

**Task-specific reach-to-grasp training after stroke:  
development and description of a home-based intervention**

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Manuscript ID:	CRE-2014-3797.R2
Manuscript Type:	Rehabilitation In Practice
Keywords:	Stroke, Upper extremity (arm), rehabilitation interventions, Physiotherapy, Occupational therapy
Abstract:	<p><b>Objective:</b> To describe and justify the development of a home-based, task-specific upper limb training intervention to improve reach-to-grasp after stroke and pilot it for feasibility and acceptability prior to a randomised controlled trial.</p> <p><b>Intervention description:</b> The intervention is based on intensive practice of whole reach-to-grasp tasks and part-practice of essential reach-to-grasp components. A 'pilot' manual of activities covering the domains of self-care, leisure and productivity was developed for the feasibility study. The intervention comprises 14 hours of therapist-delivered sessions over 6 weeks, with additional self-practice recommended for 42 hours (i.e. 1 hour every day). As part of a feasibility randomised controlled trial, 24 people with a wide range of upper limb impairment after stroke experienced the intervention to test adherence and acceptability. The median number of repetitions in 1-hour therapist-delivered sessions was 157 (IQR: 96-211). The amount of self-practice was poorly documented. Where recorded, median amount of practice was 30 minutes (IQR: 22-45) per day. Findings demonstrated that the majority of participants found the intensity, content and level of difficulty of the intervention acceptable, and the programme to be beneficial. Comments on the content and presentation of the self-practice material were incorporated in a revised 'final' intervention manual.</p> <p><b>Discussion:</b> A comprehensive training intervention to improve reach-to-grasp for people living at home after stroke has been described in accordance with the TIDieR reporting guidelines. The intervention has been piloted, found to be acceptable and feasible in the home setting.</p>

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3 **Task-specific reach-to-grasp training after stroke:**  
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7 **development and description of a home-based intervention**  
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11 **[Clinical Rehabilitation – ‘Rehabilitation in Practice’]**  
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30 **Author Contributions:**  
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Person	Relevant activities contributed
Paul Cunningham	Development of the intervention and manual, testing feasibility, writing – lead authorship.
Dr. Ailie Turton	Development of the intervention and manual, testing feasibility, writing – contributing significant text.
Prof. Frederike vanWijck	Development of the intervention and manual, writing – contributing significant text.
Prof. Paulette VanVliet	Development of the intervention and manual, writing – contributing significant text.

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**Supplementary Materials:**

There are two online data supplements available alongside this article:

- 1: 'Sample Section of Intervention Manual' - containing the cover and contents list of the final intervention manual and providing examples of activity sheets designed to support delivery of the intervention
2. 'Intervention Questionnaire' - detailing the questionnaire used to obtain participants' perspectives of the intervention and the qualitative responses in full.

For details of the research methods used in the 'feasibility randomised controlled trial of home-based reach-to-grasp training for people after stroke' associated with this article, the study protocol is published in the journal *Trials* and is available at: [www.trialsjournal.com/content/14/1/109](http://www.trialsjournal.com/content/14/1/109)

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49 additional self-practice recommended for 42 hours (i.e. 1 hour every day). As part of a  
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51 feasibility randomised controlled trial, 24 people with a wide range of upper limb  
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53 impairment after stroke experienced the intervention to test adherence and acceptability.  
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11 intervention acceptable, and the programme to be beneficial. Comments on the content  
12  
13 and presentation of the self-practice material were incorporated in a revised 'final'  
14  
15 intervention manual.  
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#### 20 **Discussion:**

21  
22  
23 A comprehensive training intervention to improve reach-to-grasp for people living at home  
24  
25 after stroke has been described in accordance with the TIDieR reporting guidelines. The  
26  
27 intervention has been piloted, found to be acceptable and feasible in the home setting.  
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#### 31 **Keywords:**

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34 Stroke, Hand, Arm, Upper Limb, Physical therapy, Occupational therapy, Rehabilitation,  
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36 Home, Reach, Grasp, Repetitive, Task-specific training, Practice  
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40 **Trial registration:** ISRCTN56716589  
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**Introduction:**

Task-specific training is recommended internationally in stroke rehabilitation guidelines<sup>1-4</sup> and involves intensive practice of actions or functional tasks.<sup>5</sup> A Cochrane overview of systematic reviews concluded that there was moderate quality evidence that at least 20 additional hours of repetitive task training was effective for improving upper limb function after stroke but that sufficiently powered, high-quality randomised controlled trials were required to strengthen the evidence.<sup>6</sup> Task-specific upper limb training specifically focusing on reach-to-grasp movements would appear to be particularly relevant, as stroke survivors consulted about their goals for upper limb therapy programmes prioritised activities involving reach-to-grasp.<sup>7,8</sup> Reach-to-grasp movements are essential for everyday functions such as retrieving objects, e.g. clothes, food and drink, and are used more frequently than other upper limb movements such as gesturing, stabilising objects or for postural support.<sup>9</sup>

With the implementation of early-supported discharge services, upper limb rehabilitation after stroke is increasingly being provided at home. Home-based training is likely to be influenced by environmental and psychosocial factors and currently there is insufficient evidence for the effectiveness of home-based therapy for improving functional recovery of the upper limb after stroke.<sup>10</sup> Therefore, interventions involving high-intensity task-specific training focusing on reach-to-grasp activities need to be developed for the home setting.

Developing feasible, evidence-based, meaningful therapeutic interventions is a key aim of neurological rehabilitation research.<sup>11</sup> However, only 39% of non-pharmacological

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3 interventions evaluated in randomised trials are adequately described,<sup>12</sup> meaning clinicians  
4  
5 do not have sufficient information to deliver tested interventions to patients.<sup>13</sup>  
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9 The intervention was developed in the context of the UK Medical Research Council (MRC)  
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11 framework for developing and evaluating complex interventions, which describes the need  
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13 to identify evidence, model the intervention for delivery and test feasibility, prior to testing  
14  
15 effectiveness in a definitive evaluation.<sup>14,15</sup> The aim of this article is to explain the  
16  
17 development process, describe and justify the essential components of this intervention and  
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19 report its feasibility and acceptability amongst stroke survivors and therapists. The work  
20  
21 was carried out as part of a feasibility randomised controlled trial of a home-based task-  
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23 specific reach-to-grasp training intervention for people after stroke (Trial registration:  
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25 ISRCTN56716589).  
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### 34 **Intervention Description:**

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37 The 'Template for Intervention Description and Replication' (TIDieR) checklist<sup>16</sup> has been  
38  
39 used to structure the description of this intervention. The 12 checklist items are displayed in  
40  
41 Table 1 alongside how each has been interpreted for this intervention description.  
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49 **[insert Table 1 here]**  
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3 The development process involved producing a 'pilot' manual that was used to standardise  
4 the delivery of the intervention in the feasibility study. The pilot manual is published  
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7 alongside the feasibility study protocol<sup>17</sup> and available to view at:

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9  
10 <http://www.trialsjournal.com/content/supplementary/1745-6215-14-109-s2.pdf>.

11  
12  
13 During the feasibility study, feedback and other data were collected from participants and  
14 therapists, as per the study protocol,<sup>17</sup> and results relevant to the intervention development  
15 and description are presented in this paper. This information was incorporated into the  
16 development of a revised 'final' intervention manual. To assist understanding of the  
17 intervention, the contents list and a selection of activity sheets taken from the final manual  
18 are provided in the 'Sample Section of Intervention Manual' online data supplement.  
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28 The entire final manual is not currently publicly available in order to minimise influence on  
29 usual care until a planned Phase III randomised controlled trial is completed. The final  
30 manual will then be made available in full, irrespective of outcome, on the 'Research  
31 Repository' of the University of the West of England at <http://eprints.uwe.ac.uk>.  
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#### 42 **1. Name:** *Intervention title*

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45 Home-based task-specific reach-to-grasp training after stroke.  
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#### 48 **2. Why:** *Rationale, definition and essential elements of the intervention*

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52 To improve a functional skill, training needs to focus on practising that specific skill - a  
53 principle known as task-specific training., A variety of terms for task specific training have  
54 been used in the literature.<sup>5,7,18,19</sup> The Cochrane review of repetitive task training defined  
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3 studies eligible for inclusion as those “*where an active motor sequence was performed*  
4  
5 *repetitively within a single training session, and where the practice was aimed towards a*  
6  
7 *clear functional goal*”.<sup>5</sup> However, considering that many people with stroke cannot  
8  
9 complete a task in its entirety, we expanded this definition to include ‘part-practice’. ‘Part-  
10  
11 practice’, as described by Carr and Shepherd,<sup>20</sup> involves undertaking tasks through  
12  
13 segmentation; for example, the reach-to-grasp action is broken down into parts (e.g.  
14  
15 shoulder flexion) that can be practised separately. Progression can take place by ‘chaining’,  
16  
17 i.e. practising first one part, then practising that part with the next and so on, aiming for  
18  
19 mastery of the whole task.<sup>21</sup> Consequently, for our intervention, ‘task-specific reach-to-  
20  
21 grasp training’ was defined as: ‘*A progressive training programme comprising practice of*  
22  
23 *whole reach-to-grasp tasks and, where required, practice of the component parts that can*  
24  
25 *be systematically reassembled into the whole task, with the aim of improving reach-to-grasp*  
26  
27 *ability in daily activities*’.

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34 The intervention was based on biomechanical analysis of functional reach-to-grasp  
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36 movements and principles of motor learning.<sup>22,23</sup> To be ‘task-specific’, each action must  
37  
38 specify an object to reach for, move towards, or to grasp when either the whole task, or a  
39  
40 component, is practised. Another requirement was that the practice should be carried out  
41  
42 under conditions as similar to the conditions of the target task as possible to enhance carry-  
43  
44 over into everyday living. Parameters considered were the: amplitude and direction of  
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46 movement, available joint range, degrees of freedom, size/dimensions of the object(s), load,  
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48 speed and the amount of gravity/friction to be overcome.  
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3 Examples and descriptions of reach-to-grasp activities, for people with impaired shoulder  
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5 and elbow movement, are provided in Table 2. The activity sheets for these examples are  
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7 provided in the 'Sample Section of Intervention Manual' online data supplement.  
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14 **[insert Table 2 here]**  
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### 20 **3. What – materials:** *Intervention manual*

21  
22 To enable standardised delivery of the intervention in the feasibility trial, the pilot manual of  
23  
24 activities was designed based on the invariant kinematic features of reach-to-grasp actions,  
25  
26 i.e.: shoulder flexion; scapular protraction and lateral rotation; shoulder external rotation;  
27  
28 elbow extension; forearm supination; wrist extension and radial deviation; thumb abduction  
29  
30 and opposition; finger extension with interphalangeal joints in some flexion.<sup>22</sup> Guidance  
31  
32 notes for therapists based on the general principles of task-specific reach-to-grasp training  
33  
34 prefaced the activities. These described procedures for the assessment of reach-to-grasp  
35  
36 using a checklist of the invariant kinematic features of reach-to-grasp actions and how  
37  
38 activities could be varied to suit the goals of each participant and optimise progression.  
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46 The pilot manual contained part-practice activities for each of the invariant kinematic  
47  
48 features and a 'whole reach-to-grasp tasks' section, which incorporated sequential and  
49  
50 simultaneous combinations of the invariant kinematic features into whole tasks. Activities  
51  
52 for each part-practice section were based on the authors' clinical and research experience  
53  
54 along with suggestions from clinical colleagues and relevant exercises from an open-access  
55  
56 physiotherapy website.<sup>24</sup> Part practice activities were ordered by difficulty (e.g. by the  
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3 number of joints involved and the amount of gravity or resistance encountered). 'Whole  
4  
5 task' activities covered the domains of self-care (e.g. brushing hair, putting on socks/shoes  
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7 and tying laces, zipping/buttoning clothes), productivity (washing cutlery/crockery, using a  
8  
9 knife and fork, pegging out and folding washing) and leisure (e.g. operating mobile phones  
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11 and remote controls, knitting, playing cards or other games requiring dexterity), identified  
12  
13 as common goals by people after stroke.<sup>7,8</sup>  
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18 All activities were discussed by the authors and included/excluded based on the previously  
19  
20 agreed definition of task-specific reach-to-grasp training. Instructions were drafted for each  
21  
22 activity and reviewed by the authors for clarity for participants. Photographs of the authors  
23  
24 performing each activity were included. The pilot manual was reviewed by two people living  
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26 with stroke, one with aphasia, who provided their views on the overall design and the  
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28 feasibility of individual activities, following which the pilot manual was amended  
29  
30 accordingly. The pilot manual, used in the feasibility study, contained 122 activities.  
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#### 35 **4. What – procedures: *Role of therapist***

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38 At the initial intervention visit, the therapist delivering the intervention assessed each  
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40 participant against a checklist of the invariant kinematic features to guide a biomechanical  
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42 analysis of functional reach-to-grasp movements. Following this assessment, the therapist  
43  
44 selected activities from the pilot manual and provided the participant with a folder  
45  
46 containing colour copies of their activity sheets. At each subsequent visit, the therapist re-  
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48 assessed the reach-to-grasp movement and progressed/amended activities as appropriate  
49  
50 for the individual. During each supervised session the therapist aimed to maximise the  
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52 number of repetitions of activities performed and encouraged participants to self-practise a  
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54 maximum number of repetitions daily between visits.  
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### 5. Who provided: *Therapist delivering intervention*

The reach-to-grasp training was delivered primarily by one research physiotherapist with absence cover provided by two additional therapists (one a Physiotherapist and one an Occupational Therapist) as required. All three therapists had worked as senior community therapists in the UK National Health Service and were trained and experienced in using upper limb task-specific training with people after stroke.

### 6. How: *Method of delivery*

The intervention was delivered on a one-to-one basis to promote engagement and motivation with the intervention and, importantly, allow specific feedback on performance; a key principle of skill acquisition. Extrinsic feedback (e.g. feedback provided by a therapist) can be focused either on the body movement (internal focus) or on the effects of the movement on the environment (external focus).<sup>21</sup> For this intervention, feedback on movement quality (i.e. an internal focus) was used only to avoid movement patterns that might potentially be detrimental to acquiring the required action; in all other instances, feedback was provided on the target / goal of the activity (i.e. an external focus). The choice of feedback focus was based on previous work on the role of feedback on improving reach-to-grasp function in people after stroke<sup>25</sup> and the findings of a recent systematic review that extrinsic feedback with an external focus, augments motor learning in stroke survivors.<sup>26</sup>

Family and carer engagement is strongly associated with good rehabilitation outcomes.<sup>27,28</sup>

It is difficult however to standardise the potential influence and involvement of carers. Instructions for therapists delivering the reach-to-grasp intervention were therefore limited to advising carers to remind and encourage participants to practise, asking them to set up equipment and assist in recording the amount of practice.

## 7. Where – *Environment and equipment*

The intervention was delivered in participants' own homes, including care homes, as home-based rehabilitation has the potential to facilitate context dependent learning; objects of relevance to the participant can be easily incorporated (e.g. comb, cutlery, cupboards) to allow occupational embedding of the activities.<sup>29</sup> As such, a variety of objects, preferably used by participants in everyday life, were selected for activity practice as varying object shape and size can influence movement kinematics.<sup>30</sup>

## 8. When and how much – *Timing and Intensity of training*

The intervention was designed to be delivered once participants had returned home from hospital and within the first 12 months after stroke. Participants (n=24) who received the intervention in the feasibility study were a median of 111.5 days (IQR: 82.0, 241.0), approximately 4 months, after stroke.

The intensity of the intervention encompasses the total amount of treatment, as well as its distribution over the treatment period in terms of the number, frequency and duration of individual treatment sessions, and the number of repetitions within each session.

Uncertainty remains regarding optimal total therapy dosage for motor recovery after stroke but there is evidence to support higher doses,<sup>10,31</sup> for example, the EXCITE trial of constraint-induced movement therapy demonstrated significant improvement in upper limb function after stroke with an intended dose of 60 hours of practice.<sup>32</sup> Consequently, with consideration given to the feasibility of delivery in community rehabilitation services, the treatment schedule for this reach-to-grasp intervention was set at a total target dose of 56 hours. This consisted of 14, one hour, therapist visits over six weeks and additional self-

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3 monitored practice recommended for an hour a day, seven days a week. The frequency of  
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5 therapist visits was tapered, three times a week in the first three weeks, twice in each of the  
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7 next two weeks, then once in the final week, with the aim of increasing self-efficacy in  
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9 practice and fostering self-management.  
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13 In terms of the number of repetitions within each session, high-intensity training was  
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15 implemented. This is a key principle of the intervention based on animal studies of  
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17 neuroplasticity<sup>33-35</sup> and meta-analyses of stroke rehabilitation trials.<sup>10</sup> However, no clear  
18  
19 guidelines on the optimum number of repetitions currently exist.<sup>28</sup> A study of moderately  
20  
21 affected stroke participants demonstrated that 300 repetitions were achievable within a  
22  
23 one hour training session.<sup>36</sup> With this in mind and to include those with severe impairment,  
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25 a target range of 100-300 repetitions/hour was endeavoured, dependent on individual  
26  
27 participant's capabilities.  
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### 32 33 **9. Tailoring - Individualising the intervention** 34

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36 The most important predictor of outcome for upper limb recovery is severity of motor  
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38 impairment and function.<sup>37</sup> Participants receiving the intervention in this study had  
39  
40 substantial loss of upper limb function: median ARAT score = 8.5 (IQR 3.0; 24.0) (ARAT score  
41  
42 range: min. 0 - max. 57).  
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47 Due to the range of upper limb impairment, the therapist needed to select activities to suit  
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49 the functional ability of each participant with consideration also given to factors such as the  
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51 patient's home environment, individual preferences, level of carer support, object shape  
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53 and size, target positions and speed of movement.  
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3 As this was a structured intervention, the scope for individualised goal setting was limited to  
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5 each participant being encouraged to identify the tasks, objects and environments for  
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7 practice, with the intention to make the intervention more personally relevant and  
8  
9 stimulate engagement.<sup>38</sup>  
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### 12 13 **10. How well – planned:** *How was adherence recorded* 14 15

16 For the 14 treatment sessions, the number of repetitions and time spent on each activity  
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18 from the pilot manual was recorded by the therapist using a tally counter and stop watch.  
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20 For independent practice, participants were asked to record repetitions and time for each  
21  
22 activity using log sheets covering the six week duration of the intervention.  
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26 At the final intervention visit, a face-to-face, semi-structured interview was completed using  
27  
28 a questionnaire designed to gauge the views of participants on the intensity and content of  
29  
30 the intervention, as well as the design of the activity sheets. The questionnaire used is  
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32 presented in the 'Intervention Questionnaire' online data supplement. The questions were  
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34 asked by the research physiotherapist responsible for delivery of the intervention. While  
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36 this may have biased responses, it was anticipated to facilitate a better understanding of  
37  
38 any changes that should be made to the content of the intervention.  
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### 43 **11. How well – actual:** *Results for intervention adherence and acceptability* 44 45

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47 A high intensity of therapist-supervised training was achieved with 94% of planned visits  
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49 completed (median 14; IQR 13.0, 14.0) and a median of 157 (IQR 96, 211) repetitions  
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51 completed within each one hour visit. Participants were engaged in upper limb practice for a  
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53 median of 38.5 minutes (IQR 35.4, 48.8) per therapist-supervised session as time was  
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55 required for assessment and to set-up and move between activities. During each one hour  
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3 therapist visit, the average number of activities practised was 4 (SD: 1.3; range: 1 to 7). Over  
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5 the six week intervention period, participants practised an average of 16.1 (SD: 3.8; range: 7  
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7 to 23) different activities. The majority of participants (17 of the 24) reported that practising  
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9 independently for an hour per day was acceptable. Logs of participants' practice were  
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11 poorly completed, but from those which were recorded, the median was only 30.0 minutes  
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13 of independent practice per day (IQR: 22.2, 44.5).  
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18 All 24 participants completed the treatment questionnaire. Analysis of responses shows that  
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20 all participants who provided an answer (n=23) considered the intervention to be  
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22 acceptable. A total of 16 participants considered the number of visits to be acceptable; the  
23  
24 remaining eight would have preferred more. The intervention appeared to be provided at  
25  
26 an appropriate level of difficulty with participants reporting a median of 6 out of 10 (IQR:  
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28 5.0, 7.5) for how difficult the treatment was on a visual analogue scale where 0 represented  
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30 extremely difficult and 10 represented extremely easy (Table 3).  
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39 **[insert Table 3 here]**  
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45 Qualitative responses regarding the benefits of the treatment highlight participants'  
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47 perceived improvements, particularly in confidence, e.g. "more confidence to try things in  
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49 my life" and "made me feel more confident that things are going to move on in the future".  
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51 These translated into a wide variety of reported functional gains such as being able to "put  
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53 on and take off wheelchair brake", "put on own socks and tie shoe laces", "steady a  
54  
55 bowl/plate to eat with right hand", "brush hair" and "able to reach for Zimmer frame by  
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3 myself, meaning I can walk by myself". The full list of qualitative responses are presented in  
4  
5 the accompanying 'Intervention Questionnaire' online data supplement.  
6  
7

8 The questionnaires also asked participants' opinions about the design of the activity sheets.  
9

10 The visual aspect of the activity sheets was evaluated positively by 16 of the 24 participants.  
11

12 However two participants thought that the photographs would be improved by featuring  
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14 people who have had a stroke rather than healthy individuals, commenting that *"it's better*  
15  
16 *to have people who have had a stroke - see there are other people like you"* and that the  
17

18 current activity sheets show people who *"obviously don't have problems, which is a bit of a*  
19  
20 *slap in the face"*. Three participants who had commented that the original photographs on  
21

22 the activity sheets were *"too straight-laced, not realistic"*, *"could be more contemporary"*  
23  
24 and *"should be 'busier' like people's houses"*. Participants also commented that there  
25

26 should be more space for additional writing. Additionally, participants were asked which of  
27  
28 the activities that they had practised they either 'liked' or 'disliked'.  
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## 35 **12. Modifications: Revising the intervention following feasibility study**

  
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39 Following completion of the feasibility study, the pilot manual was revised, based on  
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41 participant feedback and, following ethics committee approval and participant consent, to  
42  
43 include photographs of participants with stroke practising the activities in their home  
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45 environments. The authors then reviewed the ten activities which received more 'dislikes'  
46  
47 than 'likes' from participants; it was decided that these activities had potential therapeutic  
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49 merit and should continue to be included in the final manual but the instructions and  
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51 photographs be revised to improve understanding and acceptability.  
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3 The frequencies of activities prescribed to participants were calculated: 44 of the original  
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5 122 activities had not been assigned for independent practice. These 44 activities were  
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7 individually reviewed by the authors and consensus decisions were made to remove ten of  
8  
9 them. Next, a group consultation with the three therapists involved in the delivery of the  
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11 intervention, one of whom was external to the research team and therefore able to provide  
12  
13 a more independent assessment, was undertaken about their use of the pilot manual. The  
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15 therapists were in favour of the number and variety of activities in the pilot manual but  
16  
17 reported difficulties finding and selecting activities from such an extensive resource. As a  
18  
19 result, the final manual was re-structured to optimise ease of use with the classification of  
20  
21 grip types described by Napier (1956)<sup>39</sup> incorporated into the indexing to structure the  
22  
23 'grasp' sections, while all sections were colour-coded to aid navigation. Additional activities  
24  
25 suggested by the research therapists were included in the final manual, where authors were  
26  
27 in agreement, with a final total of 144 activities. Changes to the format of the self-practice  
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29 activity sheets were also made; the examples provided in the 'Sample Section of  
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31 Intervention Manual' online data supplement are taken from the final manual.  
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### 43 **Discussion:**

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46 This article has described, as per the TIDieR reporting guidelines,<sup>16</sup> an intensive task-specific  
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48 reach-to-grasp training intervention for people after stroke for use in their own homes, as  
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50 well as its development and piloting. Justification for the intervention is provided based on  
51  
52 current best evidence and principles of skill acquisition. This process has resulted in a  
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54 comprehensive intervention and final manual to support and structure its delivery. The  
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3 intervention was considered acceptable by participants and therapists, and can be used in a  
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5 subsequent pragmatic randomised controlled trial.  
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9 Standard study reports do not usually permit sufficient detail of intervention description,  
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11 particularly for reports of complex non-pharmacological interventions.<sup>12,13</sup> The 'TIDieR'  
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13 guidelines used here have provided a structured framework which has ensured that all  
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15 factors relevant to the delivery of the complex intervention have been described in detail. A  
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17 limitation of the 'TIDieR' guidelines for this report is that they are primarily for describing an  
18  
19 intervention but not the process of how the intervention was developed. For this report  
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21 therefore, a number of items required interpretation to also describe the rationale for  
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23 decisions made during the development of the intervention.  
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27  
28 Owing to the high-intensity of practice involved in the intervention, an important finding of  
29  
30 the feasibility study was the acceptability of the intervention as evidenced by the  
31  
32 completion of the majority of therapist visits and the completion of a median number of  
33  
34 repetitions per visit within the pre-specified target range of 100-300 per hour. Within each  
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36 visit participants were engaged in upper limb practice for approximately two-thirds of the  
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38 available therapy time which interestingly replicates findings from a retrospective analysis  
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40 of the EXCITE trial in which participants were engaged in upper limb training for 62% of the  
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42 in-laboratory time.<sup>40</sup>  
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47 The majority of participants in this feasibility study considered an hour/day of independent  
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49 practice to be acceptable. However, the self-report practice logs showed that participants  
50  
51 actually practised, on average, for only half this time. This finding should be interpreted  
52  
53 carefully as compliance with the logs was limited. Difficulties in accurately recording  
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55 independent practice have been reported previously,<sup>41</sup> however methods for improving, as  
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3 well as capturing, adherence in independent practice still need to be identified to improve  
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5 the accuracy of trials and quality of clinical rehabilitation. To enhance intervention  
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7 adherence, a number of practical strategies were identified and/or developed during the  
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9 feasibility study:  
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13 • To encourage participants to focus on increasing repetitions rather than number of  
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15 activities it was established that a maximum of four activities would be provided for self-  
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17 practise at any one time, i.e. additional activities needed to replace previous activities.  
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21 • To promote self-monitoring of repetitions during independent practice, participants  
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23 were offered a hand-held tally counter. For some participants, this appeared to improve  
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25 both adherence and accuracy of recording although this requires further investigation.  
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- 28  
29 • To achieve high numbers of repetitions, it was necessary for treatment sessions to be  
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31 highly structured, which was perceived as different to usual care therapy sessions and  
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33 some participants found challenging. Sessions appeared to be better tolerated however  
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35 if they were described as “training” rather than “therapy” and an explanation provided  
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37 on the intended effects of high-intensity training on neuroplasticity and motor learning.  
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40 Consultation with participants and therapists has led to an improved intervention manual  
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42 intended to be used to structure and standardise the delivery of the training intervention in  
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44 a randomised controlled trial. Although this manual is currently designed to be used in print  
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46 format, an electronic version could be used in the future, for example in the context of  
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48 telemedicine, where therapists could provide feedback and suggest new activities, and  
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50 patients could report their experiences, and, photographs/videos of recommended  
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52 exercises or patient performance could be uploaded. The current study is an initial step in  
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54 the evolution of the content and delivery of the intervention.  
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**Clinical messages:**

- A home-based task-specific reach-to-grasp training programme for people after stroke has been described and a manual has been developed to enable systematic and standardised delivery.
- The high-intensity task-specific intervention was considered acceptable and beneficial by participants and feasible for use in the home setting.

**Competing Interests:**

The authors declare no conflict of interest.

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Table 1:

TIDIER Checklist		Interpretation for this report
1	<b>Name</b>	<i>Intervention title</i>
2	<b>Why</b>	<i>Rationale, definition and essential elements of the intervention</i>
3	<b>What - materials</b>	<i>Intervention manual</i>
4	<b>What - procedures</b>	<i>Role of therapist</i>
5	<b>Who provided</b>	<i>Therapist delivering intervention</i>
6	<b>How</b>	<i>Method of delivery</i>
7	<b>Where</b>	<i>Environment and equipment</i>
8	<b>When and How much</b>	<i>Intensity of training</i>
9	<b>Tailoring</b>	<i>Individualising the intervention</i>
10	<b>How well – planned</b>	<i>How was adherence recorded</i>
11	<b>How well – actual</b>	<i>Results for intervention adherence and acceptability</i>
12	<b>Modifications</b>	<i>Revising the intervention following feasibility study</i>

**Table 2:** Examples of reach-to-grasp activities for people with impaired shoulder and elbow movement.

Ability / functional level	Activity description(s)	Activity sheet
<i>For people with significant shoulder flexion weakness.</i>	The reaching task can be practised in side-lying, with the forearm resting on a bed so that the effect of gravity is minimised thereby reducing the strength required to flex the shoulder.	31
<i>For people who are unable to perform the whole action and need to improve elbow extension with shoulder flexion.</i>	Task-specific part practice in sitting, e.g. with the hand resting on a table (to reduce the muscle force required as the limb is supported), shoulder flexion and elbow extension to touch a target object can be practised with/without grasp. This is then followed, when possible, by progressing to lifting the objects from the surface and varying direction/extent of reach.	38 and 52
<i>For people who can produce the whole action (e.g. able to open their hand and grasp an object) but may be slow or restricted in active range of shoulder flexion and/or elbow extension.</i>	The whole reaching task can be practised in the sitting position, with variations such as the speed, extent of shoulder flexion or elbow extension or direction of the reach, e.g.: - varying direction of reach and incorporating grasp/release of objects of different sizes / shapes - varying height / direction of reach and incorporating fine dexterity and precision	76 and 134

**Table 3.** Responses to questionnaire about experience of reach-to-grasp intervention (n=24). The questionnaire used and all qualitative responses (Questions 5 and 7) are reported in the online 'Intervention Questionnaire' data supplement.

	n	%	Median	IQR
1. Number of visits acceptable:	16	66.7%		
2. 1 hour/day independent practice acceptable:	17	70.8%		
3. Reach-to-grasp intervention acceptable:	23	95.8%		
4. Reach-to-grasp intervention beneficial (0-10 VAS scale; 0=not beneficial at all, 10=extremely beneficial):			8.0	(7.5, 8.0)
6. Reach-to-grasp intervention made difference to use of arm:	20	83.3%		
8. Reach-to-grasp intervention worth the amount of effort required:	23	95.8%		
9. Reach-to-grasp intervention difficult (0-10 VAS scale; 0=extremely difficult, 10= extremely easy):			6.0	(5.0, 7.5)

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# Home-based task-specific training for arm and hand recovery after stroke



# Sections

## Shoulder

- Protracton
- Flexion
- Extension
- Abducton
- External rotation  
- forearm supported

## Shoulder + elbow

- External rotation -  
forearm unsupported
- Shoulder extension with  
elbow extension
- Shoulder flexion with  
elbow extension

## Forearm

- Pronation/supination - forearm  
supported
- Pronation/supination - forearm  
unsupported

## Wrist

- Extension
- Radial deviation
- Extension and radial deviation

## Hand opening

- Finger extension
- Thumb abduction
- Finger extension and thumb  
abduction maintaining  
static forearm position
- Finger extension, thumb  
abduction and elbow  
movement

## Power grasp

- Power grasp maintaining  
static forearm
- Power grasp and  
elbow movement

## Precision grasp

- Pinch grip between index  
finger and thumb
- Pinch grip with transport  
maintaining static forearm  
position
- Pinch grip with transport and  
elbow movement
- Conjnct rotation
- Bimanual tasks involving  
precision grasps

## Combined grasp

- Tasks requiring power  
and precision grasps

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## Local services

## Reach along bed to touch .....

- Lying on your side with your weaker arm upper most
- Reach along the bed to try to touch a target
- Try to keep your elbow straight, shoulders level and not to roll over

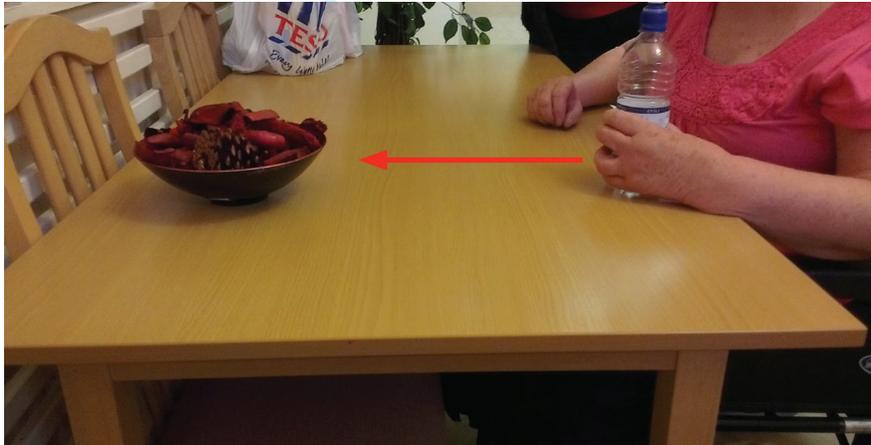


Comments

Shoulder + elbow

## Sliding object forward to touch .....

- Sit with your forearm supported on a flat surface and an object in your hand
- Position an object in front of you as a target.
- Slide your hand forwards to touch the target
- Try to stay facing forwards and keep your back in contact with the chair.



Comments

Shoulder + elbow

Move object between ..... and .....  
and ..... and .....

- Sit with an object in your hand
- Lift the object and move to different targets on the flat surface in front of you
- Your therapist can provide you with a large piece of paper with 'markers' on it.



Comments

## Lift cup onto coaster

- Sit at a flat surface with a cup in your hand
- Position a coaster next to your wrist
- Lift the cup and bend your wrist backwards to place the cup onto the coaster
- Try to keep your forearm still so only your hand is moving



Comments

## Peg out washing

- Using two hands, practise pegging items of clothing onto a washing line.
- Try also practising taking the items of clothes down without them dropping on the floor.



Comments

Precision grasp

## PARTICIPANT QUESTIONNAIRE

### Evaluation of home-based reach to grasp training after stroke.

Participant number \_\_\_\_\_ Date of interview \_\_\_\_\_

The research team would like to find out what you thought about the Reach to Grasp training you've received. I have a few questions to ask you about it. Please try to tell me what you really think; you will not upset me if you tell me you didn't like anything.

1. a) Do you think the number of visits during the six weeks was an acceptable or unacceptable amount?

Acceptable

Unacceptable

b) If unacceptable, how would you alter the visits?

2. a) Do you think being asked to practice by yourself for an hour a day was an acceptable or unacceptable amount of time?

Acceptable

Unacceptable

b) If unacceptable, how long do you think would be an acceptable amount of time for you?

3. a) Did you find the reach to grasp training an acceptable or unacceptable physiotherapy treatment?

Acceptable

Unacceptable

b) Why?

4. How beneficial do you think the treatment was for you?

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0 = not beneficial at all, 10 = extremely beneficial



5. What difference do you think the treatment has made to you?

6. Has the treatment made a difference to your ability to use the arm?

Yes

No

7. If yes, what can you do now that you couldn't do when you joined the trial?

8. Was the amount of improvement in your arm or hand movement over the last six weeks worth the work you did?

Yes

No

9. How difficult did you find the treatment?

0	1	2	3	4	5	6	7	8	9	10
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0 = extremely difficult, 10 = extremely easy



10. I'm going to show you all the exercise sheets you used. Please tell me which ones you liked and which you didn't like. [Therapist to list exercise number and put a tick or a cross next to each]

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6

11. a) What aspects of the design of the activity sheets did you like?

b) Are there any changes to the design of the exercise sheets you would like to see?

12. Do you have any other comments about the reach to grasp training or your experience of it?

**Intervention Questionnaire: qualitative responses to questions 5 and 7 on reported benefits of reach-to-grasp training.**

Participant	“What difference do you think the treatment has made to you?”	“What can you do now that you couldn’t do when you joined the trial?”
1	I think the treatment helps you to try and do certain things that you might not otherwise try.	Move my arm along the table. Reach a lot further.
2	Hand 'a lot better'.	Move all fingers. Zipping jacket "much easier". Butter bread
3		Able to put on own socks and tie shoe laces
4	'Showed me the right thing to do regarding my arm'. Appreciated advice that is not 'no pain, no gain'.	Can touch forehead. Can grip object (deodorant/talcum powder) firm enough to open with other hand.
5	'Time by time' gradual improvements.	Using knife to cut potatoes.
6	Improvement on grasping things - 'I find it easier'. Stronger arm. Encouraged to use right hand to do more.	Brush hair - both sides and back. Wrap presents - including taking sellotape off reel. Knitting. Opening fridge, cupboard and front door.
7	More movement in arm. Now have exercises can do by self. Have method of relieving shoulder stiffness by self. Learnt how to activate and de-activate muscles.	Pull shoulder back to slide shirt on. Lift arm onto worktop to hold onto milk to unscrew with other hand. Pushing doors to open and close.
8	Made me use my right hand more - 'not ignore it but try to use it'.	Put on and take off wheelchair brake. Grip clothing to assist with dressing. Squeezing cream. Holding pot to take lid off with left hand.
9	I got 'double time' on my leg rehabilitation.	
10	Motivation and guidance.	Lift arm much higher. Carry supper between rooms. Wash left arm and armpit.
11	Made me feel more confident that things are going to move on in the future.	Itch my right arm. Turn on/off light switch. Steady a bowl/plate to eat with right hand.
12	I can do more things. I'm beginning to get back to normal.	Brush hair. Put on necklace (doing/undoing clasp). Hang washing out. Turning door handle. Hold eye down with left hand for eye drops. Use knife and fork to eat. Use computer. Write. Able to reach all shelves in fridge. Pulled up weeds. Gardening (dead-

		heading flowers). Knitting. Open drawers and sort cutlery. Brushing/mopping floor. Walk up and down stairs using the left hand rail only. Ironing.
13	I've been able to see what is needed to help improve my arm. Using arm more automatically. Given confidence.	Use left arm to help get from lying to sitting. Brushing hair. Drink from a beaker. Using left hand on Zimmer Frame. Picking up and moving objects. Grasp tighter and not drop things as much.
14	More movement. More confidence to try things in my life.	Open and close hand and Lift arm. - Turn bathroom tap and light cord on and off.
15	Until I was taken ill, quite a bit of difference.	Move arm in several directions. Able to grasp. Thumb movement.
16	Yes, move fingers a little more.	Can move arm better.
17	Able to reach for Zimmer frame by myself, meaning I can walk by myself.	Able to reach for Zimmer frame by myself, meaning I can walk by myself.
18	Can move arm more but not particularly functional still. Did not meet objective of being able to put weight through arm.	
19	Not much difference although I do things better.	I can reach up higher.
20	Would now try other things more frequently. Taking more notice of arm.	
21	More confidence. The arm feels more natural - people don't notice me as much.	Hold dentures to clean with other hand. Put tops back on make up tubes.
22	Husband answered due to participant's aphasia - Hasn't seen a lot of difference in movement but 'early days'. Psychologically 'appreciated' what's happened.	
23	Encouraged me to try everything.	Knitting. Writing. Pouring. Picking heavier objects up and reaching out to side. Peeling orange.
24	Gave me more movement. Made me feel better.	Walk further and feel better about it as arm doesn't ache. Do exercises. Get dressed better, e.g. able to put top over head by self now.

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3 **Task-specific reach-to-grasp training after stroke:**  
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6 **development and description of a home-based intervention**  
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13 **[Clinical Rehabilitation – ‘Rehabilitation in Practice’]**  
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17 **Abstract: 236 words**  
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24 **Objective:**  
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27 To describe and justify the development of a home-based, task-specific upper limb training  
28 intervention to improve reach-to-grasp after stroke and pilot it for feasibility and  
29 acceptability prior to a randomised controlled trial.  
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35 **Intervention description:**  
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38 The intervention is based on intensive practice of whole reach-to-grasp tasks and part-  
39 practice of essential reach-to-grasp components. A 'pilot' manual of activities covering the  
40 domains of self-care, leisure and productivity was developed for the feasibility study. The  
41 intervention comprises 14 hours of therapist-delivered sessions over 6 weeks, with  
42 additional self-practice recommended for 42 hours (i.e. 1 hour every day). As part of a  
43 feasibility randomised controlled trial, 24 people with a wide range of upper limb  
44 impairment after stroke experienced the intervention to test adherence and acceptability.  
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46 The median number of repetitions in 1-hour therapist-delivered sessions was 157 (IQR: 96-  
47 211). The amount of self-practice was poorly documented. Where recorded, median  
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3 amount of practice was 30 minutes (IQR: 22-45) per day. Findings demonstrated that the  
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5 majority of participants found the intensity, content and level of difficulty of the  
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7 intervention acceptable, and the programme to be beneficial. Comments on the content  
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9 and presentation of the self-practice material were incorporated in a revised 'final'  
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11 intervention manual.  
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15 **Discussion:**  
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18 A comprehensive training intervention to improve reach-to-grasp for people living at home  
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20 after stroke has been described in accordance with the TIDieR reporting guidelines. The  
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22 intervention has been piloted, found to be acceptable and feasible in the home setting.  
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26 **Keywords:**  
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29 Stroke, Hand, Arm, Upper Limb, Physical therapy, Occupational therapy, Rehabilitation,  
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31 Home, Reach, Grasp, Repetitive, Task-specific training, Practice  
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35 **Trial registration:** ISRCTN56716589  
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