Functional Strength Training Treatment Manual

4. Procedures, activities, and/or processes used in the intervention

4.1 Individual exercises for Muscle Strength and Muscle Endurance

Although not directly related to function, progressive resistance training (PRT) of individual specific muscles is considered an important background to functional tasks. The aim of this section was to incorporate all the specific movements of the upper limb, in relation to both the gross proximal movements and the finer, more dextrous, distal movements. The therapist would then be able to choose appropriate movements depending on the participant’s areas of weakness and voluntary muscle activity. For the strength training sections, it was decided to give separate guidelines for ‘strength’ and ‘endurance’ training. The PRT consists of two parts:

4.1.1. PRT to increase the endurance of muscle performance;

The PRT to increase endurance consisted of basic resistance training for healthy adults, using progressive resistance and an increasing number of repetitions in sets of 10 (to a maximum of five sets).

4.1.2. PRT to increase strength.

To ensure that practice was of sufficient intensity to cause an increase in muscle strength, a way of quantifying the load called the Functional Repetition Maximum (FRM) was used where possible. The repetition maximum is defined as the load that can be lifted a number of times without resting. For example, the 6RM is the maximum load that can be lifted repeatedly, without rest, 6 times and no more. In the treatment manual we used the FRM where the load was defined either by the weight lifted, or in other functional ways such as the distance or height moved or the size of the object. To obtain an increase in muscle strength, it is recommended that a repetition maximum of between 6RM and 9RM is used. The 9RM is easier than the 6RM. The choice of which FRM was based upon the therapist’s assessment of the participant’s ability and their observation of adverse effects such as excessive activation of muscles not involved in the exercise, excessive fatigue, and pain. The FRM was assessed regularly to ensure progression of the load as appropriate.

4.2. Functional training

Functional training included both whole and part component practice of functional tasks. The rationale for inclusion of component practice is that the components may be practised in the relevant functional position only. This was to distinguish FST from task-specific practice, in which component parts may be practised in positions that are different from the functional position in which the task would normally be performed.

4.2.1. Hand Reaching/Retrieval Activity

The activities in the reaching and retrieval section were developed by our team based on everyday tasks performed in healthy adults. The reaching and retrieval activities can be practised while sitting, standing, or lying, and are progressed by increasing size and weight of each object, height of shelf, moving objects further away (and therefore increasing force required to reach it) and moving faster or by decreasing the amount of support from the environment to support the weight of the arm. Reaching and retrieval to objects both at the front and the side of the participant were included.

4.2.2 Hand Grip

Aiello and Dean 5 produced a detailed account with associated illustrations of different hand grips. This work was used in conjunction with work by Elliott and Connolly, 6 who published a classification of hand movement, and discussion with a hand therapist, to produce five different types of Hand Grip with associated functional activities. The five different hand grips were:

- Pinch / precision – one or more fingers and thumb gripping a small object
- Hook – with the fingers in flexion, for example when carrying a shopping bag
- Power – squeeze – for example when holding onto a bar or umbrella
- Power – disc – for example when unscrewing the lid of a large jar
- Flat hand – for example when carrying a plate, with the hand outstretched underneath

Associated functional activities have been sourced either from the literature above, or devised by the research team at St George’s University of London. Equipment was obtained from North Coast Medical, Hand Therapy Catalogue 2003-2004 and Nottingham Rehab Supplies 2003/04, from local shops or made to specification. Any equipment that has been made, such as the ‘block’ for attaching bull-dog clips and the ‘nuts and bolts’ underwent a risk assessment by the health and safety representative prior to use.

4.2.3 Hand Manipulative Activity

Elliott and Connolly 6 published an excellent classification of the patterns of hand movement when manipulating objects and detail three classes of intrinsic movements – that is, “coordinated movements of the digits to manipulate an object within the hand”. These specific movements and associated functional activities were incorporated into the ‘Exercises for specific activities’ section of the manual.
4.2.4. Progression of Functional Strength Training Practice
The functional training interventions could be progressed by increasing the repetitions of the specific task, increasing the weight, height or resistance in the exercise, by altering the size and/or shape of the object (either larger or smaller) to be more challenging, or by progressing to a more difficult task. It is important to sustain the participant’s level of attention, as this may be linked to functional outcome. Suggestions for progressing each exercise are given in the ‘Exercises for specific activities’ section of the treatment manual.

Therapists were instructed to try to minimise the presence of compensatory muscle activation from muscles not involved in performance of the exercise or activity, by choosing the appropriate level of difficulty of exercise or activity for the participant to practice.

4.3. Facilitating skill acquisition
The following section applied only to the practice of functional activities and exercises, and not the muscle strength exercises.

4.3.1. Motivation through goal setting
It is essential that patients feel motivated to engage in their rehabilitation. Goal setting can enhance motivation and engagement in rehabilitation and clinical guidelines for stroke recommend goal setting as an integral part of rehabilitation. Therefore, the participant and therapist discussed the activities to be prioritised, and documented these on the treatment record sheets.

4.3.2. Structure of practice
Practice has an important influence on the learning process. The therapist assessed the participant’s ability to perform each of the functional activities at the beginning of the training session and noted the movements and movement components which were difficult to perform. The guidelines below for structuring practice were followed.

Whole/part practice: assessment commenced with whole practice, to enable the therapist and participant to identify which components (if any) were more problematic than others. If the participant was able to correct the problematic component(s), then whole practice could be used. However, if they were unable to do so, practice focused on the components that were problematic. Where possible, the practice session ideally finished with whole practice to enable the participant to put the component into context, and practice the dynamics of the task as a whole (and thus the entire motor programme). Whether whole or part practice was employed, the amount of movement required was made clear by placement of targets or objects.

Constant/variable practice: constant practice involves the repetition of exactly the same task, whereas variable practice involves practice of different variations of the same category of tasks. Activities of daily living are inherently variable, so as the participant begins to master an activity or exercise under constant conditions, variable practice should be introduced. Variable practice was achieved by many means, for example, using different start and end points (e.g. reaching in different directions), different postures (e.g. sitting/standing) as well as using different objects. Over the course of treatment (either within a treatment session or over a number of sessions), practice was progressed from constant to variable with the aim to increase the complexity of the task, to continue to challenge (but not discourage) the participant and to facilitate transfer to activities of daily living.

4.4. Feedback
Augmented feedback (i.e. feedback provided by the therapist) is one of the most important influences in the skill acquisition process, and therefore its application needs to be carefully considered. Augmented feedback pertains either to the pattern or the outcome of the movement:

Feedback about the movement pattern is known as Knowledge of Performance (KP). An example is stating to a patient that they leaned sideways or elevated their shoulder during reaching.

Feedback about the movement outcome is known as Knowledge of Results (KR). Examples include stating to a patient how long it took them to reach, how much grip force they produced, or what their accuracy was in an aiming task.
4.4.1. Amount and frequency of feedback
The amount of feedback delivered to participants was an important consideration because despite
evidence that it can speed up learning and allow a higher level of skill to be achieved, and that people
with impaired intrinsic feedback processes rely more on augmented feedback, it is insufficiently used in
clinical practice. A faded feedback schedule was recommended, whereby feedback was given
frequently in the early stage of learning, and less frequently as the participant progressed. This is
based on work in healthy participants and people with brain injury which has shown that providing
feedback on 50% of the attempts at a task is often more effective than providing feedback on 100%
(i.e. every time) of attempts. This finding can be explained by the notion of independent problem
solving; where possible, patients benefit from working things out for themselves.

Another strategy for fading feedback was by providing bandwidth feedback, which is where feedback is
given only when performance falls outside the specified criteria. For example, a person with stroke may
use his/her trunk movement to reach forward for a cup. The therapist may want to discourage this
compensatory movement and stimulate active shoulder flexion instead. By placing an object so that the
participant's trunk touches it if the trunk moves forward too far, the participant will realise his/her
mistake. Note the participant only receives this feedback if he/she does something wrong, otherwise
practice continues with the participant knowing his/her performance is correct. This type of feedback
promotes consistency of performance.

Periodically, it was recommended that a summary of feedback or an average feedback score was
provided to the participant, formulated in constructive terms. An example of summary feedback is the
number of times out of 5 attempts that the movement was performed correctly. An example of average
feedback is the average measured height that the participant could lift an object over 5 attempts. Both
of these methods means that feedback is not provided after each attempt, but only after a certain
number has been completed. Both summary and average feedback are postulated to be more effective
than feedback provided on every attempt by providing the learner with an opportunity to process their
intrinsic feedback and reduce reliance on the augmented feedback.

4.4.2. Attentional focus of feedback
Feedback can induce an internal focus of attention in the learner (about the body and body parts) or an
external focus of attention (about effects of the movement on the environment). A considerable body of
evidence suggests that external focus feedback is more effective for the acquisition of a range of skills
compared to internal focus feedback in healthy people and there is also some evidence for this in
stroke. For example, to encourage greater extension of the elbow in a reach-to-grasp movement,
saying ‘next time, move closer to the cup’ (external focus) could be more effective than ‘next time,
straighten your elbow more’ (internal focus). The predominant explanation for this finding is that
feedback with an internal focus may interfere with automatic motor control processes. Participants
need to be provided with some essential internal focus information in order to avoid movement patterns
that are potentially detrimental, but the evidence suggests that thereafter feedback inducing an
external focus of attention will be more effective.

4.5. Order of activities in each treatment session
Within the functional portion of FST, the therapist managed practice of up to 3 activities in each
treatment session. If a smaller number of activities needed to be trained, the time was spent on
practising several exercises for the same activity. For example, if only one activity needed to be
trained, 3 exercises for this one activity could be undertaken. The practice for each activity began with
an assessment/reassessment of the functional activity to be trained. Performance of the activity was
observed, and the therapist decided which component(s) would be practiced in the session, depending
on the participant's areas of weakness and voluntary muscle activity.

For each activity, individual muscle strength exercises were performed first, followed by whole and part
practice of functional activities. Within the individual exercises for muscle strength, endurance
exercises were performed before strength exercises. Activities and exercises were chosen from the
menu contained in the 'Exercises for specific activities' section of the treatment manual. The activities
were progressed by modifying the weight or size of object used, and the number of repetitions. The
participant was either seated at a table, standing at a counter, or if necessary lying, when practising the
activities. Within the task-related exercises, the whole task was practised first, followed by part practice
exercises for the activity.
Exercises for specific activities
1. Muscle group specific movements: muscle strength
Activities for strengthening specific muscle groups can be seen in Table 6.1 below. Activities should be increased to three sets of 10 repetitions before the resistance is increased. In this study ‘North Coast Exercise Band’ was used (levels 1,2,3,5,7) to increase the resistance.

<table>
<thead>
<tr>
<th>Movement</th>
<th>Activity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finger and thumb adduction/abduction</td>
<td>Adduction/ Abduction using theraband and with forearm and wrist supported</td>
<td>Progress with different resistive theraband</td>
</tr>
<tr>
<td>Finger and thumb extension</td>
<td>Using theraband with forearm and wrist supported</td>
<td>Progress with Velcro of different width</td>
</tr>
<tr>
<td></td>
<td>Pulling Velcro apart with loop for finger</td>
<td></td>
</tr>
<tr>
<td>Individual and simultaneous finger flexion</td>
<td>Digital spring strength trainer</td>
<td>Progressive with digiflex of different resistance</td>
</tr>
<tr>
<td>Thumb flexion and opposition</td>
<td>Using theraband with forearm and wrist supported</td>
<td>Progress with different resistive theraband</td>
</tr>
<tr>
<td>Lumbrical flexion</td>
<td>Forearm in full pronation with forearm and wrist supported by table. Flexion at MCPs</td>
<td>Weights over fingers to progress as appropriate</td>
</tr>
<tr>
<td>Wrist flexion/extension</td>
<td>Forearm in mid-pronation and elbow at 90° directly inferior to the shoulder, and proximal two-thirds of forearm supported on a side-table.</td>
<td>Progression by increasing the number of sets of 10 attempts to a maximum of 5 sets of 10. Weights of up to 2kg may then be added to the palm/dorsum of hand.</td>
</tr>
<tr>
<td>Wrist ulnar/radial deviation a</td>
<td>Using theraband with forearm supported</td>
<td>Progress with different resistive theraband</td>
</tr>
<tr>
<td>Supination/pronation</td>
<td>Forearm supported and move between pronation to supination. Object may be held in hand</td>
<td>Progress with weight and/or lever arm, e.g. start with rolled newspaper and progress to rolling pin</td>
</tr>
<tr>
<td>Elbow flexion/extension</td>
<td>Elbow and shoulder supported as required</td>
<td>Progress with free weights or theraband</td>
</tr>
<tr>
<td>External/internal rotation at gleno-humeral joint</td>
<td>Forearm in mid-pronation and elbow at 90° directly inferior to the shoulder. Take lower arm across/away from body</td>
<td>Progress with theraband of different resistance</td>
</tr>
<tr>
<td>Adduction and abduction at gleno-humeral joint</td>
<td>Wrist, elbow and shoulder support as required</td>
<td>Progress with free weights or theraband of different resistance</td>
</tr>
<tr>
<td>Flexion/extension at the gleno-humeral joint</td>
<td>Wrist, elbow and shoulder support as required</td>
<td>Progress with free weights or theraband of different resistance</td>
</tr>
<tr>
<td>Shoulder elevation</td>
<td>Shoulder elevation with support to arm as required</td>
<td>Progression with manual resistance by the therapist</td>
</tr>
</tbody>
</table>
2. Hand Reaching/Retrieval Activity
The activities in the reaching and retrieval section were developed by our team based on normal movement patterns in healthy adults. These were broken down into components from which to instruct and encourage the participants through verbal and visual feedback.\textsuperscript{22, 23, 24} The reaching and retrieval activities are practised while sitting or standing, and are progressed using different heights of table or shelf, moving objects further away (and therefore altering the lever arm), altering the size, shape and weight of each object, reducing the amount of support provided by the environment and performing faster movements. This was a functional task in that it involved reaching for every day shopping items (listed with their weights in the results section) as well as removing the shopping items in and out of shopping bags.

The shelf height is approximately 4 feet from the floor, with a counter height of approximately 3 feet from the floor. The participants were able to stabilise themselves with their non-paretic limb when in standing, as required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Size / Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked beans (small tin)</td>
<td>200g</td>
</tr>
<tr>
<td>Corned beef (tin)</td>
<td>340g</td>
</tr>
<tr>
<td>Milk - Long-life UHT (small carton)</td>
<td>500ml</td>
</tr>
<tr>
<td>Milk – long-life UHT (large bottle)</td>
<td>1 litre</td>
</tr>
<tr>
<td>Pasta (bag of penne)</td>
<td>1000g</td>
</tr>
<tr>
<td>Pilchards (small tin)</td>
<td>155g</td>
</tr>
<tr>
<td>Salmon (small tin)</td>
<td>105g</td>
</tr>
<tr>
<td>Salt (large)</td>
<td>750g</td>
</tr>
<tr>
<td>Soup (tin)</td>
<td>400g</td>
</tr>
<tr>
<td>Spam (tin)</td>
<td>200g</td>
</tr>
<tr>
<td>Tomato puree (tin)</td>
<td>140g</td>
</tr>
<tr>
<td>Crispbread (packet)</td>
<td></td>
</tr>
<tr>
<td>Matches (small box)</td>
<td></td>
</tr>
<tr>
<td>Functional activity</td>
<td>Required movement components</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------</td>
</tr>
</tbody>
</table>
| **1. Reaching to object on table whilst side-lying** | Lateral rotation and protraction of shoulder girdle  
Flexion at glenohumeral joint with lateral rotation  
Elbow extension with some supination  
Wrist extension and finger extension  
Abduction of thumb and extension of fingers to grasp | Progress by decreasing amount of assistance provided by the environment to support the arm (e.g. towel or skateboard underneath forearm progressing to unsupported arm movement) |
| **2. Retrieval of object from table whilst side-lying** | Medial rotation and retraction of shoulder girdle  
Extension and of glenohumeral joint with lateral rotation  
Elbow flexion with some supination  
Wrist extension  
Abduction of thumb and extension of fingers to grasp | Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects |
| **3. Reaching to object on floor** | Protraction and lateral rotation of scapula  
Flexion, abduction and lateral rotation of glenohumeral joint  
Elbow extension with some supination  
Wrist extension and radial deviation  
Abduction of thumb and extension of fingers to grasp | Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects  
Progress by reaching for objects further away therefore increasing the muscle force required |
| **4. Retrieval of object from floor** | Retraction and medial rotation of scapula  
Extension and adduction of glenohumeral joint  
Elbow flexion with some supination  
Wrist extension and radial deviation  
Abduction of thumb and extension of fingers to grasp | Progress by performing faster movements which require greater muscle force |
| **5. Reaching whilst seated at a table, object in front** | Protraction and lateral rotation of scapula  
Flexion and lateral rotation of glenohumeral joint  
Elbow extension with some supination  
Wrist extension and radial deviation  
Abduction of thumb and extension of fingers to grasp | Progress by decreasing amount of assistance provided by the environment to support the arm (e.g. towel or skateboard underneath forearm progressing to unsupported arm movement)  
Progress by reaching for objects further away therefore increasing the muscle force required |
| **6. Retrieval whilst seated at a table, object at front** | Retraction and medial rotation of scapula  
Extension of glenohumeral joint  
Elbow flexion with some supination  
Wrist extension and radial deviation  
Abduction of thumb and extension of fingers to grasp | Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects  
Progress by performing faster movements which require greater muscle force |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Movement Description</th>
<th>Progress</th>
</tr>
</thead>
</table>
| 7. Reaching whilst seated at a table, object at side* | As for 5 plus:  
Adduction, horizontal flexion, medial rotation to reach across body  
Abduction, horizontal extension and lateral rotation to reach away from body | Progress by reaching for objects further away therefore increasing the muscle force required  
Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects |
| 8. Retrieval whilst seated at a table, object at side* | As for 6 plus:  
Abduction, horizontal extension and external rotation to retrieve object away from body  
Adduction, horizontal flexion, internal rotation to retrieve object across body | Progress by performing faster movements which require greater muscle force |
| 9. Reaching to shelf whilst seated            | As for 5 plus  
Increased amounts of glenohumeral joint flexion, scapular protraction and lateral rotation required | Progress by increasing the height of the shelf  
Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects |
| 10. Retrieval from shelf whilst seated        | As for 6 | Progress by performing faster movements which require greater muscle force |
| 11. Reaching whilst standing at a counter     | As for 5  
Decreased amounts of glenohumeral joint flexion, scapular protraction and lateral rotation required | Progress by reaching for/ retrieving objects further away  
Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects |
| 12. Retrieval whilst standing at a counter    | As for 6 | Progress by performing faster movements which require greater muscle force |
| 13. Reaching to shelf whilst standing         | As for 5 | Progress by increasing the height of the shelf  
Progress by retrieving objects of larger or smaller sizes and shapes and heavier weights of objects |
| 14. Retrieval from shelf whilst standing      | As for 6 | Progress by performing faster movements which require greater muscle force |

* Reaching and retrieval activities to the side are similarly practised at the counter, to the shelf, and to the floor

**Figure 2.1. Client's aim:** To strengthen the muscles at the front and back of your shoulder. **Client's instructions:** Position yourself lying on your side with a splint on your uppermost arm and a slide-board under your arm. Start with your arm down beside your body. Finish with your arm out in front of your body. Perform … sets of … repetitions. Do … sessions per week. Exercise sourced from: [www.physiotherapyexercises.au](http://www.physiotherapyexercises.au)
<table>
<thead>
<tr>
<th>Functional activity</th>
<th>Required Movement component</th>
<th>Exercise</th>
</tr>
</thead>
</table>
| Reaching to object on table whilst side-lying | Lateral rotation and protraction of shoulder girdle | Elbow straight, push arm forward away from body to push an object off the table. Elbow straight, holding object, move object forward, away from the body.  
Vary the direction in which the arm moves. |
| Flexion at glenohumeral joint with lateral rotation | Elbow straight, move arm from bottom to top of table (or in range appropriate for patient) (Figure 1, below) | As above, holding object                                                                                                    |
| Elbow extension with some supination     | Holding object and sliding it away from the body.  
Holding object, extend elbow, keeping upper arm still.  
Lift arm and extend elbow to grasp an object away from the body. |                                                                                                                                       |
| Wrist extension and finger extension     | Forearm in mid-pronation, extend wrist or fingers to push object away.  
Forearm in mid-pronation, holding object, extend wrist.  
Forearm in pronated position, extend wrist or fingers, with or without holding an object |                                                                                                                                       |
| Abduction of thumb with extension of fingers to grasp | Forearm in mid-pronation, abduct thumb to push object away. (Figure 2, below)  
Abduct thumb to target and maintain position for several seconds.  
Forearm in mid-pronation, abduct thumb and extend fingers to grasp an object a short distance away. |                                                                                                                                       |

**Figure 2.2. Client's aim:** To improve your ability to open your thumb to help pick up a cup or glass. **Client's instructions:** Position yourself sitting with your hand resting vertically on a table in front of you and your wrist bent back. Position a cup near your thumb and another cup touching your knuckles. Practice opening your thumb to touch the cup. Ensure that you keep your knuckles in contact with the other cup as you move your thumb. Perform … sets of … repetitions. Do … sessions per week. Exercise sourced from: [www.physiotherapyxercices.au](http://www.physiotherapyxercices.au).
3. Hand Grip
The Hand Grip interventions were based on work by Elliott and Connolly and Aiello and Dean. Some of the exercises are progressed using a therapy putty of different resistance. For the purpose of this study 'Sammons Preston Therapy Putty, by Roylans' was used (resistance levels: soft, medium, firm, extra firm).

<table>
<thead>
<tr>
<th>Movement</th>
<th>Activity and Items used</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinch/ Precision (pad to pad and lateral key/ pad to side)</td>
<td>Pulling out the pegs from a solitaire set</td>
<td>Progress with smaller buttons and zips / smaller laces</td>
</tr>
<tr>
<td></td>
<td>Doing up/undoing buttons / zips</td>
<td>Progress with different widths of velcro</td>
</tr>
<tr>
<td></td>
<td>Lacing a shoe</td>
<td>Progress using pegs of different resistance</td>
</tr>
<tr>
<td></td>
<td>Peeling velcro apart</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using clothes pegs</td>
<td>Progress with clip size and thickness of wood</td>
</tr>
<tr>
<td></td>
<td>Opening bulldog clips for paper (or wood blocks of different thickness)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Turning keys in a lock</td>
<td>Use keys of different lengths/ sizes</td>
</tr>
<tr>
<td>Hook</td>
<td>Picking up and placing a bag</td>
<td>Progress with different weights in bag</td>
</tr>
<tr>
<td></td>
<td>Using plastering tool</td>
<td>Progress with weights on tool</td>
</tr>
<tr>
<td>Power - Squeeze</td>
<td>Pouring water from jug to cup</td>
<td>Option of stabilising with other hand</td>
</tr>
<tr>
<td></td>
<td>Squeezing digiflex</td>
<td>Progress with increasing amounts of water. Mark jug/cup to measure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Progress with increasing resistance of digiflex</td>
</tr>
<tr>
<td>Power - Disc</td>
<td>Opening and closing jars</td>
<td>Different sizes and types</td>
</tr>
<tr>
<td></td>
<td>Picking up a ball and placing in boxes</td>
<td>Progress size and / or weight of ball e.g. ping pong, tennis ball, cricket ball</td>
</tr>
<tr>
<td>Flat hand</td>
<td>Squashing ball of putty to flat disc</td>
<td>Use putty of different resistance</td>
</tr>
<tr>
<td></td>
<td>Carrying a plate</td>
<td>Different weights on plate</td>
</tr>
</tbody>
</table>
4. Hand manipulative activity

Patterns of hand movement when manipulating objects have been classified into three classes of intrinsic movements or “coordinated movements of the digits to manipulate and object with the hand”:

- **Simple synergies** – simultaneous use of the digits in a single pattern such as pinching, where all involved digits are acting simultaneously and in the same direction (ie flexion). Simple synergies include: pinch, squeeze, dynamic tripod
- **Reciprocal synergies** – such as when unscrewing a lid with thumb and index finger. Reciprocal synergies include: twiddle, rock, radial roll, index roll, full roll
- **Sequential patterns** - include digital step; linear step; palmar slide

These patterns reflect normal spontaneous hand movements involved in manipulation of objects and involve the recruitment of individual and groups of digits into patterns. This classification was developed as a means of identifying and systematically describing deficits in hand function, but provides a basis for higher level rehabilitation of the hand in therapy. People who lack dexterity and manipulative ability due to stroke could benefit from specific training of these movements. This should be in the context of repetition and with different sizes / shapes of objects. The following hand manipulative activities are based on work by Elliot and Connelly and Aiello and Dean.

<table>
<thead>
<tr>
<th>Class</th>
<th>Movement</th>
<th>Example</th>
<th>Activity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple synergies</td>
<td>Dynamic tripod</td>
<td>Typically seen when writing with a pen</td>
<td>Simultaneous flexion or extension of digits at the interphalangeal (IP) and metacarpophalangeal (MCP) joints, and flexion/extension of wrist for larger shapes; results in the movement of the pen in a proximal-distal axis.</td>
<td>Progress by drawing lines in different directions and orientations e.g. horizontally, vertically, www, zigzag</td>
</tr>
<tr>
<td></td>
<td>Squeeze</td>
<td>Squeezing a ball, or syringe, or foam blocks</td>
<td>Simultaneous flexion of all digits and palm</td>
<td>Progress by using different sizes of syringe and amounts of liquid. Progress with 3 blocks of different resistance</td>
</tr>
<tr>
<td>Reciprocal synergies</td>
<td>Twiddle</td>
<td>A pattern used to roll small objects to and fro between the thumb and index finger such as when tightening nuts and bolts</td>
<td>Abduction and opposition of thumb; flexion / extension of index and middle fingers</td>
<td>Progress by using different sizes of bolt or nut</td>
</tr>
<tr>
<td></td>
<td>Rock</td>
<td>Similar to twiddle but using more digits, for example when moving a screw-top lid; rocking object in hand</td>
<td>Abduction/adduction of all digits with some flexion / extension of digits and abduction and opposition of thumb</td>
<td>Progress with different sizes of object e.g. jar and lid size, pencil, cup</td>
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<td>Radial roll</td>
<td>The thumb is rolled against the distal phalanx of the index finger, for example when winding a watch or re-shaping a ball of putty into a pellet / sausage</td>
<td>Abduction/adduction of thumb at MCP joint; flexion/extension of index finger at MCP and IP joints</td>
<td>Progress with putty of different resistance</td>
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<td>Index roll</td>
<td>Rolling, for example, a small pellet of putty into a ball using the thumb and index finger</td>
<td>Rotation of thumb pad around distal pad of index finger; opposition, abduction and flexion of thumb; flexion and extension of index finger</td>
<td>Progress with different stiffness of putty</td>
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<td>Full roll</td>
<td>Make larger ball with plasticine (all digits)</td>
<td>As for index roll but using up to all 5 digits</td>
<td>Progress with different stiffness of putty</td>
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<td>Sequential patterns</td>
<td>Digital step</td>
<td>Complex combination of flexion / extension of digits with occasional abduction / adduction; opposition and abduction of thumb with flexion and extension of MCP and IP joints</td>
<td>Progress using different weights and lengths of cylindrical objects</td>
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<td>A complex movement such as turning a pen end over end using only one hand</td>
<td>Deviation of the little fingers to reposition by sliding along a pen; squeezing icing from tube</td>
<td>Complex sequence of flexion and extension of all digits and thumb, but particularly digits 3, 4 and 5</td>
<td>Use different sizes of nozzle on icing bag</td>
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<td>Linear step</td>
<td>Palmar slide</td>
<td>Flexion of digits 3, 4, and 5 to stabilise object / shaft; flexion and extension of thumb and index finger to remove pen lid</td>
<td>Use different pens e.g. differences in size / diameter, and with different lids that may be easier / harder to remove</td>
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<td>Immobilisation of an object using digits 3, 4 and 5 combined with a manipulative movement of other digits, such as the index finger and thumb when taking the lid off a pen, or clicking a biro on and off, taking pen lid off and back on, using one hand</td>
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References