Neurophysiology and rehabilitation.

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The purpose of this article is to show how our present knowledge of how the nervous system functions can be used in rehabilitation. Eutony has experimented with this in 80 years. Here will be mentioned some of the experiences that may inspire others in their work with rehabilitation. The emphasis is on the practical use, the neurological mechanisms are mentioned briefly. Different themes are taken up, first the neurological mechanisms are described, then how they present themselves, and then how it can be used in rehabilitation.

Muscle tension

has 2 components:

I: muscle activity, via alfa innervation of the muscle fibres

II: muscle tone = readiness, via fusimotor innervation of the small muscle-fibres inside the muscle spindles, where rise in activity increases the sensitivity of the muscle spindles.

Some characteristics of muscle tone:
1) It ranges from the lowest in complete rest to the highest with strong physical action or emotional states as rage and fear.
2) It is universal: ideally it is at the same level in the whole body and changes to another level at the same time all over. (directed by formatio reticularis).

In practice this means
That tone can swing swiftly corresponding to the needs of daily life. In many this fine adjustment is disturbed. In some people tone is too low: reactions are slow, daily activities become burdens. More common is that tone is at a too high level without reaching rest level in the pauses of daily life. It is registered as stress, not only physically, but also mentally, as being less adjustable to surroundings. Flexibility in tone is needed for sensitivity in relationship to others.
High tone and inactivity of muscles can occur when you wait for going into action.

Often there are local disturbancies in tone, e.g. with habits of tension in an area, tired muscles that are not released, tissue that has been overloaded, pain. Local treatment can be needed and is mentioned in the last part of the article.
From what is mentioned above it should be clear that the body is always involved as a whole and should be treated as a whole.

To reestablish your flexibility of tone it is natural to start exploring how to reach resting level of tone.

To find rest. Both muscle activity and tone have to be decreased.
There is no direct pathway from cortex to neither muscles nor tone to effectuate relaxation.
Some have tried to reach rest by creating high tension and then release. But you have no guarantee that you reach resting level this way, especially doubtful because the tone, involving the whole body, has been exposed to so great changes.
Via the limbic system which has to do with emotions it is possible with intention to reach resting level by thinking of being in agreeable surroundings, remembering something pleasant.

But there are also somatic mechanisms that can be used to reach resting level, and they have the advantage that they in addition can be used to adjust both activity and tone at different levels during function.
It can be done by being conscious of
1) the force of gravity, how the weight works on the body
2) the skin towards the supporting surface.

It is observing, in a neutral way, things that really are, not <u>doing</u> anything.

The force of gravity is stimulating several kinds of senses that first of all work through reflexes, but it is possible to be aware of the influence of gravity on the body. It is remarkable that many have to practice to be aware of the force of gravity without doing something, for or against. It is very important to develop this skill which is fundamental for several of the following undertakings as well.

In the skin there are especially many sensory organs that are stimulated by pressure from the bodyweight against the supporting surface. These senses have via reflexes a strong influence on both tone and muscular activity. If stimulus is strong, unpleasant, tone goes up and you feel the urge to move.

But if the stimulus is pleasant it has a strong influence decreasing tone and muscleactivity as well. Therefore, to rest you seek out a comfortable position where pressure is distributed over as large a surface as possible. These sensory organs are constantly active contributing to reflexes, but they also have well defined pathways to cortex: You can perceive their messages. If you give attention to the skin that is supported you can increase the effect of the reflexes that decrease tone. (See later under attention). This can be used to reach resting state.
Attention can be directed to other tissues having sensory organs with cortical connections. Always try to perceive qualities that are real, not imagined -, The reflexes you in this way have influence on are all having characteristic qualities that you may learn to use for different purposes.
For reaching resting level it is recommended to start with the skin where you have the largest quantity of sensory organs.

Put into practice: Find a good resting position, lying or sitting, Close your eyes: visual stimuli are not needed now and they are so dominant in the brain that you may not perceive the fine signals from the sensory nerves. Note the influence of weight on the body, as a whole and on any small part. You can just allow it, for you are supported. Note what it feels like in the skin to be supported.
You can choose to think of an arm in detail; afterwards perceive how the arm feels compared to the other which had no special attention.
This is described in detail to show that neutral attention to the body is possible without suggestion and without interfering. It is very important to allow the body to react freely, in an individual way.

The neurological basis for attention is mentioned in the section on attention.

During the attempt to rest unpleasant sensations can arise in an area that cannot keep up with the general lowering of tone. It can be a tired muscle that has not recovered, a habitual tension, or tissue which for some reason sends pain signals.
That means there is a local disturbance in the regulation of tone. How to deal with that is mentioned in the sections on pain and stretch of muscles.

Regulation of tone in movements is mentioned in the sections on movement and how to stretch oneself.

Mechanoreceptors

Is the term in common for those receptors reacting on mechanical stimuli, as e.g. touch, pressure, stretch. They take part in innumerable reflexes necessary for balance and movement, but in addition most of them also have well defined pathways to cortex, and that makes them so important for rehabilitation because we can perceive their signals and we can put our attention to them.
How important these pathways to the cortex are can be illustrated by the cases where they are injured, e.g. by a stroke: the patient does not use that side of the body even if the motor innervation is intact.

There are 6-7 different types of mechanoreceptors in the skin, these sensory organs have different elaborate shapes and they are placed differently corresponding to their specific function. Several of the same types are found in connective tissue. In the capsule of joints there are 2 specific types, one telling about the position of the joint; it is constantly active; and one which registers movement and so is only active during movement of the joint. Both types have, beside their importance in reflexes, cortical connections.

Attention

can be directed towards those mechanoreceptors that have pathways to cortex. (In contrast to the muscle spindles which have none). Normally most of the impulses from the sensory organs are stopped in the synapses so that they do not reach cortex, but take part in reflexes on a lower level in the nervous system. With the attention on these senses their signals are facilitated through the synapses so that they can reach cortex. This selection of sensory impulses that are allowed to reach cortex is well known concerning vision and hearing. If you are concentrating on hearing your visual perceptions are less detailed, but if you want you can immediately switch your attention to vision and perceive many more details.
Just as you can train your ear and e.g. distinguish songs of different birds, so you can train your perception of sensory qualities. You can choose to concentrate on one type of sensory input, and beside the perception in addition the impulses on their way to cortex get a chance to take part in reflexes on high levels, e.g. at thalamus-hypothalamus level, taking part in vegetative reflexes, among others concerning circulation, and at the level of the basal ganglia influencing moving patterns. In cortex they can take part in planning and fine adjustment of movement.

Everybody can profit from these possibilities to improve the use of one self with better economy and a new lightness and expressiveness. But extra important it is in rehabilitation if movement, function, has to be relearned or you have to compensate for defects in the body.

As mentioned there are many types of mechanoreceptors in skin, connective tissue and joints. There seem to be differences in the reflex patterns they take part in and in their cortical connections. This gives many possibilities for influence via awareness. Eutony has experimented with these possibilities for a long time.

The role of the assistant

is as the guide in nature: to guide the attention without interfering, also to teach the pupil to be silent, observing. All the time there are active sensory receptors and right away you can start exploring with your attention. There are innumerable possibilities and you never get finished. So it is practical to have a guide who from experience can lead your attention to the sensory inputs that at the moment are most important.
You can yourself increase the activity of the receptors, e.g. by pressure or stretch given in a position where as much of the body as possible is at rest. The assistant can use her/his hands, but always with the purpose of directing the attention of the pupil to an area or to a certain quality of sensory input. It can be done as touch, pressure or perhaps by a firm grip of some soft tissue which is held steadily to give the pupil time to release and be conscious of the sensory stimuli, what is happening locally, and in the body as a whole. The entire body is always involved, as first mentioned in connection with tone. The assistant must practice to be neutral, and it is not easy; it is so tempting to try to "push", but then balance is lost. The idea is to make the pupil and the patient independent.

Planning to move

is like choosing a program on your washing machine.
As a natural beginning you can give the part of the body you want to move some attention so that the sensory inputs from here together with their central connections take part in the planning, as previously described. This goes on while the body is at rest.

We know a good deal of what is happening in the brain while planning a movement: activity starts in gyrus praefrontalis. From here impulses go to the basal ganglia which together with the cerebellum deal with composition of moving patterns, including previous experiences of movement. In gyrus praefrontalis are also the so called mirror neurons which are known to be activated by the sight of someone moving. They seem to form a bridge between the sensory and motoric cortex. The studies of these neurons will be followed with interest.
While planning to move there are also from gyrus praefrontalis impulses via hypothalamus to increase the circulation in the area that is going to move. That means that the bloodvessels open before the muscle activity starts
So several processes are going on before actual movement, and rehabilitation can profit from that. Especially important when movement for some reason is not possible, e.g. if a leg is in plaster you can think of movements and have a good effect on circulation, the immobilized joints, and the trophy of the tissue. When pain inhibits normal movement thinking movement can have the same good effects on the tissue. It also helps to decrease the bad effects of the pain reflexes on moving patterns. With pareses it is of great importance that the paralyzed part of the body is given attention as part of the whole. E.g. Movements can be planned, and if a paralysed has to be turned in bed, he is felt much lighter if he thinks the movement.
As mentioned the bloodvessels in an area open before movement. If the movement is cancelled, the extra circulation can be used for repair, restitution. In some cases cold hands and feet can be helped this way.
Planning movement is usually followed by

Movement

Until now was described how conscious use of senses gives many possibilities for deliberate influence on the processes in the nervous system. They can all be used in movement. You choose which of them you will favour and practise while resting what you can perceive. After that you try to take it with you in movement. In this way you start from the sensory side of the nervous system - a quite normal ingredience in any action, but rarely stressed in rehabilitation and training. The sensory initiative is influencing the motor response, both concerning tone and muscular activity. This approach has many advantages: the whole of the body is involved, and the movement has an individual touch.

When moving several physical laws go into action. Here will only be mentioned two, because they can be used consciously and thus have great importance in rehabilitation, beside the already mentioned attention on the force of gravity.

1) When there is a movement, a force, in one direction, there must be an opposite directed force which can be traced to where the body is supported. Many try to "catch" this counter force in the body by muscle tension. This is waste of energy and a brake on free movement. The optimal, the free flow of movement is furthered by being aware of these forces and their directions which can be followed via the bones through the body, directions that extend beyond the body.
It leads in a natural way to the next

2) a movement, a force, has a direction.
The nervous system gives possibilities for very accurate registration of direction. Many senses are involved: the labyrinths, the mechanoreceptors of the joints, supplemented by those in the skin, vision is often involved, but is not necessary. Essential is that all these senses can be perceived consciously and so can take part in conscious planning and performing of a movement in an exact direction, even when a whole chain of joints are involved. This is especially important for the weightbearing joints of the legs and the spine. Learning to perceive this exact direction through the joints ought to be part of the training right from the beginning.

Ex. 1: An illustrating example is the knee between the long leverarms of femur and tibia where even small deviations of direction give considerable shearing forces on the joint.

Put into practice with patients:
Show the patient 2 wooden blocks in row as when children play train. Show that when you push straight the whole force is transferred from one block to the other evenly distributed over the whole contact surface. But if you push in a just slightly oblique direction sideworking forces arise which have to be counteracted by the capsule and possibly muscular force: waist of energy + increased pressure on a smaller contact surface than before + pull on the capsule with nociceptors. Then practise with the patient standing, one hand lightly supported to prevent work for balance. Put the foot of the knee troubled leg forward without putting weight on it. Look at the line through ankle-knee-hipjoint - which many have to learn to place right. Next: perceive the direction from sensory input only, without looking. Now put weight on the leg in the

perceived direction without tensions anywhere, the bones are carrying the weight. Do it a few times and then walk freely and perceive the bones as weightbearing. If there are tense or shortened muscles they have to be dealt with extra.

Ex.2: The spine is another example where the awareness of its direction is of fundamental importance. The spine is built like a strong elastic rod with qualities of a spring, among others that it functions as a unit and when it is in its own alignment it is strong, but pulled out of shape it buckles and can carry considerably less. Rehabilitation should therefore start with teaching the patient about the qualities of the spine. It is remarkable that 98 % of my patients with back troubles - also those who had received treatment - believed that what carried them was close to the skin of their back. In consequence their balance was poor compensated by extra muscular activity which pulls the spine out of its own alignment. EMG studies are well known to show that muscular activity is not necessary when erect in the line of gravity, but starts as soon as you leave balance in the line of gravity: muscles are for action, not for posture.

Put into practice:
Many patients with back trouble are in pain which you have to ease before informations. Most of them are helped by a gentle stretch of back- and gluteal muscles: Lying on the back with legs bent, one knee is lifted towards the chest and hands folded around the knee. Let gravity alone give the stretch. (see section on stretch) Afterwards place the patient on the back with legs on a stool. This position is chosen if comfortable, otherwise find another. Now you can explain about the spine and if possible show the spring qualities. Show a lumbar vertebra, its size. Now the patient should try to perceive his/her own spine. Hands on the abdomen, feel its skin + the skin on the low back towards the floor, estimate the distance between and find the centre where the vertebral bodies and disci must be. Think of the size of the vertebral body and the spring quality of the disci. Follow the direction of the spine upwards; through the centre in the lumbar area, deep in the thorax (midway 8 cm in) and in the neck in the middle to between the ears. Let the attention run up and down the spine as a whole and follow the direction out of the head and of the pelvis. This is first practiced in rest, then in standing, moving. This exercise is constant in daily life. Dancers use this sense of direction out of the head, and the direction from the pelvis to the floor they call their 3rd leg. It makes balance much easier. Try it.

Next step in rehabilitation of the back is to release the muscular tensions to allow the free balance of the spine. First when that is clear training of strength is started, always respecting the spine operating as a unit.
This is very different from most training programs. Compare: a string with cubic pearls on a table. The pearls can be pushed in line from the sides, rather elaborate and never exact as when you pull the string in its length direction.
This programmation of the spine in its direction gives a fine coordination of muscles, ranging from lightness in balance to maximal use of force.
The awareness of bones is very important in Eutony, not only from an architectural point of view, but also as the living tissue it is in itself.

Pain

Quite a lot is known about the complicated processes in the nervous system arising with pain, also that neurons and transmitters can be changed by chronic pain - when changes do occur - may be also for the better?
Pain is hindering rehabilitation. The fist task is therefore to teach the patient what you yourself can do against pain. It is very important that it is something the patient can administrate on her/his own.

Fear increases the perception of pain manifold, via the limbic system. This has to be counteracted as soon as possible, with the cooperation of the patient: Explanation, information, also about what works well.

Pain increases tone and often there is muscular activity in rest as well, giving secondary pains.

The pain reflexes change moving patterns drastically, not only locally but in the whole body, abnormal pull and pressure arise on tissue whose own nociceptors become active - new secondary pains. Precautions must be taken right away.

If the source of the original pain cannot be removed various neurological mechanisms are available that the patient can use to relieve pain.
Examples:
Resting positions are important: large supporting surface with suitable distribution of pressure and the joints in a good position, aided by pillows.
Give special attention to the good support of neck and head, that have strong

connections to the rest of the body. This all means many good mechanoreceptor impulses.
Stimulation of the mechanoreceptors can decrease the perception of pain. "The pain is not allowed to play solo". Common is the use of
Rub around a tender spot, or blow on it.
Rock a child.
To sit in a rocking chair. The receptors in skin as well as in the joints are stimulated by the changing position in relationship to the line of gravity.
Passive movements, best in a distance from the painful area. E.g. with shoulder pain to sit with the arm well supported and let the other hand touch and move the pain side hand as gently as comforting a kitten.
Massage is also using the stimulus of mechanoreceptors, but if you do it yourself the effect is mixed with the activity of the arm and hand.

A more profound treatment takes place in rest and is based on studies of the tension patterns created by the pain reflexes. For each pain focus there is a pattern which seems to be universal, but it varies in strength from person to person, and there may also be individual differences in which part of the pattern is most visible. It is worth while to study these tension patterns accurately, in rest and in movements, to analyse the interplay and so be able to find the best sequence and way to dissolve the tension patterns. An example is given in the article on the muscular defence in low back pain.

Usually you start with stretch of some of the dominant muscles (see stretch). Then find a good resting position to lower tone as much as possible. There after you can use pressure as stimulant on an area you by experience know is important to get in contact with. Some use balls with elevated points to give the pressure, but in most places these balls deform the body too much; many roll on the ball to increase the mechanical stimuli, but so they miss the deeper effect by attention. In Eutony we use materials from nature such as bamboo and chestnuts to give pressure. The purpose is to call the attention of the patient to an area, to get to know the area, and pressure as stimulus to release. You try to perceive the reaction of the tissue, including when you should move the pressure to somewhere else. Each pressure point is only stimulated a few minutes - but never determined by the watch, but by the messages from the tissue. The assistant gives advice where to place the pressure, the patient is always there with attention, commenting how it feels. The art is to make it individually adjusted and simple, so that the patient later can use it alone and use it as start point for own experiences. Attention is on the response locally and on the response of the body as a whole. If the situation allows the patient now gets up and notes what it feels like. Often in

first session pain has decreased and the moving pattern improved, even if there are still reminders of the pain. The experience that it is possible yourself to have an influence on the pain often gives the patient confidence to move freer and that is encouraged: good movements are the best cure, the circulation also better than in rest.
As long as there is pain the pain reflexes will try to sneak in on you creating tensions that you constantly have to release, so that the tissue gets a chance to recover. The treatment is supplemented with what was mentioned previously.

A special pain is known by most: cramp in a calf. Most react intuitively right by stretching the muscle. If you do not and the cramp is allowed to continue, the pain is intense. When the same happens in the back it can be dealt with in the same way by stretching the cramping muscle, but not so many are aware of that. In stead the cramp is allowed to continue. The pain is increased by fear: what has happened in my back? A vicious circle is started.

It is worth some thoughts that muscles with so little pathology can develop so strong pain just by some decrease in circulation. Equally remarkable is the immediate effect of stretching in this uncomplicated case. With long term painful muscle tensions stretching can also be a good choice.

Stretching

has 2 components, a mechanical and a neurological. The latter is often completely neglected.
Tired muscles in sport or after other physical activities can be managed by mechanical stretching as it is usually done.
But in case of habitually tensed muscles or muscles influenced by pain you have to include the nervous system in your treatment. Two important components are
1) low tone
2) attention

1) Put into practice it means that the body should be at rest in a position where the weight of one part of the body can be used as the only stretching force. Positions can be found to stretch any muscle group in the body in this way. If there is postural work or you use muscular force in stretching, tone goes up in the whole body including in the muscle which has to be stretched, a conflict for the muscle. The low tone means you are at rest free to give all

2) attention to the stretched muscle, perceiving the signals from it with the resting body as a background. You can study what release feels like in this tissue meant to be elastic, estimate the suitable degree of stretch and the duration of it. It should be like cooperation with the tissue. If the tissue is very rigid, take a pause and repeat. It should always feel comfortable afterwards.

Stretching has 3 phases:

a) stretch itself with attention on the area

b) rest on the back with attention on the muscle that has been stretched now in relationship to the body in this position. How does the muscle feel now? Compare to the other side that has not been stretched. The more details you can perceive from the more elastic tissue, the easier it will be to reproduce it, also without stretching.

c) stand up and walk with the attention on the stretched area: can it remain elastic, or do you have a habit of being tensed here? Experience the area as a part of the whole body.
This phase is very important that stretching does not become a 5 minute affair + 16 hours habitual function.

To stretch oneself

Small children and animals have a natural urge to stretch themselves. Grownups also stretch, but often in a quite different way so that they miss a lot of the good effect. So an analysis of stretching oneself is necessary.

1. It is a movement away form you, with a clear direction.

2. The initiative is from the perifery of the body: If you want to stretch your arm the initiative is from the fingers, the rest of the arm and the body should just follow. It is here it goes wrong for many, because they, after the start from the fingers, let the muscles of the arm help - a stretch with the brakes on. Look at a cat or a dog how long they become.
Neurologically it is a fine adjustment of tone and muscular activity reducing pressure on the joints and equal stretch of the joint capsules all around each joint. That means the mechanoreceptors here fire with equal frequency. Via

reflexes it has a harmonizing effect on the muscles that are on the same time slightly stretched. The more joints are involved the more wide spread the effect. It should not hurt - but it can be used against pain, because the reflexes of this stretching can overcome the pain reflexes.

3. Stretching oneself has a direction and it creates a counter force towards the surface supporting the body, as a stretch meeting resistance = a push.

4. You can see animals in the utmost stretch go into general high muscular activity: maximal force with minimum of pressure on joints, accurately distributed over the joint surfaces and an exact direction through bones.

5. Stretching one self is an introduction to daily activities: when you reach for something your fingers with attention go in a direction.

6. There is a beneficial effect on the whole body , among others the flow og lymph is increased.

Put into practice: side, best on the floor, at rest. Give attention to the upper arm as it is supported, and while still at rest, send the attention to what the fingers can feel and decide on a direction along the floor - some what like putting the light on, before you drive -. The movement can now start from the fingers while the arm and the rest of the body are lazy, but willing to follow = adjusting tone slightly higher than at rest. Try a few times. If the movement is free it can be followed through the body to the counter pressure against the floor. Depending on the direction you choose, the stretch follows different routes through the body to the ground. Try some different directions.
Errors:
The movement is stopped by tensions.
Muscles go into action to "help",
The direction is changed.
Most pupils can feel the errors and on their own work on correcting them, not to be cheated for the pleasant experience of a free stretch.
The same can be done with the upper leg. Do not stretch from the toes as it can give a cramp. If you stretch from the middle of the foot and let toes and heel just follow cramps never occur. The direction should be in prolongation of the body - otherwise the body tilts in a disturbing way. The knee leaves the floor at a point and it can be quite difficult not to add protecting tensions, but it is an important experience to let the knee just follow the foot without side deviations in spite of the force of gravity making the movement more

complicated. If it is too difficult the knee can be supported on a big pillow covered with plastic to decrease friction.

Stretching yourself is a good way to learn to move without tensions = without putting on brakes. It is first practiced as above, then lying in other positions, then in standing and sitting. Vertical stretch from the fingers is a good way to restore postural alignment. For schoolchildren and others who sit a lot the best is to get up and move around now and then. The second best is a stretch while sitting: the pelvis well placed on the seat, feel the sitbones on the seat and let them stay in contact with the seat while you stretch vertically from the fingers of one hand, ending up with using force. Feel the counter force downwards from the sitbone on the same side. The connection between the two forces is the spine which is easier to feel this way and which at the same time restores its alignment.
Stretching one self helps the restitution of tired muscles also after monotonous work.
With pain where protecting reflexes make the muscles pull in different directions stretching one self is a quick way to restore alignment through joints with minimum of force and compression of joints.
With osteoporosis and fragile bones for other reasons stretching one self gives possibilities for muscle training with minimum of pressure on the bones: lying down stretch with attention and no pain to the outer limit and in this position activate the muscles to maximal force without pain. When the patient has a good perception of the bones and the pressure they receive, it is tried in standing, gradually increasing force, accurately controlled by the patient who evaluates what is tolerated. Often an astonishing amount of force can be tolerated this way. At the same time scoliosis and other deviations are seen trying to correct themselves - the pull on the string of pearls.

This is written about unused knowledge which belongs to all of us and ought to be widely used in work with ourselves and from there on in rehabilitation. It is put it into practice thanks to Gerda Alexander and the Eutonypedagogues after her, supplemented by experiencies made together with our pupils and patients. Eutony is much more than here mentioned. There are good reasons that the education lasts 4 years.