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Rehabilitation of the upper limb after an stroke. Part 6. Dissociation to an “open “chain and hand treatment !

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Abstract

Introduction: *The treatment to get the best recovery of the hand stand in this article central. Last article part 5 had on the end also the hand therapy central.*

F.E.S and CIMT stand there as two possibilities to lay more pressure on the possibilities of the wrist and hand function. There are more treatments with the focus on the hand/wrist function.

Some of this treatment is never proper investigated and others are treatment that has the origin out the sciences investigation. Especially the robotics or exoskeleton systems are solutions that come from the technic and with must be incorporated in the existed treatment program.

Methods : *Sometimes this are treatments were no other activity are use and that will have an effect on the system of the body. The building of your body through diagonals asked for an stability to get one point get his best stability and that part will always have influence on the outcome from each treatment. Sitting on chair an having an exoskeleton on the under arm and hand asked still for an activity of the shoulder. That activity must be controlled in the keypoint of the diagonal –back and front. When one of the diagonal is too dominant than is the movement in the affected shoulder not right. But look also under the table and observe the reaction of the legs or the not-affected arm and (on) the leg. There build the individual chain to get the best control over the affected keypoint and that is essential part of the treatment that also by the hand treatment must be watch and take care off. There they must also search for stabilization and often is that the affected arm/hand (upper trunk) and that will have an negative influence on the possibilities of this affected arm/hand. This part start with an observation paper. Here we focus on elements of the use of the hand/arm in the ADL . And this is an good start in the search for the exercise of that hand when there is some possibilities in the hand himself.*

Conclusion: *Again is there always the possibility to make the exercise an task-specific resistance treatment that lead to an better coordination and more power in the muscles of the hand but that must be lead to an situation that the brain must search for an solution and that this function is incorporated in the ADL and IADL.*

Keywords. *Arm-hand rehabilitation, electro treatment, robotica , stabilization .*



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Creation of an 'open "chain and stimulating the hand possibilities and tone- and tissue control! An multi-eclectic approach !!

Introduction.

Part 5 ended will al kind of possibilities to try the recovery of the hand to lift to an higher level. CIMT [1] en FES [2] were the possibilities to create more exercise for an hand function that was poor or was poor used. CIMT [1,3] has proven to work by individuals after an stroke with existed "poor" or better said – not use - hand function, but the amount of time that is done by this approach is great. The question is therefore at his place or huge amount of "time" is necessary to get the same results [4]. There are investigations M-CIMT and the results are almost equal. Therefore the question what is the stimulus inside the CIMT –approach that give this good result. Still think on the fact that all patients that had CIMT had hand-function and an lot of them within 24 hours had extension function in wrist and fingers. Still compared with control groups that has the same possibilities but has usual care [5], the different between this two groups was there. That means that working with the affected hand and only with the affected hand stimulated great. In all that investigation there was no TIDieR (Template for Intervention Description and Replication) [5,6,7], because the amount of active exercise was the greatest difference.

Another essential point in rehabilitation in the intensity

Working with only your affected hand and solving problems in the treatment phase but also in the ADL is very high and is the stimulus for the brain to solve problems. As we see what the control group does what mostly not was described, than were the difference often very great between the two groups and that is science of an low profile or PEDRO (Physiotherapy Evidence Database) level.

Further investigation must be done what the relation is between the amount of time and the level of load (intensity), because both are present but what is the most important. Load will give in an task-specific exercise that is done according the rules of the R.M. scheme and possibility to created more coordination and power (strength × speed) and that will have an brain reaction too because the brain must search for an solution. But there must be an way to do it because otherwise the brain will realize that it isn't possible and will learn that. This is an implicit way [9] of learning with the focus on the goal[10] and it can be extend by part of explicit learning par example trial and error[11], but never must the explicit has an to prominent role, because we have patient with an brain damage and we asked than often too much.

F.E.S [2] only one research have proven that an combination of goal directed exercising and Functional Electro Stimulation has remarkable positive effects on moderate damage hand /fingers functions. Still this were also patient with function in the fingers that give an present of an cortical-spinal pathway with some damage. That were the items in part 5 and that were approach that has the attention of the investigators all over the world especially CIMT. But there are others approach to get an better hand / fingers function that has be done but where nobody knows how well it works.

Well is it important that investigation in future will be done according the TIDieR – method because often where part of the approaching that now come part of the usual care !!

Because the relation with the ADL stay very important, it always important to analyse what the possibilities in the ADL are and what the possibilities of the arm are .

Therefore an form of an ADL list with an list of hand and arm possibilities (M.I. – Motrocity Index [12]) but observe and invest also the diagonal system[13,14] [Table 1 and 2]



Table 1 What can the patient = Activity possibilities [15]

What are the possibilities of his arm / hand?	Independent	Supervision	Assistance/ Facilitaion	Not possible	Clinimetric
<ul style="list-style-type: none"> The patient has attention for his affected arm/hand. 					
<ul style="list-style-type: none"> Capable to nurse his arm / hand. 					
<ul style="list-style-type: none"> He is capable to move his arm spontaneously and arbitrary. 					
<ul style="list-style-type: none"> Abduction of the shoulder from 0° to 90 ° <p>M.I. (Arm) = 0 t/m 33</p>					■
<ul style="list-style-type: none"> Flexion elbow, complete flexion elbow. <p>M.I.(arm) = 0 t/m 33</p>					■
<ul style="list-style-type: none"> He is capable to move his hand spontaneously and arbitrary. 					
Capable to use the arm /hand as support.					
<ul style="list-style-type: none"> Support forward 					
<ul style="list-style-type: none">side way 					
<ul style="list-style-type: none"> Back ward 					
The patient can hold something in his hand.					
<ul style="list-style-type: none"> An orange or an tennis ball. 					
<ul style="list-style-type: none"> an banana (cylinder grip about 3 cm.) 					
<ul style="list-style-type: none"> an glass and trink. 					
<ul style="list-style-type: none"> An tweezers grip (pincer,pincet) <p>M.I.(arm) = 0 t/m 33</p>					■
<ul style="list-style-type: none"> The patient is capable to manoeuver something in his hand. 					
<ul style="list-style-type: none"> Wash and dry his hand with towel. 					



Table 2. What can the patient = Activity possibilities

	Independent	Supervision	Assistance/ Facilitation	Not possible	Clinimetric
• Wash					
• Dry					
• Dress on Barthel i = 0 t/m 2					■
• Dress out Uittkleden					
• Make up etc. Barthel c = 0 -1					■
• Going to the bathroom Barthel d = 0 t/m 2					■

Explanation table 1 and 2.

-Independent means that no assistance is necessary not that this is done on an normal way. That means that we must observe why this is the way the patient this do so.

-Supervision means that the observer think that this can be go wrong or isn't safe.

-Assistance or facilitation isn't the same but assistance is take somewhat over and facilitation means that the therapist make the movement/action easier but without taking somewhat over.

- Not possible.

- Clinimetric , both table we can count the M.I. [12] and parts of the Barthel Index [16,17].

To get the highest level of hand function, one op het main problems is the perception of the hand and of course the selectivity but that is in our opinion something that goes together.

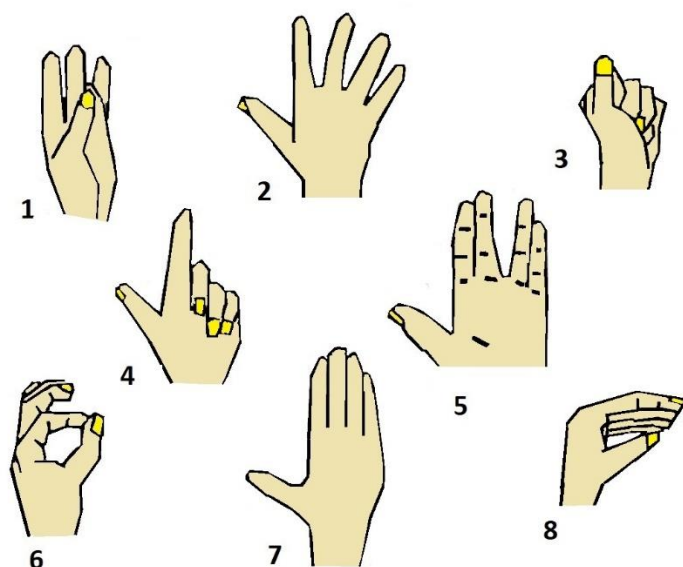
An disturbed perception (=knowing where the hand is etc.) will be the "brace" on the use of the affected hand because the attention that this hand need is much higher than with an normal perception.[17,18,19] So must the individual with an perception that is disturbed always look to his hand to be sure that that what is in his hand, stay there. The increase of perception will also by stimulated the selectivity of the affected hand and that effect can be increased by load in the activities, thus by task specific resistance treatment.

An Motricity Index of that hand is measure by hold an piece between thumb and first finger (pincer) and the researcher pull on that piece. That is the investigation part but when we know what the R.M. is we can also use it for an task-specific resistance therapy. Or we search for an load in this kind of grasp and exercise or we give the individual an scissor and make the same movement.

Always this two elements when there is an possibility to do the movement ;

1. Search for the R.M. and give an task- specific resistance therapy and
2. Search for an ADL and IADL that will stimulated the brain for searching for solution and with the possibility of rehearsal with variation. (Differential motor learning [8])

The most selective hand movement or position are ;

**Figure 1.**

Gives an picture of the different hand and fingers position that are equal with an high selectivity of the fingers. To place the fingers /wrist in this position there must be high selectivity and of course the perception can be change but when someone this can than it is often an case of disuse[21].

Figure 1 published with the responsibility and permission of the author by j.v.d.Rakt.

Figure 1

Position 1 : Thumb to little fingers, that can be done with no resistance, with speed but also with holding something in the position what is heavy. The movement asked for an stabile wrist and the opposition of the thumb and the little fingers. This are muscle that are small and active almost alone in the hand and therefore an cortical control. For the ADL necessary to fold up an towel , together with the other fingers.

Position 2 : Spread the fingers, all and equal. Doing this in the swimming pool by the arm stroke will give this an different resistance and also an different perception [21], closed will the resistance higher and ask for correction in the whole arm, but open will the resistance through the turbulence of the water have an effect on the hand and fingers directly. Keeping this hand open makes stabilisation of an flat object better possible in the ADL and IADL.

The muscles that this movement make possible are small and almost starting in the hand to the base of the fingers , together with an extension of fingers and an neutral position of the wrist.

Position 3 : Make an flexion of all fingers in the palm of the hand with an dorsal flexion of the wrist and with an thumb that is in extension and placed with adduction against the flexed fingers.

This we need to hold something in our hand with less pressure. Example take an egg and see how your hand fold himself over the egg without use too much pressure only control.

Position 4: The thumb and the first fingers are in complete extension with the wrist in the middle between dorsal and plantar flexion. This means that the coordination of the wrist must be optimal because also it is the middle of ulnar and radial deviation. The other three fingers are in flexion . You make an "shooting"- gesture. This we need to free the first finger and the thumb to make position 6 possible – the pincer grip. This and 6 are the precious finger possibilities and important for doing fine work but also take the end of the sleeve and pull on it in the ADL dressing.

Position 5; All fingers in extension but spread together digit one and two from digit three and four . Again work of small finger muscles in the hand .

Position 6; Pincer grip

Position 7; All fingers in extension with the wrist again in the middle and with an maximal thumb abduction with extension in the small joint.

Position 8; The "lumbricalis" - grip, the wrist stand in the middle and the fingers flexion in the metacarpal joint 90 ° and able us to fixated an object firm, everything that is what larger we will use this grip. Therefore in the ADL and IADLK very important . Every pack we take on this way and we adapt with our fingers- angle on the broadness of the object. This positions asked for an intact cortical-spinal



pathway and not always will that the case but seeking in the ADL for the best way to handle is it important to have an good control over the wrist and independent thumb movement and control over the extension. By neurological damage this level of motor function and that of the perception be always decreased. Because the amount of damage of perception and selectivity is almost the same in brain damage, especially in stroke patient but there are always exceptions. Still when the function is so selective that the position can be made and the perception is still very poor than mostly the reason must be search not in the central system but in the arm /hand and especially in the nerves-tissues. [22,23]. There will be than damage on the nerve-tissue himself before or at the entering of the spine. This can be an secondary damage that is also possible by an stroke patient when the nerve has to must pressure and isn't functioning optimal anymore or through another illness. Beside the motoric and/or ADL treatment and there are approach that are developed to get this improved but there is by the most little investigation about their impact and some are investigated but there was no clear prove when this investigation lay along the TIDieR –lath.

Perception.

Exercise programs that are pointed at the perception and there is an program that point on perception and selectivity by using more rhythmic bilateral movements .

1. The Yecutiel performance[21] .
2. The Perfetti program[24].
3. The mirror exercises [25,26,27,28] .
4. The Stambak /Gerard Worm method[29,30,31].
5. Imaging, mental practice and virtual reality training[32,33,34,35,36,37,38]

1. The Yekutiel performance.

Learn to feel again and be able to recognize, that object with the feeling of the hand and the foot. That is the base of the concept of Yekutiel[21]and Perfetti[24]. Increasing the perception from the base feeling of two point to an level that there is an possibility to recognize an object with the tactile information out of the hand and foot.

Start with learn to feel :

1.Feel points in the hand palm and feel how far the distance is between two points. To reach this goal all elements of feeling will be activated and used. Cold and warm together with two points but also soft and hard, all modalities that are possible to activated the two point discrimination because feeling between point is important to feel the end and the start of an object. This exercise will be continued through the therapy to decrease the distance between the two points and give the hand his extreme good discrimination sense back as the base to recognized.

2.Feel the line that is draws in your hand. Start with the underarm but go as soon as possible in the hand palm. And then is it important that the individual focus on ;

- A.How many lines there are draw.
- B.Where this line start and stop
- C.Are there interruption and where
- D.Is this line small or thick.

3.Recognise letter when that is performed on the body. Starting on the underarm and then in the hand palm. First the feeling and the search to the form, therefore after lesion two the line is change in forms and the assignment is to feel and to try to recognise the figure. After this is done well , now start with letters.

1.The texture of an object. The focus is now on the recognition of the texture of the object. Is it hard or soft, smooth or rough etc. and is the individual capable to recognised the texture from which this object is make of.

2.Now the last lesion "what is it". Thus recognition of the object with at least only the fingers and the hand palm, of course with the eyes closed.

Base of the Yekutiel approach :

Lesion one: Feel two points.

Lesion two : Feel lines in the hand and how the “walk “.

Lesion three: feel and recognised letters

Lesion four: Recognition of the texture of the object.

Lesion five; Identification of the object with the hand.

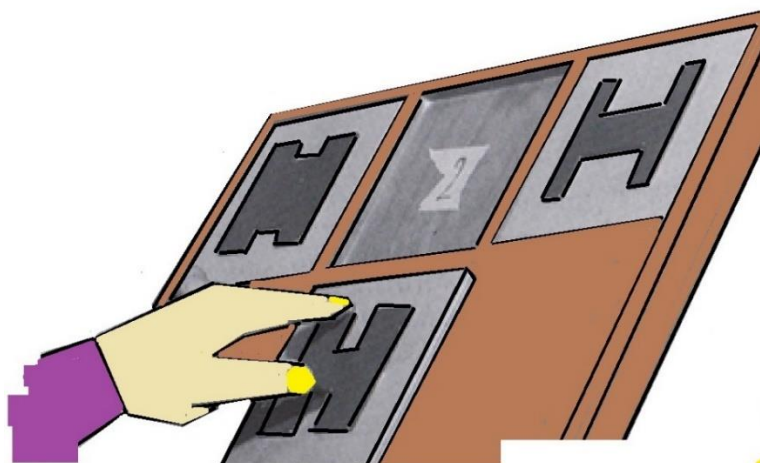
Always with the Eyes Closed

2. Perfetti- approach.

The principle is equal with that of Yekutiel, but there is an difference. Yekutiel has an great focus on restore the feeling possibilities by exercise on the arm and hand. Equal with the works of Rood, Goff and Stockmeyer[39,40,41], she exercises the hand and the arm with stimulus on the skin and try so to get in the brain on an low level. Sato[20] has investigated this in water with the hair follicles and say higher electric activity when there was moving water along this follicles. Perfetti go faster in his approach to the level of recognition of the objects and especially attention on the position of the hand (or foot). He try to increase the proprioception by exercises the position feeling and use that as an starting point to come to an recognition.

This approach will often need some finger movement because only the information of the structure without the muscle spindles is very difficult and this approach ask from the individual an lot . Very much concentration and imaging what he feel and what that means. There are more approaches that do an appeal on the individual to get an picture in the head of the movement that they want to make or in this example the position that they want and not many individuals after an stroke are able to do this. This because there must be an projection that can let go the film in the brain of the movement they want.

The amount of individuals after an stroke that can participated on this kind of exercises is little because the motor learning system that is use, ask an lot of the brain. And most damaged brain have not that amount on attention, concentration and motivation to do this. Furthermore the hand must have an possibility to feel it with all sense that there are otherwise this isn't an exercise anymore. That means that there must part of cortical - spinal tract must be present, not total but there must be an lot of this tract be there otherwise it is an wrong exercise program. Still parts can be use and will have an positive effect.



Picture 1.

Picture 1.

Feel with an finger what the scape is and recognize the form of this letter.

Yekutiel will be use more input on the hand /underarm and therefore use more different input than the Perfetti approach.

Picture 1 published with the responsibility and permission of the author by j.v.d.Rakt.

3. Mirror – therapy

This kind of therapy is for the first time use by individuals after an amputee. They had often complaints that they feel the foot that was amputee and these complaints varied from stiff till extreme pain. Ramachandran[28], Neurology professor on the University of California, San Diego was one of the first that introduced this therapy to give an relaxation and an decrease of pain by this individuals.

End of the last century there were experiments with individuals with stroke and the investigations that has published give a little but significant decrease of complaints. The question of the hand has improved isn't clear yet. The goal is that the individual see not his affected hand but looks in the mirror and see in the mirror his not-affected hand and think that that is his affected hand. Now will an movement of the not-affected hand give the image that his affected hand moves also and in the investigation was an decrease of tone visible and some movement but of this result maintain and for how long isn't clear.

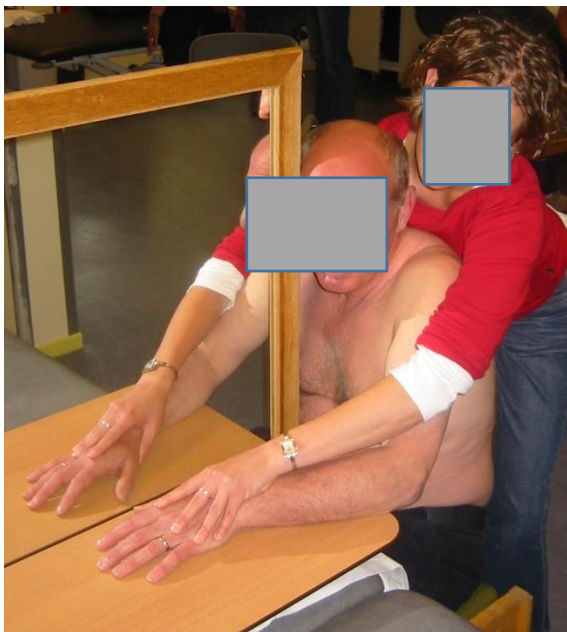


Photo 1

Photo 1.

An example of this mirror therapy. This individual has possibilities in his affected hand but that are hand movement that are crude. But there are also possibilities to make fine movement such as moving the thumb to the inside of the hand with the fingers remains in extension. But when he hold something between the thumb in this position and there must be more power to hold it there, than will the flexion in the fingers occur. And not only in the fingers but in his whole arm. The flexion movement synergy will than again dominated and that means that there are some elements of the cortical –spinal system but restricted.

Photo 1 published with the responsibility and permission of the author by j.v.d.Rakt.

In this exercise was the idea that with this position ;

Upper trunk forward (Protraction of the shoulder girdle)

Support on the elbow with a little pressure (activation of the front diagonal)

And looking to the not-affected hand that the pressure on the thumb by moving in and outwards will give an equal movement on the other side with less influence of the flexion movement synergy. After an month of exercise one an week was he capable with the mirror in this position to control the flexion movement synergy better and the thumb movement against resistance on the not-affected side give more movement in the affected thumb. But without the mirror he wasn't capable to do this. And the change was only the mirror . We removed the mirror but he closed his eyes and do the same exercise again and the effect was less.

In another position there wasn't an change .

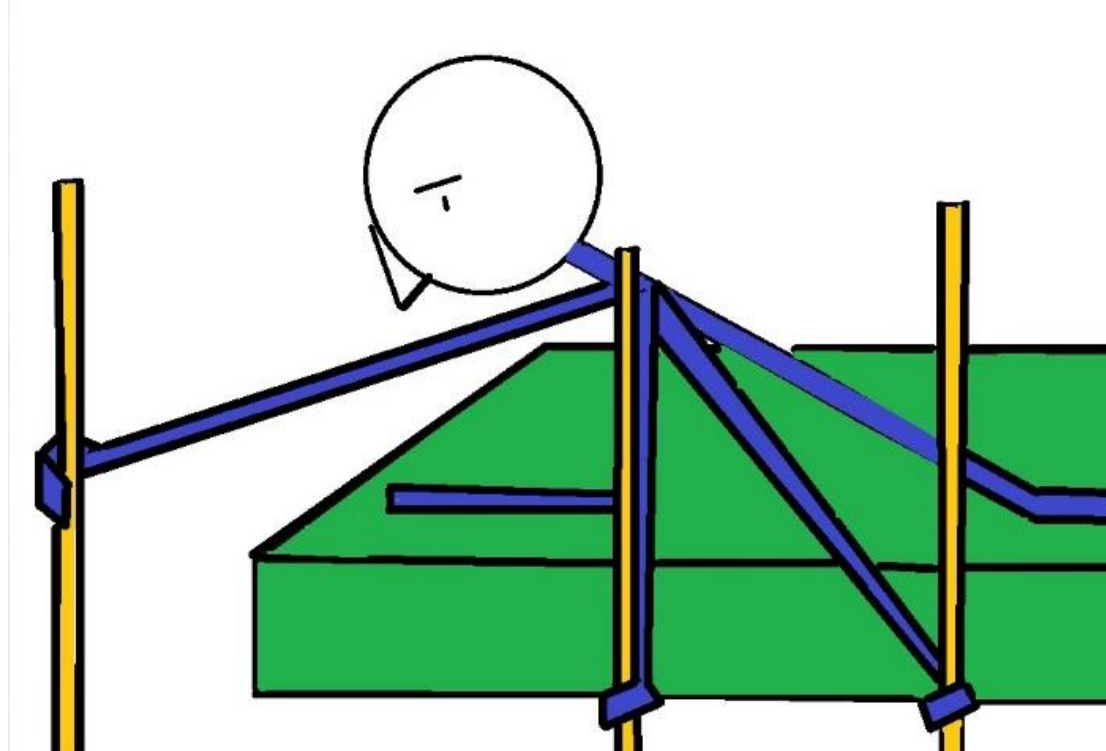
Therefore there is something that occur with this mirror therapy that is better than without it, but there was no generalisation to other moment in which he use his thumb and the position to inhibit the flexion movement synergy was necessary to get the thumb finger.

Then we try this on other way and more task-orientated way and then he was capable to control the flexion movement synergy on an better way and could this movement use in his ADL by holding something between thumb and first finger and released it but with eye control.

That exercise was very heavy and ask an lot of him and he needed some elements of the flexion movement synergy to do it but when he release the stick, he was capable too perform the movement with the thumb also against resistance both ways.

He could hold something and release it with almost no associated reactions in the arm.

The resistance therapy has increased the coordination of the arm but also the part in the hand that was necessary to do the movement and the placing of the stick. (Picture 1)



Picture 2

Picture 2.

The purpose was to place the stick from the position along the buttock to the front. Of course must there an support on the not-affected side but to lift the stich is some aspect of the flexion movement synergy necessary but to hold the elbow in extension ask for the other one.

Picture 2 published with the responsibility and permission of the author by j.v.d.Rakt.

After some time he was capable to do this faster and with an better placement and with an faster reaction. That reaction was also to lose the stick immediately when the therapist ask therefore.

Than make an flexion of the thumb with nothing in between (open chain) and then open again and hold the stick again.

That there was an resistance given on the stick and he must hold without flexion of the fingers and then place the stick in three steps to the buttock height.

Of course by start with some assistance but the coordination was improving and also the power and the possibility to open closed the thumb without flexion of the fingers and now he was capable to do this also with his sleeve of his shirt. The arm go in the sleeve of the sweater to the end and he hold the end and make the movement over his head with the other part of his shirt en release the end of the sleeve on the right time to give the other side more "shirt. Than his was able taking the end of the sleeve of the not-affected side and pull him down to the wrist and finished the job

Why, this worked with him ???



We don't know, but convict us that task specific resistance therapy can more than most people think. And make it possible to get some hand function that is functional but don't forget that is all must have an place in the treatment because generalisation is extreme difficult for stroke patients [42].

4. A. Imaging, mental practice and B. virtual reality training .

This are new approaches that are investigated and design in the laboratories of the rehabilitation. They have investigated or this approaches has an benefit for individuals with an stroke[43,44,45,46,47,48,49,50,53,57,58,59,60].

There are a lot of investigations but often for an very small number of individuals with an stroke and then always individuals that were found in the rehabilitation centre and that is in the Netherlands about 9% of the individuals with an stroke. From this group is an small number of individual capable to do this and used it in the rehabilitation. That makes the outcome of the different investigation very poor and almost impossible to do this on individuals with an stroke at home or in the geriatric rehabilitation. The approach (Robotica) that now today are present in the rehabilitation centre for exercise walking and balance and robotic arm exercise are not superior with other therapy forms. Walking and balance will always need an translation in exercise over the ground at home, outdoor and in all others places. Only over ground training seem also benefit as much as the apparatus that take care of some aspect of the movement of legs and arm. The only difference is that severe patient can walk with such apparatus early and longer than by over ground exercises. But in this view was no room for hydrotherapy. Hydrotherapy takes also an part of the body weight and control over and gives further an lot of perception stimuli that isn't there by the apparatus .

Sato has investigated the perception part and many people [50]) has seen that hydrotherapy can be superior on land exercise when we want to train balance and walking.

The walking apparatus such as the treadmill, Locomat give the patient an faster start with the walking and balance action but this isn't significant. We think that this is the same with arm-/hand-function but still use it in an whole treatment will always make more movement possible and the problem solving possibilities where greater and always make an connection with the ADL and that is an great possibility with virtual reality to exercise on the subject.

That means that we must investigated on an right way (TIDieR) but also make combination with the purpose that the patient can use his arm /hand better as with only one part.

A. Imaging, mental practice.

The idea is that the individual is capable to imaging the movement that he want to make and exercise in his brain the movement that he want to make.

Example :

Look at an high jumper who make himself ready for the sprung.

In his mind this person make the jump, but we see that his body react.

We see that his arms go up when he is at the moment that he must go up and that combination of rehearsal in the brain but also, some elements, in the body.

The rehearsal make in the brain an track that will stimulate the body to follow that track.

Furthermore will this bring an part of the muscle pattern on the right tone and perfect ready for the track that is created in the brain.

Realize that this track is an almost stiff track and that we see by the jumper when somewhat go different that will the jump often going wrong.

This principle out sport, is done by patients after an stroke will but the most important factor is that there is goal where that movement must go that must be rehearsal in the brain. Often that is cut in

piece to get the performance right, better is to get the imagining of the whole movement to the goal. This imagining gives in the brain the same brain action as by the performing only the muscular part isn't present.

There are investigation that give an positive result, but we have never read that this result is significant. Furthermore there is an problem with which movement the individual this must do.

Now part of the walking ability are try to improve with this technique, more knee flexion in the walking performance –imaging and mental practice and then combined with walking in an treadmill and focus on the flexion of the knee.

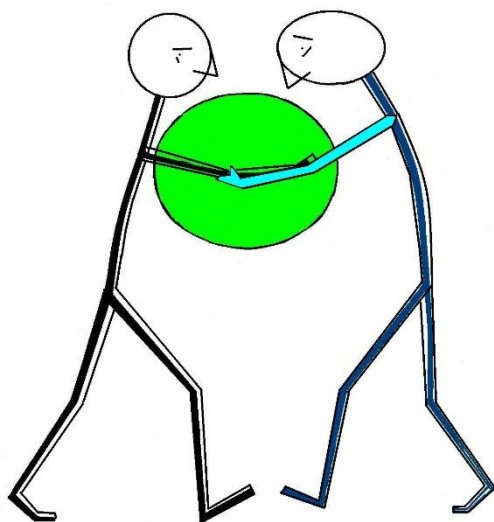
The results that are obtain by older patient in the geriatric rehabilitation are still now none.

An combination of walking and thinking on the flexion of the knee is practice all the time in the explicit learning way, but we know that this is only possible when the patient performs on an “lower” level. And that makes the question realistic what has the greatest learning effect, walking on an lower level with an extra task or an motoric learning program in which the individual must push away an heavy chair of someone else.

This is than an task specific resistance therapy in which we know what the R.M. is and lower the pressure of the load, we have an resistance of 75% and can calculated the amount and the rehearsal to get an muscle fatigue and an increase of coordination and muscle power in pattern.

At the moment that an individual push something away he must flexes his knee to do this and that moment is the best R.M. for walking with knee flexion and then is the problem not the performance imaging but do it. Even in an pool let individual walk faster and the water create resistance and the attitude of the individual will change with more flexion of the upper trunk and the knee will flex[51].

This is an implicit way of learning and the possibilities that the individual learns is far more greater than by the implicit approach because often will verbal instruction give only problems with interpretation and is tactile sign necessary to get the right result.



Picture 3

Picture 3.

The approach with an large ball, pay attention on the way the therapist (blue) hold the affected arm hand of the individual with an stroke .

Holding on this way makes it possible to activated the arm and affected hand, because the power must come from the front diagonals with an upper trunk forward.

The push will be give an reaction in the legs on two ways ;

- 1. The affected leg will have an better swing. More tone in the frontal diagonal.*
- 2. The push of the affected leg must come from the buttock with an flex knee.*

Picture 3 published with the responsibility and permission of the author by j.v.d.Rakt.

When there is an activity in the plantar flexors than there can there be even an push –off occur but first is the flexion of the knee. This control will in this exercise and when the rules of muscle strengthening are follow, will lead to an better coordination of the affected knee and hip and maybe foot. Maybe? Because the foot has often an cortical -spinal pathways necessary to give the push off possibility.

B. Virtual reality training.

What are the possibilities of this new inventions that can stimulated the arm /hand movement.

There are also robotic systems that helps the individual to perform with his affected hand. Till today only in rehabilitation centre and there often only in laboratory.

Thus that means that there are two new approaches and robotic arm that helps to train and that can than over an very long time on an day and with all resistance possibilities. But that can also mean that this is an part of his affected arm and that this arm with this robotic can perform on an higher level (exoskeleton arm).



Photo 2

Photo 2.

This is an proto type of an exoskeleton for the arm and hand function that is loss.

The system is in an developmental phase and not ready.

But with this the individual can exercise but also can this the affected arm give more function and using this the whole day can also improve the affected shoulder, elbow and fingers.

Photo 2 published with the responsibility and permission of the author by j.v.d.Rakt.

This will be the future and then the possibilities are greater than now.

That is the important part of this inventions. The possibilities to train more . Jens BO Nielsen[52] write in his article that individual must train for about 10.00 hours , that is 3 hours each day 10 years long!! That is only possible when there are this invention for every individual with stroke. Jens Bo Nielsen isn't very happy with the robotic because he is afraid that individuals will learn somethings else than the recovery of their affected arm /hand. But this devices is necessary to get an greater possibilities with virtual reality training with the arm and hand.

This can also make the amount of exercise an much larger but then must there be the possibilities to make the movement with the arm that is necessary in the game. And there must be games that has an great equality with ADL and IADL movements. =====



Photo 3

Photo 3.

An example of a virtual reality training with a system that gives the hand function an extra support. In this example, it is the extension of the fingers and the task that is now in virtual is an A.D.L. task in the kitchen.

The benefit of this system is that in a room with no connection with the task, this is a change in a virtual kitchen that stimulates the movements that the person is now making.

He sees therefore that he takes a bottle out of the closet and pours it into a cup.

And this with support of the wrist and fingers.

Photo 3 published with the responsibility and permission of the author by j.v.d.Rakt.

The group around J. Nielsen[52] make a list of what is important for the rehabilitation of stroke patients. They made this list after investigating animals after a stroke and their activity to regain normal ability. Of course, this isn't equal, but the amount of exercising is always according to all scientists around the world, to low intensity but also the amount of time that there is for exercising and also the amount of time that stays after the acute phase is gone.

Furthermore, this group gives other important advice that was important for the recovery from animals and that is also important for humans.

It is therefore not the question of virtual reality with imaging etc. isn't right, but how we can create an optimal situation that the individual can exercise on his optimal level and learn to solve problems and stimulate his brain to recover or compensate or use its ability of plasticity.

Till today, there is a struggle which therapy is the best and that has used a lot of power to create a common therapy with optimal conditions for the stroke patient and especially the arm/hand-function has been enormous, investigated, but the outcome is poor. Only CIMT has shown that this is a way that can make a difference. But then we talk about high intensity with a time of almost the whole day. The approach of the Roundtable gives us the hope that we now search together for the best option to create the optimal climate for the recovery/compensation.

Therefore, it is wise to make a combination of all therapies that are available and search for the patient that can handle this and will recover the best way.

That is one of the first elements everyone must understand: there is no therapy that can do it alone. Search for a treatment that fits this patient.

All treatments of hand and arm are limited, but all together we have a great amount of possibilities that we also can combine.

Still be aware of the fact that the arm is an element of the whole body and that the body will be asked for assistance of the arm when that is needed.

Make almost a fall and see what your arms/hand do to get the body safe again!!

5. Stambak test and therapy[29,30,54,55].

Developmental by Mira Stambak: Une épreuve de pointillage and René Zazzo Manuel pour L'examen psychologique de l'enfant, 1960.



Other people that has contributes to get this approach on this level are Dr.Mesker[56] and colleague Gerard Worm[31].

This is always stay in the physiotherapy “behind the scene”, but the experience with it and with some patient that can perform it, is amazing.

Stambak, Mesker and Worm are people that search for the answer looking and treat children with brain damage because they must also search for an way to build up their brain system.

The developmental of this children has also need for the right stimuli qua intensity but also through the day on an way that it is learning with the greatest motivation and therefore with the greatest result. The test and the therapy is the result to get more out the arm and hand on an complete different way !! The Stambak test start with an set of circle and search than which frequency is for both hands the easy way and which combination is the difficult one .

The test form has an lot of circles that are placed in an different direction and the individual must perform with both hands this test , both hands are at the same time active.

The search is which method is the easy one to perform and in the case of an stroke individual in which case the affected hand can participated the best with the not-affected hand.

All kinds of rhythmic can influence this movement and therefore is there also an search which rhythmic is the best. The must be some arm possibilities but the hand can be use as holding an pen and touch the circles.

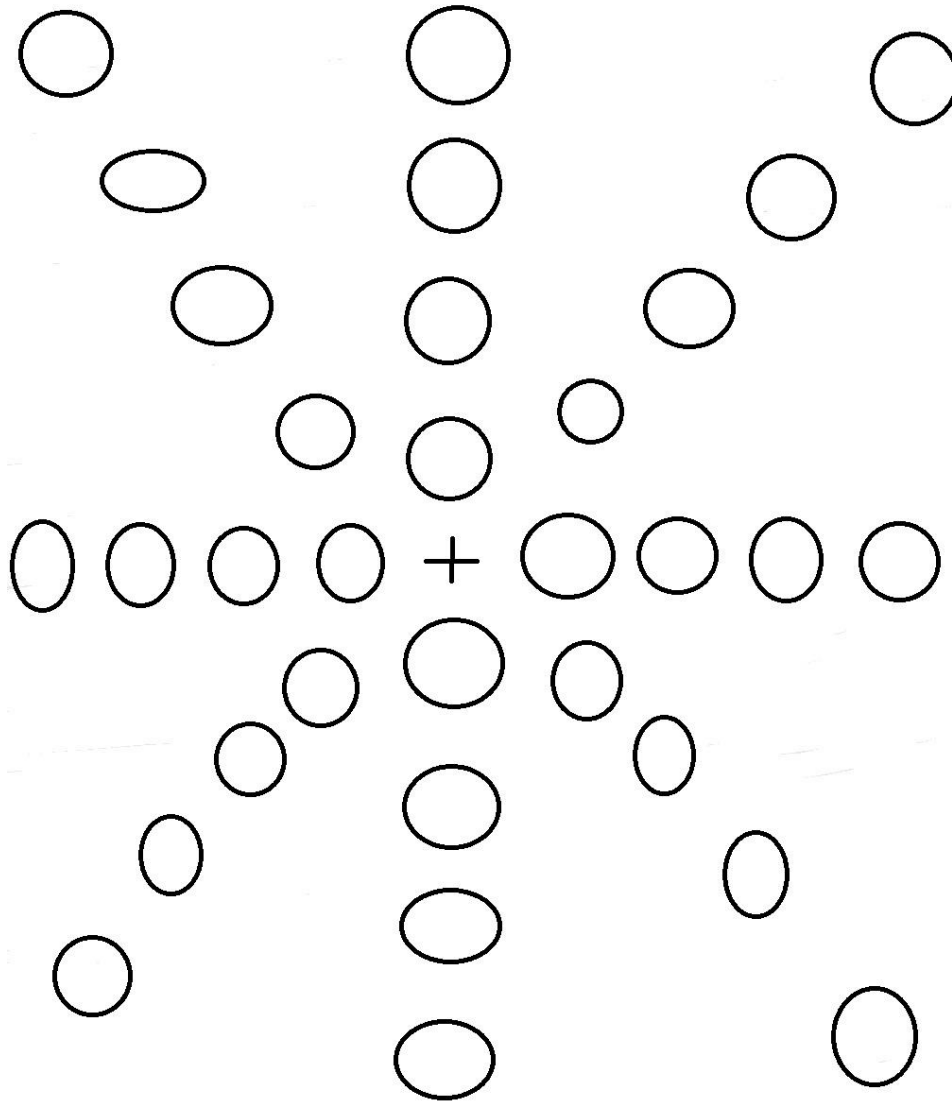


Figure 2

Figure 2. *The base of the Stambak test and the start of an treatment .*

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The purpose of this circles is to investigated what direction and rhythmic is the best way for the individual to perform. With two hands on the same time try to touch the circles with an pencil. Often must that pencil be make greater so that the individual can hold this and make an point. Starting in the centre and go to the edge or other way .

But also start with one hand on the edge and the other in the middle and go to the right or left and of course little assistance or facilitation is okay. The purpose is to investigated what movement is the easy one and what is the more difficult way. We can touch the point but also draw an line between the circles. The result is immediately visual for the patient.

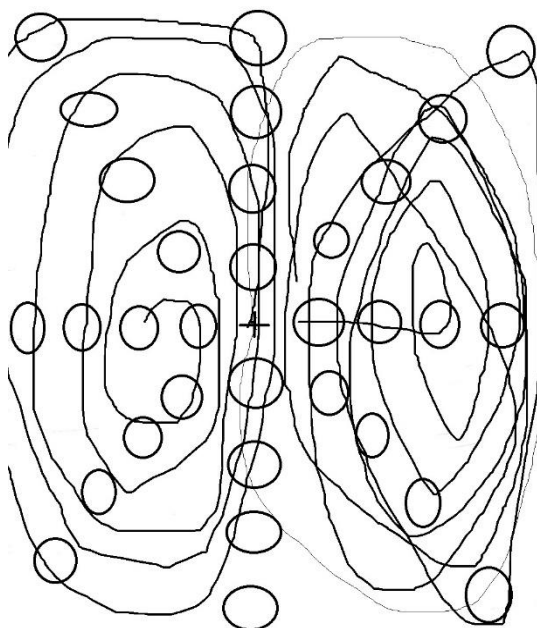


Figure 3

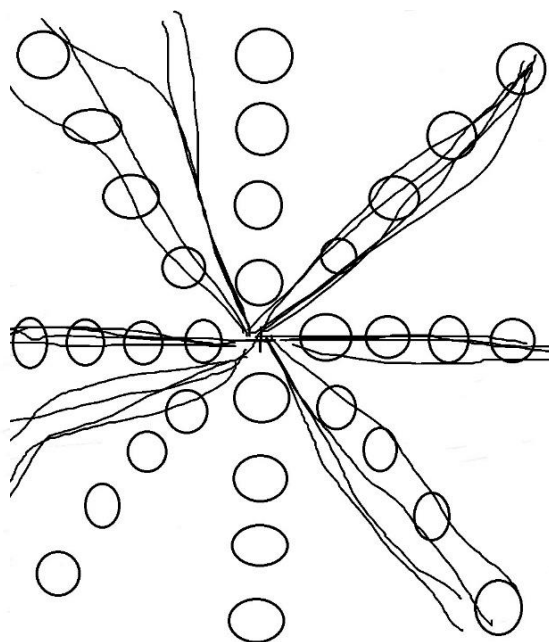


Figure 4

Figure 3 and 4.

This test is from an individual with the affected side on the left side. The greatest problem were the movement in the diagonals on the test paper. From out to the inner point or from the inner point to the outside was difficult but with two hands on the horizontal line goes an lot better.

The first exercise was to make circles and try to touch as much as you can the circles with both hands on the same time starting in the inner and then going up to the side and then down .

Starting with great circles and try to make this circles smaller. This isn't no more an test but is an kind of therapy and on this movement we going to build movement with both hands in al direction always bilateral but the movement can be also opposite from each other.

Figure 3 and 4 published with the responsibility and permission of the author by j.v.d.Rakt.

You need no paper for this activity, you can also do it with ticking on the table in different direction and rhythmic but drawing give always an result that the individual can see.

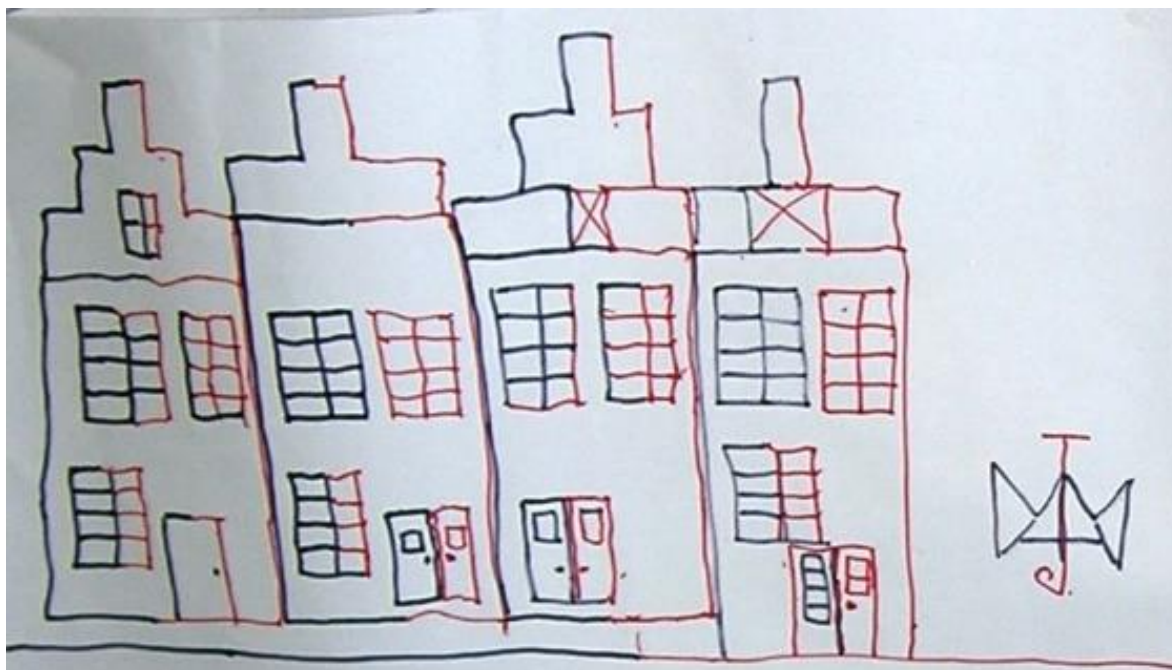
Gliding over the paper he was capable to make an movement from the inner point to the outside but he draw an line and no lift movement was there.

Make movement to the end of the paper asked for more flexion in the shoulder and extension in the elbow and that was difficult because the flexion movement synergy was dominant on the end. But doing this he asked for an lower table and was capable to reach the last circle.

This is problem solving approach and by placing the table lower he was capable to go outside with his affected side –following the not-affected side and make the first attempt for an circle.

To get the pencil from the table and go from circle to circle, he use rhythmic. Both hand go on the same moment and the not-affected hand give the base of this rhythmic.

He has in the past draw an lot and after an while he want to use this capacity to draw an picture and then with two hand and two different colours in which the two hand work together.



Picture 4

Picture 4.

One of the first drawings of this person.

The line in the diagonal direction are not present and the black line are in the minority but there is an complete drawing with two hands together.

The only diagonal line is his signature !!

Picture 4 published with the responsibility and permission of the author by j.v.d.Rakt.

This individual loves to draw after the therapy session in which we first exercises also with the Stambak symbol by using an ball and later on an medicine ball (load) to touch so fast as possible the points in all directions and of course especially in the diagonal directions from left up to right down as most difficult part. Starting with both hand and after that will two balls.

When that was possible we started this treatment in standing and in the beginning there was facilitation necessary but after an while he could do it alone.

The next step was to hang the paper on the wall and he must try to draw now an picture.

That means that the environment was changed and he must draw and pay attention on his balance but there were more moments that his balance wasn't the most important one and we place from the beginning an bench behind him, because he make an step behind to see what his result was.

Of course he goes further with drawing with one hand – his affected one, but at home when he was painting than he paint with his best arm/hand.

He started with painting after he has experience the Stambak test and treatment and when that goes on at home while this improve his capacity certainly.

It is always difficult to find an “job” for the affected hand.

That we search in the ADL but not by asked some abnormal as dressing with only one hand when there are the possibility to dress with two.

That asked for treatment on the level of every individual.

Bilateral training and of course in this case there was an stimulus to get further and created an situation that he goes on with his hobby painting. There other forms of bilateral training as with an apparatus that can be used as an bilateral training but also as an unilateral training. And the difference in effect between bilateral or unilateral training isn't great according an systematic review [59], but still is this important ?The important thing is that there is an treatment on the right level and that this give

success. And when we composed an treatment that has all elements, than there will be the best outcome when the intensity is right and the amount of time that must be exercise and the environment is positive for searching for solution.
This intensity andetc, isn't clear and is still part of all discussions.



Picture 5

Picture 5.

The first picture in standing position. The paper was hanging on the wall and that was an very difficult position because now he must work with his affected hand concentric in the keypoint – the affected shoulder.

Picture 5 published with the responsibility and permission of the author by j.v.d.Rakt.



Photo 4

Photo 4.

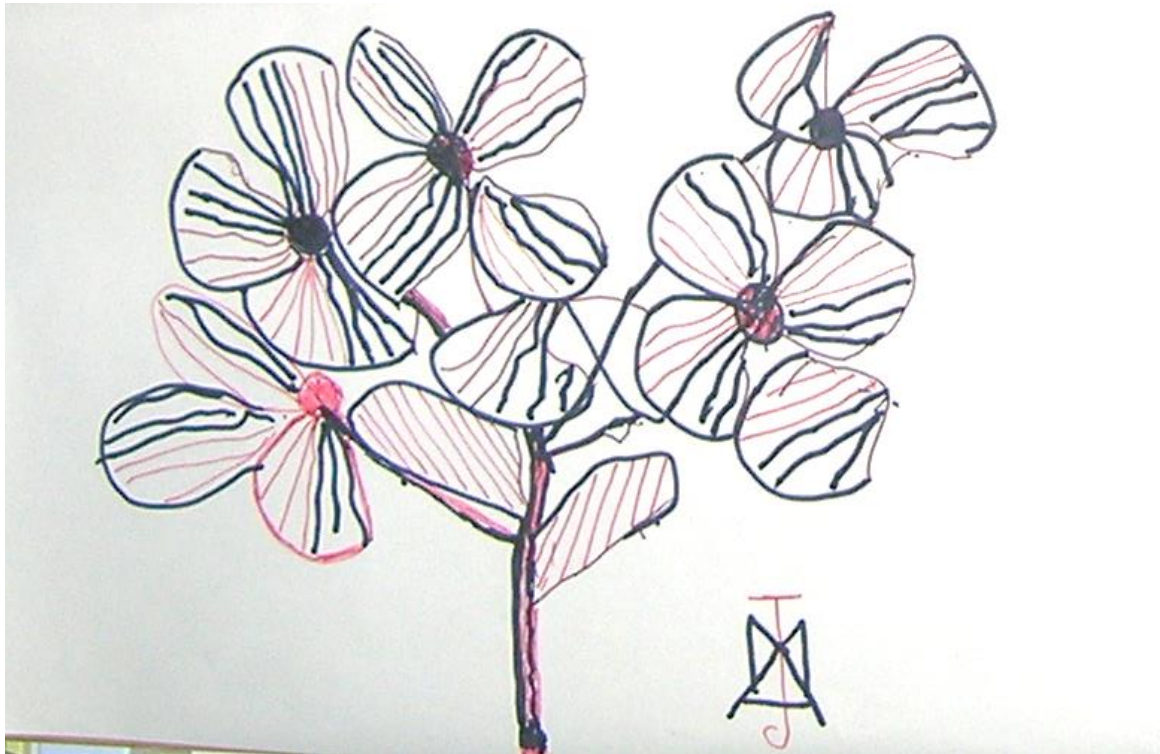
An apparatus to stimulated the bilateral movement or unilateral, both is possible . There is the possibility to give resistance and make the intensity of the movement from and too the body be heavier.

There is also an trunk restriction system applied to hold the trunk in one position. This will stimulated the front diagonals because mow there is an stop of the chest an stimulation to create more protraction.

Photo 4 published with the responsibility and permission of the author by j.v.d.Rakt.

What is the best way ? Not important, because the result is that what matters. When an patient exercise on high level with high intensity and long-time with what makes no differences on exercise level but the problem is ;

“is the brain stimulated to solve an problem and can we make the step to use in the ADL !!



Picture 6

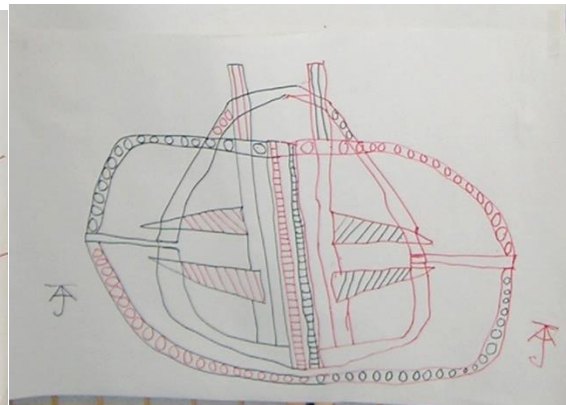
Picture 6.

An artist is born ! This picture was for him the evidence that he still could draw. He was left- handed but his affected side was so far going better that the black line are the dominant lines and the not-affected hand has an lesser role.

Picture 6 published with the responsibility and permission of the author by j.v.d.Rakt.



Picture 7



Picture 8

Picture 7 and 8 are two picture that were perform in an standing position with the paper in front of him on the wall.

Picture 8 gives an picture of the problem he had to hold his hand in his shoulder in the 90 ° angle but after exercising he managed that also.

Picture 7 and 8 published with the responsibility and permission of the author by j.v.d.Rakt.

Again not all individuals must draw but they will see immediately the result and that can stimulated then to go one. There is also no therapy the best, that isn't important there must be an therapy that is for the individual the motivation to do it and therefore recover from his stroke. It is so important that the brain must search for solution thus never can the treatment be the same as the treatment the last time .

Use:

- Task specific resistance treatment of different hand position that there is an increase difficulty (intensity) in the exercise.
- Do it and when it is possible and increase the difficulty
- Don't stand still, but stimulated further improvements

Use the capacity to use two hand also in the ADL. Move with two hand together in both sleeves of the sweater and see what this give as result. He was much faster after an while than the strategy he has learned on the ward.

Bilateral[57,58] arm treatment has an lot of discussion because the not-affected hand will take too much over. But when the affected hand isn't part of the daily hand exercises what will then be the influence of the not-affected hand on the affected hand, now there is an action in the arm/hand. And in combination with other forms, drawing the picture according Stambak with robotics or F.E.S, the focus will lie on the picture -the result- and that must give the motivation to get all on an higher level.

6. Robotica

In this field there is an lot of inventions that makes walking and handling with the arm/hand easier. By walking we have seen the Lokomat and there are now skeletons that give people with spinal cord failure the possibility to stand and walk.

We are always enthusiastic about this new inventions because new methods are available to get the treatment on an higher plane and increase the results.

Regrettable this has often an dark side and that is that the treatment that was given isn't right any more. We must go on with the robotica approaches and that because it is another possibility to increase the possibilities to treat people after an stroke but makes combinations.

That the rules about intensity and carrying -over effect to the ADL and IADL must be the base of the treatment not an apparatus. But It is very expensive and all great institution must have this apparatus and there must be much done with this apparatus because it was so expensive.

But when we use an combination ??

Walking on the lokomat as an training on aerobe level and maybe anaerobe level but the training to learn walk in their home and on the street must be done at home and on the street.



Photo 4

Photo 4.

Lokomat, this apparatus is capable to give more support where the function is too low to get an normal walking pattern. Also is it possible to increase the speed and give an aerobe training.

Photo 4 published with the responsibility and permission of the author by j.v.d.Rakt.



But when the enthusiastic period was over, the results in difference with the USUAL care wasn't not there[61] . What we do know, not use it anymore or make it an part of the exercising for an stroke patient especially who has great problems with standing and walking after an severe stroke.

And often lies that person not in the Rehabilitation centre but on the rehabilitation ward of an nursing home where she cannot pay so large amount of money and there should be an cooperation must started to make this possible.

But not with the option :

“Come to the centre “! We have the apparatus that can you teach walking again, but with an program that the use of the apparatus can be part of the whole treatment plane !!

Make an treatment plan and be **eclectic!!**

And can we combined the specific conditions:

- Walking with different speed and direction
- Walking at home or even on the street
- Walking with all sort of unexpected moments that asked for solving
- Walking with high intensity that increase the coordination and the muscle power.

On one site the robotica that helps to walk and photo 11 (the FLOAT –system [60,62] give an example that is stimulated to walk within the possibilities and stimulated the patient to search for his borders. In this he use everything also the swing of his arms that are now an part to recovery the balance but also stimulated the walking capacity and speed of his legs.

Here we see that the diagonals work together and that means that the base for the synergy(pathological) is less and that the whole system makes an swing to the front to get the other leg as fast as possible to the front and vice versa.

What is an rule for walking will be also an rule for using the hand/arm. There must be an reason to do it by solving problems.

The CIMT approach let see us and what the intensity must be (almost against the border of the possibilities) and the amount of time.

Further it always important that we control the reaction of the affected arm in robotica system. The FLOAT system we see it but in the Locomat the affected arm has no contribution and the not-affected hand is to control the upright attitude and balance. Often the affected arm is going the whole time in retraction because the not-affected leg do the most and will fixated the affected arm in retraction. And that will inhibit the possibilities of this arm and increase the tone and the synergy and asked for an special attention because complaint about this are known.

With this in our mind look to the possibilities of hand/arm function improvement with robotica.

Also in the arm and hand movements are people searching for Robotica[63,64,65] that can take over or give sufficient support to get more use of the affected arm and hand.

Especially an recent invention ;

The “Gloreha” that's has the possibilities to let de hand and the fingers do things so independent that exercises for the different fingers is possible with total support but also with an decreasing from this support.

Exercising the wrist and hand and the finger movement independent but also exercising picking up things and transport then and place this somewhere else.

**Photo 5****Photo 5**

The Gloreha is an system that now is activated by the muscle of the underarm to the fingers but this activated can be total but also only helping to get the job done.

In this photo pick up and release this piece is possible because this system make sure that the hand closed good and open at the moment that this is correct.

Photo 5 published with the responsibility and permission of the author by j.v.d.Rakt.

But this isn't not an brain instruction of the individual to his affected hand but this instruction is done by the computer that will let the fingers move.

The problem will be that the instructions of the affected brain are not reached the affected fingers and that the computer must do this. By looking at the computer the individual get information what the computer is going to do and the individual must follow that instruction. When there is total no function the computer will do the whole job and we have the same as the Handmaster of the NESS system[66]. Further one we need an robotica system, one that works with the hand and one that take care of the shoulder and elbow movements and we know that this also included and part of the upper trunk and because this upper trunk is an part of the whole must also the diagonals work otherwise the movement has no right fixation.

This robotica system is capable by using an computer to stimulated the movements of the hand. The shoulder and the whole shoulder girdle /upper trunk is yet no part of the system.

The function of the hand can, through this computer program, pick up something and place it again on the table but need an support system for every movement that involves the rest of the arm.

The difference is that the computer is finer than the Handmaster because there was only an muscle stimulation by electro impulse, now the hand is stimulated by the computer and that can be very selective.

But still the activity in the damage brain is minimal because the brain has often an damage connection and projection and the rebuilding of that projection isn't present.

But there are some directions that the input of this movement give an reaction in the brain and that is very useful in the period that the spontaneous recovery take place.

Till now by walking and hand/arm function an robotica system give support on the outside with his own computer and makes therefore walking and hand movement possible . That means that the individual has to carry an outside system with computer and that can be very much and very heavy to get this thing on !!

Here we can make also an comparison between the lokomat as walking "aid" that is capable to take complete over the walking movement and the FLOAT system that make walking lighter and make therefore more walking specification and training possible.

Now we have :

1. Intensity , because the person must work against the border of his abilities.
2. Time , because the amount of time that he can make in that system is almost endless and dependent of his condition.
3. All form of task specific resistance therapy is possible that will increase the coordination and power of the muscle in the task. This will make the carry-over to the ADL easier.



4. And we have the perfect learning environment because every step must be a problem solve and we are able to make so many problems that the variations are endless.

This 4 point must we have also when we are working with the arm and hand recovery. Of course some point are too realize with his hand Gloreha but it is too large to carry with him and experience his abilities through the day on all kind of ADL moments and with every time new problems.

What the FLOAT system show is that the amount of arm force to get the walking on the right speed and the balance under control will be the challenge that this apparatus must do with the hand and arm and has an good connection with the ADL.

To solve this problem all kind of computer program are made in which the hand make an movement that the patient can follow on screen and try to pick up the item in front of him or make an movement on the screen through an tennis play program.

But the missing link is the ADL.

This exoskeleton show what the future must bring!

An system attached on shoulder, elbow and hand that able the person to use his arm / hand in the ADL and that must be done the whole day and then we have the problem solving approach and will the therapy be pointing on the task specific resistance therapy and hand-on facilitation further recovery of the dissociation of the synergy and an further working on an higher selectivity but.....

Than must this device available for everyone for 24 hours and much finer and lighter.

Robotica that has the capacity to control the affected shoulder /arm always to the hand and fingers is the ultimate outcome to replace the cortical- spinal pathway. But the amount of activity that this hand/fingers must capable off, must be equal with that of our hand/finger function.

That is now utopia but the start must be reaction in the hand that can used in the ADL and make it possible to learn with this system.

And that asked for light ,simple device that can be used the whole day.

Summary hand therapy.

What is clear is that the sciences and also the engineers try to find an answer to get the function of the arm and especially the hand on an higher level.

The recovery of many stroke patients is increase but the recovery from the hand stay on an too low level.

The CIMT was perfect for an small group that don't use there paretic arm but has the ability. That means that the cortical-spinal pathway was still present but all others that hadn't that the outcome was still poor.

Science has search for an technique solution and we are coming close to an device that is easy wearable and will give some control over the possibilities of the hand but now we must have an treatment that fits .

We have learned from the CIMT that the intensity must be very high and the amount of time that the arm is use must be high with therapy that askes more of the possibilities and give an muscle pattern fatigue to increase the coordination and the power.

That means that we must have high skill therapist that are able to push the dissociation forward and control the tone, mobility and the alignment and are capable through hand-on facilitation to get the patient on an higher level with the robotica as part of the treatment plan.

Than will be an lot of ADL and IADL movement be possible with hand function and will the total recovery of the diagonals also take place.

Now the invention are used in an room where the patient is exercising for an computer screen and the problem will stay that the transfer to the ADL is much too large.

The amount of therapy for the arm/hand is great and of course not all patient fit in such an program therefore be sure that you have enough possibilities to change the approach.



The robotica and also the F.E.S. must develop further to small devices that the patient can wear the whole day and now start the treatment with all that wonderful approach there are. See the patient with the Gloreha paint or draw according the Stambak approach or In their book Pat.Davies[67] give an hint, how that total therapy must be realized. With this robotica the whole day on go through the moments of the ADL to solve the problems and create better mobility, coordination and muscle pattern power in the physical treatment sessions. And she is not the only that point in that direction

At the end of this article, listen to another sound to stimulated recovery !!

On the other hand there are many investigators that have investigated the recovery by animals and see that the human stroke patient is slow and exercise on an very low level.

Investigation from Prof. Jens Bo Nielsen[52] and his group give him the conviction that the therapy that individuals after an stroke received, is but an fraction of what she must have to get the best possibilities to recover to far as possible.

Animal research give him this conviction and then he calculated that animals after an stroke are much more exercising.

Points out his article "Science -based Neurorehabilitation : Recommendations for Neurorehabilitation from Basic Science Journal of Motor Behaviour" from 2015[52] are :

1. **Intensive- heavy – and long-time exercises. An calculation is that there are 10.00 hours needing to get the best results. That means every day exercises for 3 hours on the right level for 10 years.** Every day also in the weekend, must there be an high intensity for 3 hours but the remaining part of the day the intensity can be lower but the problem solving goes on. Still in the Netherlands there is only one rehabilitation centre that has this program for young people till 35 but the large group of stroke patient must be glad when the receive 45 minutes for 5 day and then are often the robotica not available and is the hand therapy only be present when the prognostic is positive.
2. **Passive movement are useless for the recovery of the brain projections, the brain must have active movement and there information.** The brain has nothing on passive movements but there is also the assignment of every therapist to hold the mobility, alignment and the condition of the body on the highest level and that means also that the tone must be inhibited when this is too high because than are no movement possible.
3. **Aids, apparatus and robotic not too fast, because this will change the ADL/IADL to fast and changed the search of the brain to solutions.** The relation with the ADL and IADL is so important this aspect makes that an treatment will be use during the day and no treatment can without this aspect and that makes all laboratories treatment so vulnerable, because the "transfer" to the use in every day practice isn't there. An patient that can walk in the Lokomat but not on the ward will not relearn his walking capacity because he cannot use his abilities. That is also the case for robotica that makes an hand-function possible, when that isn't useable in the practice it will not give an change in the brain and make an new projection.
4. **The system must learn solving problems with his new possibilities.**
5. **Exercises with an lot of variation because always the same on the same way will give an decrease of the projection in the brain and therefore loss of possibilities.** This is an important item because in many geriatric rehabilitation centre, patients do every day the same and that makes that the brain isn't stimulated to solve problems because the problems are always the same. By using task specific resistance or exercise in another environment can solve that problem and create an whole new world in which the patient can use his new abilities.
6. **Sleep is essential to hold that what the individual has learned. And sleeping after the treatment is thus an very positive moment and must be stimulated.** [68,69,70]The importance about sleep is growing. An good sleep will able the brain to "re-organising" the system by that what that day is happen or in other words the learning aspect take place during



the sleep. Therefore a good sleep is important and the occurrence of apnoea[71] or bed sleep will decrease the learning effect.

7. **Diet with glucose and neurotransmitters will stimulate the recovery process and that must be given extra.**
8. **The must be challenges – targets – to stimulate the learning process.** Is so simple but look to the locomotion he takes over the way of walking and the total balance the only variation is the speed and that speed is then the only target. But with the FLOAT is even dancing possible. Be sure that there is variation.
9. **Always end with an aerobic training. Stimulate the circulation of blood and O₂ in the brain.** Correct but at the beginning has also great importance because that the circulation is improved and is the damage brain in optimal condition, on the end is also important to get the feeling of fatigue and an stimulus for a good rest and even a short sleep.
10. **Take care for motivation and reward because that increase the level of dopamine.** Reward has an effect on the dopamine system !!
11. **Our level of exercises is about 19 % of that of animals after a brain damage.**
12. **Targets must be realistic but not easy**
13. **Use load to increase the difficulty of the task .**

Here we see what the word intensity means and what the amount of times means. Happy that the discussion “More is Better”[72] is ended and that we search for the optimal dose .

Dose with the right intensity (heavy –load) and the period that this must be done (time) and then we know how often this must be done (Frequency) and when we Prof. Nielsen believe that is the amount of time and the frequency far too low and look the intensity better but still there must be some progression in that intensity otherwise there is no result and that isn't often not the goal of the patient but from the treatment.

Be obvious that the treatment of the arm and hand after a stroke in an open chain will be benefit from science and their invention but that must that invention be so that people can use them during the day in their ADL.

Then the treatment plan must be complete.

That means that the difference between the physical therapist and the occupational therapist must be not so large, the first do the walking and leg and the other ADL and arm /hand.

In all treatment must be an aerobic and anaerobic element, there must be task specific resistance treatment be present and there must be problems solved.

That can start in the morning by the washing dressing an movement in the out bed but also in the mid of the day by going to bed to rest or standing up after the rest. That is possible during the meal and of course tired an going to bed.

That can on the physical and occupational ward with a specific treatment on a higher intensity level but also in diverse environment as in the swimming pool. The amount of moment to integrated ADL and IADL are so big that the whole can be exercising on diverse level of course but always with the elements aerobic and anaerobic and with sometimes more focus on the arm –hand function, or leg , balance walking or diagonals but never only one element.

The whole body asked for a treatment even the hand must have a shoulder and that depend of an upper trunk and the upper trunk must have a lower trunk to stabilised.

Therefore the last part of this article goes over the stabilization that a paretic arm must do when the other part are working hard but also when the paretic arm /hand are working what must do the rest of the body to able this.

Conclusion.

Treatment of the affected arm/hand is very difficult and the result are often minimal. That has to do with the importance of a cortical-spinal pathway and when this is damaged than is a good result that



look like an “normal” hand function almost impossible. Therefore the search for system that can replace or stimulated the hand function. Till now this isn’t found but that this must be searched in robotica is sure. Still an good shoulder function is also necessary and that part will be asked for an treatment that use the system of closed to open chain and will be necessary always.

Furthermore is the relation with the ADL so important because here we can create an climate in which the patient used this new skill and lift it on higher –automatic- level.

What is very interesting is the discussion of learning and intensity.

Till today so many therapist are using an explicit form of learning by damaged brain –patients and also is the intensity dependent of the time that the institute give for the patient. Even are the centre where the family is asked to take an part of the therapy over to create more time and that isn’t intensity. Intensity has to do with heaviness and difficulty and to ignored this the base of the treatment isn’t right.

Hopeful is that no ended and we search for the right way to learn and exercise with the right intensity over an long period to get the optimal result.

And hopeful the arm/hand will receive that amount and intensity of treatment that he deserved.

In the chronic phase the treatment are often stopped of firmly decreased and we know that often people will feel that they cannot hold that level. But often is in the sub-acute phase an moment that it look that the recovery falls on lower level. The reason can be that the spontaneous recovery is stopped but more often is that the diagonal system has problems with the stabilization of it system.

By person after an stroke we see often that the affected arm goes in an synergy pattern when people walk or do other exercises. That stabilization is often not seen and neglected with all negative effects for the arm/hand possibilities. That is the main item of part 7.



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