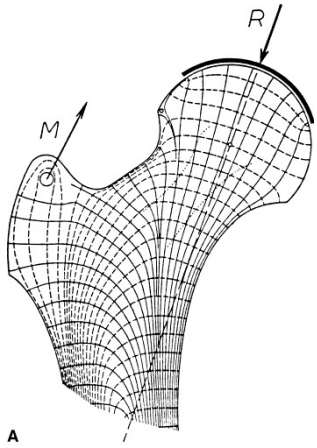
When this phase change takes place, the molecules alter their shape, often becoming less ordered or straight and more bent and curled; and the water bound to them is released. This dual effect results in a substantial shrinkage of the suddenly dehydrated molecule.

The other main thing to note (that we know so far!) about structured water is that it excludes everything that it can. In exactly in the same way that ice can freeze from seawater and refuse to retain the salt. Thus sea ice is pure rather than salty, and similarly, the ordered water pushes all ions and other debris such as proteins or micro-fragments of any kind away from itself towards the nearest surface. Therefore (a) the surfaces become densely packed with whatever was in the water, and (b) the water becomes very pure. Clearly this purification and separation process also has the potential to produce rhythmic changes and to create a cascade/chain reaction. It is possible to see this separating force in action by mixing dirt with water in a glass and then allowing it to settle. The result after a very short time is a film of very clear (pure) water on the surface, which becomes thicker (up to about 0.5 or occasionally 1mm) if the water is left still and the glass is in sunlight. This surface layer is six or so orders

2 These are most familiar (in the context of global warming) as submarine Calthrates, which bind methane on the sea floor at temperatures below about 4ºC, and which release the methane when warmed. e.g. http://www.realclimate.org/index.php/archives/2005/12/methane-hydrates-and-global-warming/

of magnitude thicker than can be accounted for by simple surface tension or the usual few hundred layers of water molecule that are expected by conventional models of water behaviour. Neither can it be accounted for by simple particle settling.

The cause is structured water, brought about by a hydrophilic surface (air) and an energy supply (photons). An air-water surface, although hydrophilic, is also relatively unstable due to evaporative processes. When water is exposed to a stable hydrophilic surface, Pollack has recently demonstrated that this structured "interface" can grow in laboratory conditions to be tens of centimetres in thickness when it has an energy source to facilitate structuring – and simple light photons are adequate to perform this task[3]. The main difference between this and structured water in a living cell is that hydrophilic surfaces are so close together in a cell that the "impurities" have nowhere to go except to attach to organic molecules. In our glass jar experiment, the dirt cannot evaporate and mix with air, so it is pushed towards the "other" boundary – the remainder of the water column.



With structuring, the water and its associated tissues take on unusual electrical properties. It may not be coincidental that bones are piezoluminescent[4], and emit sparks of light when loaded, just as the (piezoelectric) clamped quartz crystal in your digital watch emits small sparks of electricity – which is then harnessed as a timing device by the watch. In fact, piezoluminescence is a special case of the phenomenon of piezoelectricity. It is particularly relevant that the most common molecule in the human body – collagen – is also piezoelectrically active in response to physical forces – particularly shear forces, and will mineralise according to load direction within about 60 load cycles[5]. Taking bones as one example of how that might be useful, bone growth is accelerated in the presence of small electrical potentials, and this was one line of research by Becker and Marino[6,7] in the 1980's. If collagen emits electrical pulses when under shear and bone grows more quickly when subject to these impulses, then bone would naturally re-align itself according to its loading pattern to give the highest strength in areas of highest shear. This provides a very simple mechanism to explain Wolff lines[8].

3 http://www.youtube.com/watch?v=P5WYW1Lq5DE , http://www.youtube.com/watch?v=86MVE7rn3-w and http://www.youtube.com/watch?v=86MVE7rn3-w are all worth watching

4 http://en.wikipedia.org/wiki/Piezoelectricity#Materials

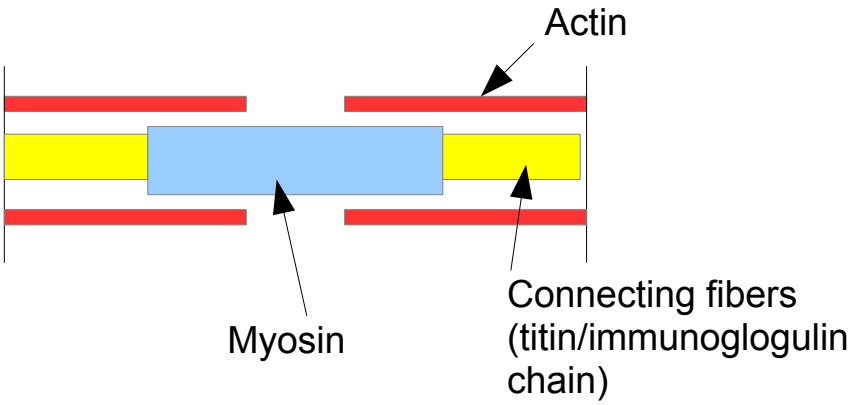
5 C.H. Turner (1998) Three rules for bone adaptation to mechanical stimuli. Bone 23(5), pp 399-407. The bone response to loading is actually very well described by the formula {total daily load stimulus} = {strain}.$N^{0.286}$, where N = number of loading cycles

6 Robert Becker & Gary Selden (1998) The Body Electric: Electromagnetism And The Foundation Of Life. Publ Harper Collins, 368 pages ISBN 0688069711

7 Robert O. Becker & Andrew A. Marino (2010) Electromagnetism and Life. Publ Cassandra, 216 pages ISBN 0981854907

8 http://en.wikipedia.org/wiki/Wolff's_law

2. Pollack's model of muscle action



The three contractile elements of a single sarcomere/muscle cell (after Pollack, 2001)

Viewing the sarcomere (muscle cell) from a gel perspective, Pollack *(op cit)* points out that each element of the cell is capable of contraction.

i. All three types of fibre : Actin (A), Myosin (M) and Titin (T) : contract when presented with a proton source or other stimulus that overrides their bond to structured water.

ii. In each case the contraction represents an increase in entropy (loss of structured order of both water and protein : i.e. loss of information) and therefore is a low energy state.

iii. Elongation/relaxation is a high energy state. This means that the muscle fibres are like small batteries, each waiting to discharge/contract. Thus, contractile motion is primary and dissipates energy, and relaxation/extension of the muscle requires energy in the form of ATP to re-charge the fibre ready for its next contraction.

iv. There is a cycle of Calcium (Ca^{++}) uptake (contraction) as water becomes unbound from the protein and thus enters the liquid phase; followed by ATP uptake (relaxation) as water once again becomes bound to the protein and becomes structured. If there is no ATP *re*-uptake, this causes a state of *rigor mortis*. This is also (!) the state of a chronically contracted muscle.

v. Connective tissue is *also* capable of contraction when Ca^{++} is absorbed. Actin is a form of connective tissue particularly responsive to phase changes of its bound water. So consideration of muscular action should not exclude the tendons or ligaments or periosteal material or even fluids in any part of the body that might influence motion. It certainly makes sense that connective tissue is contractile, simply because muscle fibre bundles are wrapped in connective tissue, and when the muscle shortens we have to somehow dispose of a lot of surface area of connective tissue.

vi. In a muscle bundle, the contraction and extension/relaxation can propagates through each molecular chain and may also propagate through a series cells.

This is all important not only for remedial work on muscles, but for dealing with the entire human organism. As pointed out on a TED talk by Daniel Wolpert[9], the entire central nervous system has developed with the primary intention of controlling motion. Motion is fundamental to being alive, and to being human – and the processes described above are at the pointy end of that expression of life.

3. Other implications

The three different parts of a muscle fibre clearly have different ranges of action both in terms of strength of pull and magnitude of motion; and since they have a different molecular structure, they also have different trigger conditions. These differences imply that the three strands also have different practical applications/uses/roles and may have different rates (and other qualities?) of propagation through a muscle bundle.

Myosin is the "workhorse" of these three fibres, producing the greatest contractile force. Three possible fibre types to trigger gives muscles up to 8 different combinations of fibre action (the "0" option is the relaxed state) :

0, A, M, T, AM, AT, TM, ATM

Thus there is the *possibility* for several different types of muscular action which would be initiated by different threshold conditions and would be used in different circumstances. One can subjectively compare the different *qualitative* movements such as (e.g.)

- the floating effortless muscle usage familiar in Qigong
- body-armouring reactions
- heavy load carrying or wrestling
- delicate work (e.g. repairing a watch)
- loving touch
- dance
- feverish shivering (vs shivering in intense cold vs fearful shivering)

and surmise that the activation of A,M,T may be different in each of these cases. I am particularly intrigued by the immunoglobulin (titin) connector fibres and their possible relationship to immune system reactivity (and therefore *also* to emotional state).

There may also be small differences in the proportion or molecular structure of each of these molecular types or modifier proteins that alter the behaviour of the muscles – e.g. cardiac, skeletal (1, 2a, 2b), and smooth muscle. The well documented adaptive malleability between types 2b and 2a with heavy exercise (thickening of the actin and myosin fibres, with possible changes in innervation and capillary density, myoglobin content and mitochondria density)

9 http://www.ted.com/talks/daniel_wolpert_the_real_reason_for_brains.html

reduces reaction time but increases physical strength.

It is generally considered that the muscles are fired by nerves, and obtain their power supply from blood. This simplistic arrangement needs to be re-considered. A structured Gel will change its phase with any type of signal that a) it recognises, and b) exceeds the action threshold for de-structuring/phase change. Nerve firing only one way in which this may occur.

The third fibre type (Titin) is particularly interesting in this regard because it is structurally composed of immunoglobulins. Thus, in addition to possible "normal" muscle behaviour it might be expected to participate specifically in immune system responses. However, all three will fire if there is a metabolic excess of Calcium or Phosphorous.

It is particularly striking that Pollack's description of muscle action is one in which the fully extended and relaxed muscle fibre contains the highest potential energy. It is almost as if by relaxing and extending the muscle is recharging its battery, just like a portable 12V power tool, and the battery contains most charge when the muscle is most elongated. This is reminiscent of Martial Arts training, in which the aim is to move with completely relaxed muscles that only tense up in short explosive bursts, and then return immediately to a state of relaxation and elongation. Another example of this applied by the pianist Lubomyr Melnyk[10] in his "kung fu" piano technique (up to 19 notes per second!) can bee seen and heard on the BBC website[11].

It is also relevant and accurate to think of the extended/ relaxed muscle fibre as being straight, ordered and hydrated, whereas the contracted protein is dehydrated, disordered and folded into itself... echoes of Rilke...

I want to unfold
I don't want to stay folded anywhere,
because where I am folded,
there I am a lie[12]

In terms of bodywork, the musculoskeletal system and its reaction to any kind of stimulus must necessarily be viewed completely differently if we are to take up Pollack's view of the interaction of structured water with hydrophilic protein, and the primacy of the phase-change of water in all cellular processes. Since he is one of the world experts on muscle fibre, it would be wise to consider the implications of his work :

10 http://www.lubomyr.com/
11 http://www.bbc.co.uk/news/entertainment-arts-16794606
12 Copied with permission from http://listeningtothebody.wordpress.com/

(a) ***Connective tissue may contract and lengthen in exactly the same way as muscle without the need for embedded muscle fibers***. Thus, we should not only be looking at muscles but also the entire connective tissue system.

(b) *There are three major components of muscle shortening (A,M,T) in which one or two may be triggered whilst the remainder remains elongated.* We can therefore have muscles in a semi-contracted state and still capable of almost their full range of action. And likewise, it may be possible that only partial triggering is possible, or that triggering does not activate all three of the sarcomere components.

(c) *Muscle triggering is usually via nerve impulse, but may also occur when any threshold is exceeded that results in a phase change around at least one of the three components.* Electric shocks, excess saturation of calcium or other ionic imbalances, or the kinetic energy of some types of physical impact are all capable of inducing or maintaining a water phase change [as may possibly be changes in emotional/mental state].[13]

(d) *Muscles contract and relax both locally (at a cellular level) and regionally by means of a reactive cascade in which water changes between ordered (semi-crystalline) and disordered states.* This implies that the electrical/electronic properties of tissue also change – which may be something of a two-way street in terms of how the tissue responds to and influences the body globally. **There is also a principle that the most basic movements that can be made are rhythmic.**

(e) ***Contracted muscle is muscle that is de-energised, whilst elongated soft muscle is fully charged and ready for action.*** Thus, somehow, the process of softening muscles is also a process of re-energising them by altering conditions such that ATP can return to the muscle fibres and replace Calcium ions. This may require physical mobilisation of the muscle and its fluid water, or a change in local/global ionic balance/ concentration or a change in the activation state of the local nerves – or something else.

Lengths, Areas and volumes

One aspect of muscles is that the bundles are wrapped in connective tissue. When a muscle contracts, it becomes shorter and fatter, and geometrically this must be accompanied by a substantial reduction in surface area of the muscle bundle. The surrounding pockets/sleeves of connective tissue must therefore also be capable of changing their surface area – otherwise they would throw loose rucks and creases when the muscle contracts. We have already noted that Pollack states connective tissue will also contract (but is not as efficient as muscle in either distance or strength of action), and so one of the first implications to consider is that

13 A change in ionic composition (in this case, probably a sodium concentration threshold) as a means to activate a connective tissue gel is very well demonstrated by the anti-shark defence of the hagfish – see http://www.bbc.co.uk/news/magazine-21954779. If bitten, the primitive fish releases a collagenous material from its wound that reacts with seawater (i.e. Na) and forms a thick slimy gel.

perimuscular connective tissue sleeves must (ideally) contract simultaneously with the muscle such that the connective tissue continues to retain the muscle fibers in a closely contained bundle. If they were not so supported laterally, the individual muscle fibers would be far weaker. A second, intriguing corollary is that, over and above its role in simply containing the muscle bundles, the external connective tissue may itself exert part of the muscular effort. This in turn implies that a fully relaxed muscle may not be truly relaxed, but there is some kind of balance in which the surrounding connective tissue maintains a small amount of tension, and the muscle fibers exert a small lengthening force. The possibility that muscles *are capable of* exerting a lengthening (as well as a contractile) force is supported by embodied experience during the practices of Yoga and Qigong. This *pre-loaded* state would not be unique in the body, and is analogous to the over-pressure found in the nucleus of an intevertebral disc.

There are also similar questions in the same around the way that individual muscle fibers can fire and their neighbours not fire. How does a shortened fiber lie against neighbours that are still at their full length?

Myoglobin and the conventional model of muscle function

The conventional wisdom regarding muscles is that slow action muscles are red because they contain Myoglobin, which acts as a store of oxygen and therefore prevents the fibers from fatiguing. Looked at from the point of view of relaxed muscles being like a battery, this interpretation needs to be re-considered. In fact, no matter how much myoglobin is available, it will have very little effect on the long-term strength or fatigue resistance of muscles – its storage capacity is necessarily limited – in effect, it is another battery, or a pre-charger of some kind. Considering that slow-twitch (and intermediate-twitch) muscles have a dense capillary bed, surely the capillary bed itself is capable of providing oxygen? The answer may lie in peak oxygen demand compared to average oxygen demand when muscles are being worked. If the capillaries can supply average (time-averaged over several seconds) oxygen demand, then when muscles are being recharged there will be an oxygen deficit, and so myoglobin allows faster recharging, and as the muscles are used, the myoglobin recharges itself from hemoglobin. Blood speeds in dense capillaries are approximately 0.7mm/sec, so there is a limit, based on cell size and proportion of cells to capillary volume) on how much oxygen can be delivered per second.

There is no point in having high in fast-twitch muscle, because there is insufficient blood capilliary supply, and the myoglobin would not give any appreciable advantage. This situation is different in sea mammals, who have adapted their myoglobin so that it is not sticky, by altering the molecule to make it positively charged. Therefore, more myoglobin can be retained in the muscles, because the charge prevents the myoglobin from clogging the muscle. This allows sufficient myoglobin content to allow tens of minutes of activity without breathing. Note again, it is the surface charge that gives the molecule functionality – a common theme in Pollack's new model of hydrated tissue.

An additional possibility is that myoglobin provides a burst of oxygen to allow the initial relaxation of the muscle – assuming that muscle contraction may compress capillaries and some areas of muscle may therefore have a marginal blood supply when contracted. In this case, the myoglobin would be an inbuilt supply of oxygen so as to allow muscles to release sufficiently to a point that capillary infusion is sufficient to complete the process. We are here starting to possibly approach a rationale for fibromyalgia. Since chronically tight muscle usually feels "stringy", this may point to a difference between the propensity of slow and fast twitch fibers to go into pathological rigor.

We therefore have a slightly extended and altered list of the possible *physical* reasons for fibromyalgia :

- excess nerve signalling
- (as a specific case of the above) incorrect stretch receptor feedback
- some other physicochemical origin of the Ca^{++} pulse produced by the action potential
- loss of local blood capillary flow
- (as an extension of the above) loss of myoglobin oxygen and compression of the local capillary bed.
- some alteration (restriction) of lymphatic flow which produces one or more of the above
- some alteration in connective tissue function which produces one or more of the above
- an incongruity between connective tissue and muscle tension

Bioelectronics

It must also be pointed out that structured water is literally a liquid crystal, and since it exists in an electrically active environment (the body) it has the potential to act electronically. It has been demonstrated that biological tissues have all necessary components (resistivity, capacitance and inductance) to create effective electrical/electronic circuits. Here, Pollack has provided a handle onto yet another field of "alternative" medicine that has been a hard nut to crack in terms of reconciling physical processes with known tissue properties. This particular topic – health and structured water – has been a particular target of sceptical dissent and of various pseuoscientific descriptions of biology, most of which have unfortunately been directed at selling health products. *(Adding this history of "health products" to the institutional witch-hunts that had followed the cold fusion debate[14], Pollack was originally warned that he could study "anything except water".)* The presence of almost universal electronically active crystal structures in the body opens up another potential layer of communication. This has already been identified by several very different authors. James

14 http://en.wikipedia.org/wiki/Cold_fusion

Fulton[15] has several patents based on the fact that the structure of synapses is physically (in terms of electrical properties and physical arrangement of semiconductor materials) exactly the same as that of a pixel on the LCD screen that you are probably looking at every time you use a computer. He estimates a communication transfer rate of about 250kHz for this kind of biological transistor, *some 100 times the usual signalling rate attributed to neurons based on neurotransmitter diffusion[16] rates*. The progress of these packets of signal (action potentials) that emanate from a synapse could be likened far more to the pulses of water produced by a peristaltic pump[17] than the random fringe attributable to diffusion processes. Valerie Hunt[18] also came up with a signalling rate of 250-300kHz when she analysed EMG signals by assuming that the "noise" usually filtered out is actually important information. Hunt considered that this electronic communication (which is transmitted as a kind of radio wave/field both through and around the body, and is not constrained to transmission along physical structures) integrates body function and is particularly related to mental/emotional activity. She found that there was a direct correlation between certain EMG frequency range patterns and the colours seen by accurate medical psychics.

It could also be guessed that many of the electronic healing devices including Radionics detect something of these "EMG" frequencies. A third, recent development in this field is by an Egyptian doctor, who has developed a device that detects Hepatitis C[19]. Although there is as yet no recognised physical mechanism to explain it, Dr Gamal Shiha's device has been tested empirically by doctors in clinics around the world and found to be very accurate. Here we have a rather odd distinction between practitioners of modern medicine and a more traditional pre-20th century perspective. Before the modern skeptical rationalist was able to emerge due to the successes of predictive physics, science observed phenomena and accepted them, and *then* (post-facto) attempted to explain "why". The idea that a visible process could be discredited and ignored because "it has no plausible mechanism" is a very modern distortion of science.

Now we have statements such as

> *"It's not a miracle. It works," said Prof Massimo Pinzani, chair of hepatology at University College London's institute for liver and digestive health.*

15 http://neuronresearch.net/vision/

16 In fact, Pollack has quite strongly suggested that healthy cells in real tissue (as opposed to cells sitting in a laboratory Petri dish) rarely if ever use diffusion as a transport mechanism, but rather transfer packets of protein and proteins/cations through structured water by generating a cascade of de-structuring / restructuring. One rather unfortunate implication of Pollack's work is that any experiments with water (e.g. in geological, hydraulic, meteorological, hydrological and biological sciences) or with living tissue in water (e.g. most in vitro laboratory experiments) are probably invalid unless the water was in the same state (either liquid or 4th state/quasi-crystalline) that it would normally be in under similar circumstances in the real world. There are other more difficult implications – in that it is not so easy to discern the difference between health and disease if the main difference between these two states is defined by the structure of water (and the consequent degree of openness/collapse) of the surrounding proteins. There would be very little discernable chemical difference other than a change in ionic balance between each cell interface and its surrounding fluids.

17 http://www.liquid-dynamics.com/animations/pumps/Dampener-match-Hose-pump.html

18 http://valerievhunt.com/ValerieVHunt.com/Valerie_Hunt_EdD.html

19 http://www.guardian.co.uk/science/2013/feb/25/scientists-divided-device-hepatitis-c

> *Pinzani witnessed a prototype of the device in Egypt earlier this month, and now hopes to trial it at London's Royal Free hospital. He said that if the scientific basis for the concept could be proved, it was potentially a "revolution in medicine". Pinzani added that before being accepted the technology needs to be validated and endorsed by an independent panel of experts, and that he would be available to participate in the study once the validity of the technology was established. ...*
>
> *In a comparable case in 2009, the Nobel winner Luc Montagnier – the man who discovered HIV – also claimed that DNA molecules emitted electromagnetic waves[20]. But his research was ridiculed by fellow scientists as "pathological science", and seen as an apology for homeopathy.*

In other words he is saying that he wouldn't be able to sustain a credible professional face if he used something for which there was no currently known explanation. For the sake of people suffering from Hepatitis C, one would hope that sense will prevail and modern science will admit that it is possible for something to work even if they have no consensus explanation as to why it works.

This apparent conflict between chemical/neurotransmitter-based neurology and electronic signalling is not an "either/or" situation. Rather the so-called "EMG" activity is a communication system that works *in parallel to* normal nerve signalling. It may also represent the total activity *at* neural synapses (as predicted/demonstrated by Fulton's LCD analogy) whilst signalling *through and along* nerves would take place by means of axoplasmic flow, according to Pollack's model. Thus, there are at least three different layers of communication in the body with transmission speed differences of several orders of magnitude between each :

Electronic signalling	250,000+ bps
Nerve synapses	~3000 bps
Peptides, hormones etc. (via blood flow)	Up to several seconds

Let us assume that physical health is related to its ability to maintain integrative communication channels of all kinds as open as possible; and that on an electronic level the body needs water to be structured so that signals will propagate and be received. It then follows that the body's ability to maintain structured water over as large a volume of its cells and other tissues as possible becomes an important requirement – *in addition* to its importance in maintaining proper cell function on a local level. This hypothesis leads to several further interesting insights.

One is that use of muscle creates transient areas of de-structured water in muscles that have fired but have not yet re-energised/relaxed. If we assume that the reception of Hunt's electronic level of signalling requires structured water, then muscle/tissue contraction (i)

20 http://www.homeopathyeurope.org/media/news/MontagnierElectromadneticSignals.pdf

changes the total body signalling network and (ii) temporarily disconnects those muscles/ tissues from that level of the communication system (though they are, of course, still connected by neurons and through capillaries to the chemical blood communication network). This arrangement will be immediately recognisable to anyone who has dealt with embodied "tissue memory", where re-lengthening and softening of muscle tissue (or of connective tissue, particularly joints) causes memories to surface of events and emotions relevant to the initial tissue contraction.

The change in whole-body signalling is itself a huge subject, and brings us into the territory of Mudras, symbolic meanings of various body postures, positional memories, and the relationship between available (and non-available) dynamic ranges of posture/movement and personality. Small alterations in muscle tone in one area of the body could initiate substantial changes in physical and physiological states elsewhere and whole-body (or regional) emotional and mental states. Particular postures or actions might make specific mental and emotional states more or less easy to access. Etcetera.

Again, all of the above is highly familiar ground to any Yoga practitioner or bodywork/ movement therapist. The availability of a *potentially* demonstrable mechanism for all these phenomena *that obeys known physical laws rather than invoking an unidentified energy* should increase interest in this wide field of potential, not least because we have a way of describing *one aspect of* the *physical processes* underlying the two-way interaction between mind and body. I feel the need to be cautious here only in that – this (i.e. water structure) is probably not the only physical process. The topic is discussed from a different perspective in the essay *Nerves and the embryological fluid force*[21]. This is not to say that things do not happen on a non-physical level in humans, but at some point even metaphysical processes have to step down to a physical level in order to manifest. Whichever way you care to look at it, the Gel model of cellular function either obviates the need for "energy" to explain a lot of strange but important mind-body phenomenology, or in addition to its inherent physical processes, it provides a possible means by which non-physical processes affect the physical (biological) world.

Partial firing

The idea that muscles can fire partially is well supported by the experience of living in a body and practising bodywork. If I enter a loving/grateful/appreciative state, then regardless of how relaxed I was feeling prior to this, an immediate feeling of warmth and softness flows through my body. If I generate an angry state, then the sensation is that muscles have become harder (literally as armouring) is a very clear experience – and at the same time it is also clear that those muscles are still capable of motion, indicating that somehow the muscles have tensed partially. When I have considered this phenomenon previously, the most simple physical explanation has been that only some muscles fibres tighten, allowing the remainder to still be used for motion. However, this concocted explanation is not well supported by the

21 Nerves and the embryological fluid force, Cook 2013, http://www.hummingbird-one.co.uk/pdf/MTubes.pdf

neurology. But the experience is very well described by Pollacks triune sarcomere if just one of the protein types were taking part in armouring whilst the other two remain to perform normal motion. If I were a gambling man, I would say that the titin/immunoglobulin is the most likely of the three possible muscle protein types to be involved in any armouring/ defence response.

Experientially the volume of muscle engaged in armouring has also lost some of its sensitivity – there is a mild numbness that accompanies the increased feeling of strength/solidity. The practicality of this is very logical. The discharged muscle fibres no longer take up ATP, thus freeing up more ATP for the other fibres, whilst not substantially decreasing either strength or movement capabilities. The numbness is useful for any tissue that is going to be pummelled and bitten; and this simply comes about by virtue of the muscle no longer taking part in the electronic communication band. The muscles meanwhile are perfectly well connected on a blood and synapse level, and so remain fully functional for all intents and purposes. The loss of sensitivity is so small on the grand scale of things that it could even become familiar and be part of the normal background sensory experience in a very short timeframe.

However, the effects of such an arrangement becoming chronic (instead of being a short-term expedient measure) are not so good. The entire organism is now less efficient in its ability to communicate internally on one level. The affected muscles in particular cannot be stimulated by this level of communication and so the question then arises – how do we bring them back into the fold? There must be some non-electronic level of communication at which this can be initiated, and some signal which is recognisable. Until that signal is received, although we can move, that motion is restricted in both strength and range. Furthermore, the increased muscle tone reduces flexibility of that part of the body, thereby reducing the ability of functional muscle to maintain local movement. And this is important because it is by moving gross muscles that some parts of the physiology (e.g. lymphatic circulation) maintain their functionality. If the Myosin and Actin also take part in this chronic contraction, then the numbness increases (at least initially) and there is even less high level communication.

Tremor

We now look at the subject of normal muscle contractility patterns and the interface of the nervous system. It has been known for some time that muscles complete all types of motion by using a primitive form of movement – the *Physiological Tremor*.[22,23] The tremor occurs at a frequency of about 8 to 12 cycles/sec, which is an interesting number, since it is also the frequency of Alpha Waves[24]. One question that arises is – does this tremor originate in the

22 OCJ. Lippold (1970) Oscillation in the stretch reflex arc and the origin of the rhythmical, 8-i2 c/s component of physiological tremor. J. Physiol. 206,pp359-382

23 OCJ Lippold (1971) Physiological tremor. Scientific American 224(3):65-73, PMID 5546818

24 *"Alpha waves are neural oscillations in the frequency range of 8–12 Hz arising from synchronous and coherent (in phase/constructive) electrical activity of thalamic pacemaker cells in humans. They are also called Berger's wave in memory of the founder of EEG."* quoted from http://en.wikipedia.org/wiki/Alpha_wave

nervous system, the muscle fibres themselves... or both? Recent papers[25,26] and review[27] give the following picture:

Firstly, it is important to distinguish between different types of tremor, though we will eventually bring them back together into a common framework. Also, although I use the word "muscle", the implication is that connective tissue also takes an active part in contractile cycles.

Physiological Tremor (PT, also termed Kinetic Tremor when its amplitude is large) was first described by Lippold *(op cit)* and is a very low level background tremor that (apparently) occurs in all people during muscle contraction and is thought to occur during normal activity of nerves/muscles. Quoting from his original paper :

> *We have found in examining a large number of normal human subjects that <u>most</u>* {my emphasis} *of them have some tremor superimposed on their muscular activity. The amplitude of the tremor usually does not exceed 2 percent of the physiological range of movement...*
>
> *One ingenious and plausible idea imagines the muscle to be acting as a low-pass filter that screens out all impulses except those at about 10 cycles per second. We know that during a voluntary contraction motor units composed of functionally identical muscle fibres start discharging at about seven cycles per second and then accelerate up to 30 or 40 cycles per second as the strength of the contraction increases.*

Essential Tremor (ET)[28] was first described medically in 1817 by James Parkinson, and although similar to Parkinson's disease, it is not the same – i.e. it is not caused by an *organic* lack of dopamine. It does not occur when resting or relaxed – only when voluntary movement is occurring; it is bilateral and affects mainly the hands; and generally increases in both incidence and severity with old age and social anxiety (though it can start at any age). The indication is that it is probably *in many cases* a physical expression of non-conscious fears, which become exacerbated in a feedback loop as the shaking interferes with normal social interactions. In fact, the general presentation is remarkably similar to the uncompleted processes first described by Pierre Janet. ET is particularly characterised by abnormal high amplitude bursts of EMG activity (active use of muscles does not induce these bursts) with a frequency of between 4 and 12 Hz. Both burst frequency and phase may be different for different muscles. On the other hand, Parkinson's disease is characterised by a *continuous* high amplitude EMG burst pattern with a frequency of about 4 - 5Hz.

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25 Martin Lakie, Carlijn A. Vernooij, Timothy M. Osborne, & Raymond F. Reynolds (2012) The resonant component of human physiological hand tremor is altered by slow voluntary movements J Physiol May 15, 590(10) 2471-2483

26 Constantinos N. Christakos, Nikos A. Papadimitriou & Sophia Erimaki (2012) Parallel Neuronal Mechanisms Underlying Physiological Force Tremor in Steady Muscle Contractions of Humans. J Neurophysiol 95 pp53-66 doi: 10.1152/jn.00051.2005

27 Rob R Herbert (2012) Shaking when stirred: mechanisms of physiological tremor. J Physiol 590(Pt 11):2549 June 1st, PMID 22787166

28 Mark Plumb & Peter Bain (2006) Essential Tremor: The Facts. OUP, 176 pages ISBN 0199211272

Postural Tremor (also called Action Tremor) occurs when a fixed stress position (i.e. with a relatively high gravity load) is taken up and then retained. Eventually the muscles begin to shake with relatively low amplitude EMG bursts at 5 - 9Hz. The physical amplitude may be anything from very small through to whole-body shaking.

Hypothermal shivering, initiated centrally by the hypothalamus is another important form of tremor, in which the metabolic cycle of the muscles is unleashed with no organised central control to direct their force. Shiver frequency is typically 5-10Hz, and varies from muscle to muscle, with shivering becoming more strong in bursts of a few seconds. Muscles no longer function when core body temperature falls below 34ºC[29], so this kind of shaking is a last ditch attempt by the body to keep muscle function available. Without movement there are no choices that can be made to ensure survival. The body is also capable of temporarily resetting its core temperature baseline in cases of infection (and possibly shock) so as to induce a *quasi*-hypothermal shiver (*rigor*). Perhaps as a result, we have no innate ability to know our core temperature (although as far as I know, the only bodily senses capable of calibrating to an absolute value are the external senses of touch and vibration – which group includes the auditory and balance senses – and the magnetic sense).

There are also various other tremors associated with major problems with the CNS (e.g. Cerebellar tumours, hydrocephalus/MS, Lithium and heavy metal poisoning) and drug/alcohol withdrawal or major nutritional deficiencies. Shock of various kinds (post-anaesthetic shivering, intense pain, internal bleeding, fluid loss or other major disturbance of the viscera) and ADHD can also be associated with tremor, as can any temporary Adrenaline excess. Visceral or infection-induced shaking is termed c*hills* or r*igor*.

All studies of PT have found that – although gross muscle activity is directed from the brain - the tremor is a purely local phenomenon with feedback between muscle and local reflexes. i.e. there is a resonance between the mechanical properties of the muscle and the local reflex arc. It could be said generally that visible (high amplitude) tremors and gross tremors associated with EMG bursts and/or frequencies that fall below the normal *approx* 10Hz[30] range are caused by (first) a loss of central control, followed by a degradation of the resonant connection between reflex arc and muscle and between different muscles. Thus, part of this tremor does not arise from any neurological signal, but rather is a physical process in the muscle which includes factors such as muscle elasticity and ATP/Calcium cycling rate. The similarity to cardiac muscle is immediately obvious, and it would seem that cardiac muscle acts exactly the same as ordinary muscle, but at a higher amplitude and with (even) less need for external stimulus. And, just as with cardiac muscle, nerve action potentials are capable of modulating the frequency of other types of muscle contraction to some limited degree around a physiological baseline frequency.

This background frequency has usually been considered to be some kind of "hunting" phenomenon familiar in control systems, where the feedback mechanism is inefficient – and

29 http://www.sld.cu/galerias/pdf/sitios/rehabilitacion-fis/cold_stress_and_hypothermia.pdf

30 It should be noted that the range of frequency covers a scale approximately 0.3 to 30 Hz – so this is not a rigid system, though the peak at 10Hz is very strong and universal between human subjects and human muscles.

therefore slightly overshoots the ideal required level of damping/stimulus. Given several hundred million years of evolution and the extraordinary efficiency and adaptability of body physiology, I am a little doubtful of this explanation. In fact, the neurology appears to show that a complex or sustained movement is the result of a series of rhythmic pulsatile movements that have been added together. So the basic type of motion available to the body is a short transient contraction (PT), and whilst this has remained its physiological basis for motion, Nature has found ways to modify this to produce an almost infinite range of different movements.

The role of dopamine in controlling muscle tremor is well known due to its association with Parkinson's disease and the production of dopamine (or lack of it) from the Substantia Nigra. Without the regulatory action of dopamine, the amplitude of tremors becomes excessive due to the high amplitude relatively low frequency bursts that are produced by the motor cortex. Although this may not tell us a lot about the causes of Parkinsons disease, it may give some indication as to the relationship between dopamine (which is produced when we experience "positive" feedback for our actions – a reward mechanism) and the general firing/use of muscles. It would make a small amount of sense that a no-reward (low dopamine) environment might induce a preference for random movements. On the other hand, high dopamine tends to be associated with curious exploratory outgoing behaviour, whereas low dopamine tends to be associated with its opposite, which is more or less categorised as anxiety. This is quite clearly visible in healthy/happy dog behaviour (compared to the behaviour of dogs who have been badly treated). Thus, dopamine is a neurotransmitter that mediates between activity (movement) and the type of relationship that is being experienced with the outside world, modulating the type of behaviour (peaceful vs anxious) that is used to express moderate to high levels of adrenaline. The ability of dopamine to increase the smoothness of movements is visible even in normal human body language (as well as that of animals).

Resonance

The physics of resonant systems was applied to analyse muscle tremor in a recent study[31], and some interesting results emerged. It would seem that the most efficient muscle usage possible involves continuous resonant interaction between agonist and antagonist, such that the mechanical-elastic properties of the muscle are fully used. This means that in most efficient usage/movement, there is a continuous vibration occurring between muscles, and remarkably little difference between physical force exerted by either agonist or antagonist. The optimal vibrational rate is slightly higher than the dynamic load frequency, so – if the muscles are to attain this efficiency - they require modulation via some external stimulus which is able to use proprioceptive feedback - which is a pretty good description of how the neuromuscular system works. This load-frequency relationship was picked up by Lippold (see previous quotation from his Scientific American paper). As the load becomes heavier and the

31 Farahat WA, Herr HM (2010) Optimal Workloop Energetics of Muscle-Actuated Systems: An Impedance Matching View. PLoS Comput Biol 6(6): e1000795. doi:10.1371/journal.pcbi.1000795

movement less dynamic, this type of efficiency becomes less attainable. If an optimum efficiency is attained, then calculations indicate that the *muscle agonist/antagonist group* can provide a force of *up to seven times* the force that can be applied by a static muscle contraction. Having worked in heavy industry for some time and moved some very heavy loads "by hand", I can personally say that anything is easier to move when a dynamic movement is applied rather than a static lift or push. I had always attributed this to simple momentum, but maybe there was more happening than I was aware of.

Again, I am also reminded of the smooth and effortless floating motion that occurs in Qigong and Taiji. Attaining these muscle efficiencies requires good connection to the CNS (afferent proprioceptor information and efferent action potentials to provide a resonant timing signal), an uninterrupted ATP/Ca cycle (i.e. a plentiful energy supply – although of course, less energy is needed when a high efficiency resonance is attained!), and a well tuned local resonance between muscle and spinal reflex. Looking at the muscle fibre proteins, the most efficient and likely candidate for this kind of muscle usage is the Actin fibre cage; and I guess there must be some relationship between propagation speed/frequency of the structure/de-structuring wavefront (both in single muscle fibres and in muscle bundles) and the action potential timing signal.

Moving laterally from this, we have already noted that the entire function of the CNS could be said to revolve around movement. There is an interesting study available online[32], looking at the ability of the human brain to take in new information of *any* kind. It would seem that we are incapable if assimilating information at a rate faster than 10 bits per second (10 Hz). Since all information is processed by the premotor cortex in order to ascertain meaning (and all meaning for the primitive brain is symbolically represented by movement), it could be that there is something quite fundamental about a ~10Hz "refresh rate" for many different parts of the human organism. For example, the peripheral nerve conduction speed is about 30m/s, so this gives a small but adequate margin for signalling through a 2m long body at a rate of 10Hz and is just about fast enough to allow consecutive two-way signalling at that frequency.

Another aspect of muscle resonance is to be found in evolutionary biology. Initially, at a primitive level of organisation, movement was rhythmic and undifferentiated. This may be seen today in the pulsatile motion of flagellae and the swimming actions of the simplest of sea creatures. No nervous system is necessary – all that is required is that the action threshold (for phase change of bound water around the "muscle" protein) is exceeded. And in the simplest of organisms, that protein is Actin. So without a nervous system, the frequency of motion is unmodulated, has a limited set of choices (if any) as to when it is turned on/off, and is largely controlled by propagation of the ATP/Ca exchange cycle and its associated phase change front through the contractile tissue. As organisms become more complex and gain a functional (central) nervous system and symmetrical structure – say a primitive (chordate/vertebrate) fish – then this simplicity is enhanced slightly by the ability of the fish to rhythmically contract alternating sides. Here we have the classical lateral fish muscle groups coming into action, with very little initial need for anything complex.

32 http://www.humanbottleneck.co.uk/

Sophistication first comes about through tuning the muscle rhythmicity to the hydrodynamics of the animal (via the kind of proprioceptor-pulsed modulation feedback loop described above) and by propagating the wave of contraction/relaxation down each side (rather than just contracting alternate entire lateral muscle groups), producing a sinuous snake-like (or of you will, fish-like) motion. Thus, rhythmicity is not only inherent in the way that individual muscle fibres work, or even muscle bundles or agonist/antagonist pairs. Rather – rhythmic motion is hardwired into the entire neuromuscular system, and rhythmic motion not only connects us to this ancestral form of motion, but also uses the most primitive and fundamental parts of the neuromuscular system – probably in the most efficient way.

As we add fins, the movements remain rhythmic, but now gain some complexity, with figure of eight movements and small changes in "static" position becoming possible. Adapting musculature to these movement patterns results in the whole-body slings (lateral line, front, back) and functional spirals described by Myers[33], along with many spiral muscle groups and joint surfaces. And so on. As the movements become more sophisticated and less obviously rhythmical, then there is a greater and greater need for proprioceptive and other sensory feedback loops to be engaged as the muscles are used, relating the muscle firing and joint position to the intended motion and also checking that an appropriate level of force is being applied. This feedback system has been recently explored in a simple tactile experiment[34]. The results indicate that movement and the sensory system are very deeply connected. Another example may be found in the primitive "speech" of the Gelada monkey, which makes a kind of transitional sound between primate screeching and human speech – here again we see the less sophisticated version being far more similar to a simple rhythmic muscle action[35].

Taking the principle of tremor into a broader context...[36]

> *We frequently shake when we are cold, anxious, angry or fearful. We may also tremble when in love or at the climax of orgasm. Patients sometimes tremble uncontrollably, in cold shivers, as they awake from anaesthesia. Wild animals often tremble when they are stressed or confined. Shaking or trembling reactions are also reported during the practices of traditional healing and spiritual pathways of the East. In Qigong and Kundalini Yoga, for example, adepts who employ subtle movement, breathing and meditation techniques may experience ecstatic and blissful states accompanied by shaking and trembling.*
>
> *All of these "tremblings" experienced in diverse circumstances, and having a multiplicity of other functions, hold the potential for catalysing authentic transformation, deep healing and awe. Although the fearful trembling of*

33 Thomas W. Myers (2008) Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists. Publisher: Churchill Livingstone; 2nd Revised edition. 440 pages ISBN 044310283X

34 Kerry Grens, February 1, 2013, Human Whiskers : Scientists probe our sense of touch for a feedback loop between sensation and motion. The Scientist. http://www.the-scientist.com/?articles.view/articleNo/34161/title/Human-Whiskers/

35 http://www.bbc.co.uk/news/science-environment-22067192

36 Pete Levine (2010) In an Unspoken Voice: How the Body Releases Trauma and Restores Good. Publ. North Atlantic Books ISBN 1556439431

anxiety does not in itself ensure a resetting and return to equilibrium, it can hold its own solution when guided and experienced "in the right way". The distinguished Jungian analyst Marie-Louise von Franz notes : "The divine core of the soul, the self, is activated in cases of extreme danger". And in the Bible it is said that "God is found where you have trembled".

Tremor does have other physiological functions, though it is not necessarily constrained to this ~10Hz window. Ocular Microtremor (approx 80Hz in humans) is one way that the eye scans the field of vision. This provides a means to assess temporal change[37], and may be important in trajectory tracking. Similarly, one could consider peristalsis and the cardiac pulse to be very slow forms of tremor. They all exhibit the utility of a hardwired rhythmicity which may then be modulated by more sophisticated (and evolutionarily more recent) feedback and control mechanisms.

Too much of a good thing?

It could at first glance appear that structured water is the answer to life, the universe and everything. Pollack has recently found that anaesthetics tend to reduce the ability of water to structure, and so reduce the ability of nerve synapses to fire. And aspirin appears to increase the ability of the connective tissue to structure water. Similarly, calculations indicate that the heart is physically incapable of powering blood flow through the capillary bed by a factor of about 10^6. So the likelihood is that some local process – probably related to structured water (analogous to the way that muscles have been shown to move) – is responsible for transporting erythrocytes through capillary tubes that are nominally far too small to permit their entry or movement. The suggestion is that a very tight contact with the capillary wall is necessary. On perhaps a similar theme, it has been demonstrated that a healthy sinovial joint can *never* compresss so far that the cartilage surfaces meet – and this is another mechanical property of charged (what Polack calls Exclusion Zone or EZ) water.

My instinct (which may be incorrect) is that the body cannot possibly function if *all* of its water is structured. There has to be liquid water so that fluid-based transport is possible in larger vessels and so that there is lubrication between sheets of connective tissue and different structures. For instance, cerebrospinal fluid *must* be fluid for a substantial fraction of its (apparent) volume so that the brain can float in it and so that its surfaces (especially the spinal cord) move feely against their connective tissue neighbours such as the falx and dura. In the case of the limbs, connective tissue must also form a surface of ease of movement. However, dissection of a freshly killed animal (as opposed to a preserved cadaver) indicates that whilst some muscles are more or less in a slab, and connective tissue is firmly adhered to all surrounding structures, there are other parts (such as the cavities medial to the limb insertions) which provide a very clearly defined sliding surface. Where these open areas are exposed to air, they first are slippery, but soon become like glue, and any other organic matter (soil,

37 http://neuronresearch.net/vision/themes.htm#premises

grass, fingers) refuses to be separated from them. Pollack ascribes this to the evaporation of protons. Thus, adhesions are attributable to disruption of local charge fields (and their associated pH states) in the fluids and tissue. Therefore it is purely electrical charge (specifically, the surplus and deficit of protons) that define external cells (skin, lung alveoli, mouth, digestive tract, urethra, vagina, etc) which must never adhere – and which distinguishes them from cell-cell boundaries that must adhere. Some structures have to alter their capacity to adhere in very specific ways – e.g. the midline fascia of the abdominal muscles separates during pregnancy, and then re-attaches in the few weeks or months post-partum, so the body is capable of changing its internal polarised charge state in some circumstances.

In hindsight (having read Pollack's books), although we talk about fluids in the body - when I have butchered freshly killed deer, pheasants and rabbits for the pot I have never seen liquid water emerge. Even the blood that comes out is highly viscous, and CSF that is capable of flowing (in the usual way that we experience flow) is a tiny dribble. The only exception to this was on the one occasion I picked up a road kill deer and it turned out to be pregnant – the amniotic fluid was nevertheless highly viscous, almost like strongly sugared water in texture. So it may be that we have to reassess our ideas as to what body fluids are and how they move.

Going backwards for a short diversion, the connective tissue that is firmly anchored to muscle and lies within a large volume of muscle must change its length as the muscle changes length... To some extent this may be accommodated by changes in muscle volume as it contracts, but it is likely(?) that the enveloping tissue and regionally connecting fascial sheets (Myers 2008, *op cit*) also contract with their corresponding muscles in one continuous motion.

Pollack has demonstrated that photons are capable of inducing order in water if at least one surface of the water is adjacent to a hydrophilic surface. This structured fringe only extends if the water is relatively undisturbed, and it is particularly important that blood pulsatility continues to disturb the free liquid water in the body so that a structured water layer cannot build up to include a relatively large volume of tissue. It may be that the “pins and needles” sensation that marks the transition between numbness and normal circulation is caused by this re-liquefaction of interstitial and capillary fluids?

Soft or Firm?

It would (also) be nice to be able to measure the pliability of a muscle and determine how relaxed or tense it is – however, as any body therapist can tell you from experience of palpation, that is not the case. “Well toned” muscle is fairly firm as well as having a soft texture, and this would be the state expected where there is no spare water in the muscle, and most of the water present is in an ordered state (rather than fluid). In this case, the limb would feel to an external observer slightly heavy for its size (dense), and the owner of the muscle would feel a relative effortless in moving the limb. This can especially be seen in people whose physique is particularly “wiry” or lean. Whereas if somebody does not have

that particular metabolism, relaxed would also equal soft due to the additional (spare) water content.

Use of a fully relaxed muscle is very much dependent on intention, and it must be said that most people do not usually engage with their muscles in quite so aware a manner that they can invoke different types of motion. It is an interesting exercise to lift an arm slowly whilst deliberately intending the motion (and all muscle movements) to be elongating rather than forceful.

To summarise...

A few of the practical conclusions that may be drawn from the above hypothesising and discussion,

- Rhythmic motion is inherently more beneficial to the body, more emotionally stabilising and more capable of regenerating any damage to physical tissue or nerves. This arises from the fundamental importance of rhythm/resonance in the everyday functioning of all parts of the neuromuscular system and the evolutionary inheritance we are walking round with.
- Most importantly, it is the *quality* of motion that is important rather than just motion – because there are several different ways to use muscles, and these different modes of operation of the sarcomere have different symbolic meaning in the premotor cortex[38]. If used consciously, they have quite different modes of access through the subtle media of intention and emotional state.
- In applying this model, stretching and the deliberate softening of muscle through exercise and therapeutic touch (e.g, massage) needs some consideration and awareness. Because the question now arises – exactly what are we stretching/ softening? Is it muscle or is it fascia? Are we interested in Actin, Myosin or Titin? Or some combination? Most importantly we have to ask the question – if some part of these tissues is chronically contracted, how do we communicate so that it can wake up again? Does it just need to have blood flow re-connected? What level of communication is missing? And – regardless of which layer(s) of communication we are addressing - which *other* areas of the body might help to make this area more connected and energised/relaxed?
- Vibratory techniques such as those used in Trager Work come out particularly well on a physical level for muscles, as does any kind of sound (including singing!). Light movement practices such as Qigong and Taiji, Yoga, and many forms of dance and sport also score highly because of the rhythmic nature of moving over the ground and the whole-body nature of those movements.
- In particular, remedial exercises for muscles should seek out non-linear rhythmic

38 http://www.hummingbird-one.co.uk/pdf/MirrorNeurons.pdf

movements and take more time to refine the *quality* of motion (rather than thinking that all movement is equal).

- An important component of exercise is the mood and environment in which it takes place. The greater the level of dopamine, the more normalised (as opposed to hyperaroused/activated) the muscle usage will be, and the muscles will then be "trained" with this quality of e-motion. They will be less likely to be armoured, and therefore will be more likely to be capable of their full range of motion and full strength capacity.

And of course, many other vital aspects of the body (such as breath or the organisation of form[39]) have not even been mentioned, so the above list is by no means a definitive one.

Part of a series of essays on the human body-mind, available at
http://www.hummingbird-one.co.uk/resources2.html

Any comments on this essay are welcome
please email strixaluco@gmx.com

39 http://www.scienceoflife.nl/html/embryology_of_belief.html