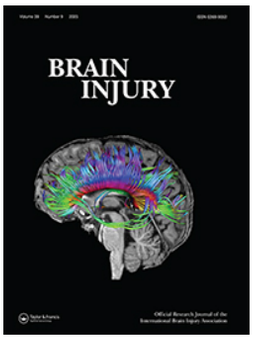

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A feasibility randomized-controlled trial of an executive functioning telerehabilitation intervention for stroke survivors

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ABSTRACT

Background: Executive dysfunction affects most stroke survivors, limiting their ability to adapt post-stroke. Despite clinical guidelines recommending executive functioning rehabilitation, robust evidence for interventions is lacking.

Aims: This study assessed the feasibility and acceptability of an executive functioning telerehabilitation intervention for stroke survivors. It examined recruitment and retention rates, adherence, completion of outcome measures, intervention usability, and participant experience. Preliminary changes in executive functioning, self-efficacy, and wellbeing were explored to inform the design of a future efficacy trial.

Methods: A feasibility randomized-controlled trial was conducted with 19 adult stroke survivors randomized to receive either an executive functioning telerehabilitation intervention or stroke psychoeducation. Interventions were two 30-minute videos with accompanying homework delivered asynchronously over two weeks. Outcome measures validated in stroke populations assessed executive functioning, wellbeing, and self-efficacy at baseline, post-intervention, and one-month follow-up. Feedback was collected on usability and acceptability.

Results: Recruitment and drop-out rates were acceptable. Participants indicated that both interventions were acceptable, relevant, useful, and easy to engage with, though some found the homework tasks challenging.

Conclusion: The executive functioning and psychoeducation interventions are feasible and acceptable for research. A larger RCT is needed to evaluate efficacy, retaining multiple recruitment sources, including public healthcare services, for representative samples.

ClinicalTrials Registration: NCT05461937.

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Stroke; executive dysfunction; cognitive rehabilitation; telerehabilitation; stroke rehabilitation; feasibility trial

Introduction

Executive dysfunction affects as many as 75% of stroke survivors (1,2), with persistent deficits frequently observed (3). As executive functions (EF) are thought to underpin goal-directed behavior, with impairments affecting a wide range of abilities (e.g., planning, problem-solving, initiation, sequencing, monitoring, divided attention, flexibility, working memory and inhibition (4,5), post-stroke EF impairments have the potential to interfere with both performance of familiar tasks and management of novel situations. This is important because it means that executive dysfunction may disrupt stroke rehabilitation and the process of adapting to other stroke-related impairments, such as mobility or language difficulties. Conversely, there is preliminary evidence that training specific EF skills generalizes to improvements in activities of daily living after stroke (6,7), suggesting that EF rehabilitation might facilitate adaptation to life after stroke more generally. EF rehabilitation post-stroke is also recommended in clinical guidelines (8). Systematic reviews of post-stroke EF rehabilitation, however, highlight the lack of robust efficacy evidence supporting specific EF rehabilitation interventions (9–11).

Stroke survivors can face challenges accessing cognitive rehabilitation interventions. A recent survey found that nearly one in two stroke survivors were not able to access the level of support they needed for memory and fatigue (12), and cognitive dysfunction post-stroke has been highlighted as an area of unmet need by a recent consensus (13). Making post-discharge rehabilitation more widely available is part of the NHS Long Term Plan (14). Telerehabilitation has emerged in the last two decades as a potential, more cost-effective, approach for delivering cognitive rehabilitation, particularly for individuals with mobility limitations or difficulties accessing in-person services. Its use is also recommended by the National Institute for Health and Care Excellence (NICE (15); as an alternative to face-to-face interventions for stroke patients where this is the individual's preference. Similarly to cognitive rehabilitation trials more generally, there is insufficient evidence relating to the effectiveness, as well as feasibility and acceptability of technology-based cognitive rehabilitation (16–18). Although telerehabilitation has not been found superior to traditional forms of therapy, the fact that no systematic reviews found that it may lead to inferior outcomes (19) points toward

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the potential of implementing technology-based interventions to help bridge the accessibility gap of cognitive rehabilitation in the community. In addition, research in other clinical populations has demonstrated its feasibility and potential effectiveness. Studies have reported cognitive and functional benefits in individuals with mild cognitive impairment and vascular cognitive impairment (20), as well as in patients with breast cancer experiencing cognitive deficits related to pharmacological interventions (21).

Goal Management Training (GMT; 22,23); is one of the leading rehabilitation approaches for patients with executive dysfunction. Goal setting is an integral part of all post-stroke rehabilitation (24,25) and recommended in clinical guidelines (8), but relies on EFs that may be disrupted by stroke. Theoretical accounts of EF highlight goal-setting and problem-solving as potential targets for treating executive dysfunction post-stroke. Duncan's (26) theory of goal neglect proposes that a common feature of frontal lobe damage is the inability to perform actions, in spite of understanding task requirements. Diamond (27) distinguishes between 'core' EF components including working memory, inhibitory control, and cognitive flexibility, and 'higher order' components, including reasoning, problem-solving, and planning. Stuss (28) proposed task-setting and monitoring as the key executive functions subserved by the frontal lobes. Barkley's model (29) further differentiates five functions that mediate goal-directed behavior: time management, organization and problem-solving, exercising restraint, self-motivation, and emotion regulation. Goal-setting and problem-solving skills are common targets in psychological interventions for other populations where these skills are a recognized difficulty, such as individuals with depression (30,31), as well as key elements of cognitive-behavioral therapy (32). The theoretical conceptualization of problem-solving and goal setting as essential components of EF, the transdiagnostic applicability of enhancing these skills, and preliminary evidence that this can have a positive impact on re-adaptation to life post-stroke, support the value of interventions for problem-solving and goal-setting after stroke. Theoretical models of EF informed the intervention we developed for this study, and the elements of problem-solving, goal setting, planning, and monitoring, that feature across models, were incorporated into the intervention. Duncan's (26) theory of goal neglect and the model proposed by Stuss (28), were particularly important for the development of the intervention.

One way to address the challenge of designing and conducting high-quality clinical trials of stroke rehabilitation interventions that can produce findings to inform guidance is to conduct feasibility studies prior to commencing a full trial, to preempt issues that may otherwise limit the validity and generalizability of the results, such as not meeting recruitment targets, or issues delivering the intervention in line with the protocol (33).

The overarching aims of this research were to explore the feasibility and acceptability of a randomized controlled trial of a theory-based telerehabilitation post-stroke EF intervention targeting goal management compared to a psychoeducation control condition for stroke survivors, as well as their preliminary efficacy, to inform the protocol for a future definitive trial (see Figure 1 for the study questions).

Is the intervention trial **feasible**?

- Are the data parametric?
- What are stroke survivor recruitment, retention, and attrition rates?
- What is the completion rate of pre- and post- outcome measures?
- What are the levels of adherence to the intervention and control?
- What is the magnitude and variability of change in outcome measures post-intervention (effect sizes, standard deviations)?
- Is the change in outcome measure scores indicative of improvement?

Are the intervention and trial procedures **acceptable**?

- Are randomisation and blinding of participants to the two conditions acceptable?
- How acceptable are the outcome measures (average time required, ease of completion)?
- Is the online format acceptable (willingness of participants to do the intervention online, ratings of appropriateness and ease of use)?
- What is the participant's experience of the intervention, its perceived usefulness, and areas of improvement?

Figure 1. The study feasibility and acceptability questions.

Methods

This report complies with the Consolidated Standards of Reporting Trials (CONSORT; see appendix A) guidelines (34,35).

Design

This was a feasibility study (ClinicalTrials Registration: NCT05461937) incorporating a blinded parallel-group randomized controlled feasibility trial (EF vs Stroke Psychoeducation, 1:1 allocation ratio).

Ethical approval

Ethical approval was obtained from the university faculty ethics committee (ETH2122–1680) and the Health Research Authority (22/EE/0094).

Setting

The study was conducted fully remotely (online, and participant screening over the phone). Recruitment was conducted through three early supported discharge public health services, three Third-Sector National Charities, and a university database of stroke survivors who have consented to be invited to participate in research.

Participants

To be eligible for the study, participants needed to have a diagnosis of stroke, which was confirmed during the screening call, be over 18 years old, able to provide capacitous consent to participate, and have access to a computer or tablet, the internet, and an e-mail address. The presence of executive dysfunction was not an inclusion criterion, as the intervention focuses on goal setting and other general adaptive skills which are potentially useful for all stroke survivors. However, not having executive dysfunction as an inclusion criterion may impact results in a subsequent full trial by creating a ceiling effect. It may have facilitated recruitment in the current feasibility trial, though there is also the possibility that participants may have been less motivated to engage if they felt the intervention was not required to address an identified deficit. Exclusion criteria were having another significant mental or physical health condition, current involvement in another research trial, severe depression, indicated by a score of over 20 on the Patient-Health Questionnaire-9 (PHQ-9 (36), being unable to read or understand English, having visual, auditory, or motor difficulties of a severity limiting the person's ability to attend to the content of the interventions, read the Participant Information Sheet, or complete the consent form and outcome measures, and not being registered with a General Practitioner (GP) or being unable to provide GP information (for reporting suicidal ideation concerns and scores of over 20 on the PHQ-9 (36). Severe depression was an exclusion criterion to minimize potential risks and adverse effects due to the remote nature of the study. Recent guidance (15) comments on the importance of considering depression in remote telerehabilitation, as there is tentative evidence it may lead to an increase in symptoms.

Recruitment

Participants were recruited through public health services, Third Sector charities, and a university database. Potential participants were identified by staff from participating public health stroke services, who provided them with the study Participant Information Sheet. Potential participants had the option to consent for their contact details to be shared with the research team or to contact the team directly via e-mail or phone. Three national stroke charities advertised this study to their network of stroke survivors by posting the study poster which included study eligibility information and the contact e-mail for the research team. Participants were also recruited from an ethically approved university database of contacts of brain injury survivors managed by one of the faculty members. Participants were sent the study Participant Information Sheet via e-mail and post.

Interventions

Both conditions were designed to be delivered asynchronously online. Each lasted two weeks and consisted of one 30-minute video recording being made available each week, along with a homework task. All materials were provided by e-mail. The videos were presentations developed by the research team, with information presented in both written form as well as verbally by a member of the research team. The homework tasks were explained at the end of each video, and handouts were provided to support their completion. Participants were given the option of a reminder to complete each module once or twice a week via their preferred contact method (e-mail or text message).

Executive functioning intervention

An asynchronous telerehabilitation intervention was developed to target skills relevant for setting goals, self-monitoring, and problem solving (28,29); see Appendix B for content summary and slide examples). We adapted preexisting tasks used in executive functioning rehabilitation. The content is closely related to Goal Management Training (GMT; 22,23) and the Goal Management Framework (37,38). However, as existing EF interventions are typically therapist-led and delivered over multiple weeks, they do not readily translate to an asynchronous, self-guided format. This adaptation retained key EF rehabilitation principles while ensuring accessibility for stroke survivors. Findings from the systematic reviews conducted by Chung and colleagues (9), Cicerone and colleagues (10), and Poulin and colleagues (11), alongside theoretical models of executive functioning (28,29) were also considered when mapping the intervention content. As the aim was to improve goal management, the focus was on cognitive executive functions (i.e., problem solving, task-setting, monitoring), rather than emotion regulation. Additionally, each module included psychoeducation relevant to each skill.

Stroke psychoeducation

Participants in the control group received a matched asynchronous stroke psychoeducation intervention. Psychoeducation was deemed preferable to a waitlist condition to maximize retention rates, whilst being distinct in content from the EF intervention, as well as matching the level of input provided by the active intervention. The information provided covered definitions and descriptions of different types of stroke, areas of the brain, impact of strokes affecting different parts of the brain and the role of different professionals (see Appendix C for content summary and slide examples).

Randomisation

Randomization occurred after baseline assessment. It was conducted on a 1:1 basis using a computer-generated randomization sequence (www.randomization.com). It was not possible for the person providing access to the intervention and control recordings and materials and collecting the data to be blinded to group allocation. However, questionnaire data were gathered anonymously through an online survey platform (JISC surveys). Participants were blinded to intervention; the Participant Information Sheet stated that two interventions were being compared (one concerning goal-management and problem-solving skills and the other providing information about stroke) but remained neutral regarding any specific hypotheses.

Outcome measures

Self-report questionnaires that have been validated in stroke populations were completed at baseline, after completion of the two-week intervention, and at one-month follow-up. The PHQ-9 (36) was completed as part of the screening process to assess eligibility. As this is a feasibility study, no primary outcome measure was identified. A variety of self-report measures were used to assess executive functioning (Revised Dysexecutive Questionnaire; DEX-R (39), health-related quality of life (ICEpop CAPability measure for Adults; ICECAP-A (40), wellbeing (Short Warwick-Edinburgh Mental Wellbeing Scale; SWEMWS (41), and self-efficacy (The Stroke Self-Efficacy scale; SSE (42). The DEX-R (39) is a 37-item questionnaire based on the DEX from the Behavioural Assessment of Dysexecutive Syndrome (BADS (43), with items such as 'I act without thinking, doing the first thing that comes to mind' being rated on a five-point scale, ranging from 'Never' (0) to 'Very Often' (4). Higher scores indicate greater reports of dysexecutive problems. The ICECAP-A (40) is a five-item questionnaire, with participants being asked to choose one of four options for each item (e.g. 'I am able to feel settled and secure in all areas of my life' (4), 'I am able to feel settled and secure in many areas of my life' (3), 'I am able to feel settled and secure in a few areas of my life' (2), and 'I am unable to feel settled and secure in any areas of my life' (1). Higher scores indicate greater quality of life. The SWEMWS (41) is a seven-item questionnaire with items such as 'I've been feeling optimistic about the future' being rated on a five-point scale ranging from 'None of the time' (1) to 'All of the time' (5). Higher scores indicate higher psychological wellbeing. The SSE (42) is a 13-item questionnaire, with items such as 'How confident are you now that you can cope with the frustration of not being able to do some things because of your stroke?' being rated on a 4-point scale ranging from 'Not at all confident' (0) to 'Very confident' (3). Higher scores indicate higher self-efficacy. During screening we also collected information about stroke rehabilitation interventions already received, sociodemographic information relating to age, gender, ethnicity, and stroke-related information such as site and type of stroke. A feedback survey utilizing a mixture of open-ended (free text response) and closed (Likert type response) questions was administered to participants after completing the intervention in order to further assess acceptability (see Figure 2).

Process measures

The following data were collected to evaluate monthly recruitment rate:

- Number of invitations to take part sent by public healthcare services and proportion of patients who responded.
- Retention rates at each study timepoint (each assessment point and follow-up).
- Completion rates per intervention; in the feedback survey, participants were asked whether they had watched the videos and completed the homework tasks).
- Outcome measure completion rate.
- Number of questionnaire reminders sent.
- Number of participants requiring support to complete questionnaires.
- Patterns of missing data.

Procedure

The procedure steps are shown in Figure 3. Prospective participants who expressed interest in participating in the study were screened for eligibility by the primary researcher via a 15-minute phone call. They were asked to provide their GP details before completing the PHQ-9 (36) and made aware that the research team would contact their GP with their consent if the result was indicative of severe depression or suicidal ideation. If they met eligibility criteria, prospective participants were given at least 48 hours to consider whether they wanted to participate, following which they were asked to complete an online consent form.

Informed consent was obtained online using MS Forms. Participants were then assigned a code in line with the randomization sequence and emailed URLs to access and complete baseline outcome measures. They were then sent e-mails containing the URL for the video and an attachment with the homework task, in line with their group allocation over the course of two weeks. E-mails were sent on Mondays for two consecutive weeks for each condition. They were sent reminder e-mail messages according to their preference (once or twice each week), if requested. Following the two sessions, they were emailed the outcome measures and feedback survey URLs. One month after completing the study the participants were emailed URLs with the final set of outcome measures.

1. **Did you watch the first presentation? (Yes/No)**
2. **Did you watch the second presentation? (Yes/No)**
3. **How relevant did you find the presentations?**

0…….5

Not relevant at all Very relevant

4. **How easy to engage with did you find the presentations?**

0…….5

Not easy at all Very easy

5. **How useful did you find the presentations?**

0…….5

Not useful at all Very useful

6. **Did you complete the first homework task? (Yes/No)**
7. **Did you complete the second homework task? (Yes/No)**
8. **How relevant did you find the weekly homework tasks?**

0…….5

Not relevant at all Very relevant

9. **How easy to engage with did you find the weekly homework tasks?**

0…….5

Not east at all Very easy

10. **How useful did you find the weekly homework task?**

0…….5

Not useful at all Very useful

11. **What were the things that you liked about the intervention? (free text response)**
12. **Was there anything about the intervention that you did not like? (free text response)**
13. **How did you find the length of the weekly presentation?**

0…….5 (too short – just right – too long)

14. **How long did it take you to complete the weekly homework task? (free text response)**

Figure 2. Intervention feedback questionnaire.

If participants had not completed questionnaires at any of the three timepoints, they were emailed a reminder message a week after the initial link was sent, asking them to complete them. After completing these stages participants were given the option to be emailed the materials from the intervention they did not complete (i.e., participants in the control group were sent the materials of the executive functioning intervention and vice-versa).

Data analysis

Diagnostic plots were visually inspected to identify departures from normality in the distribution of variables/residuals, as well as to identify outliers (>3 standard deviations above the mean). Baseline data were analyzed using chi-square tests of independence for categorical variables and independent samples t-tests for continuous ones, to check for between-group differences. The dataset was inspected for patterns of missing data. Descriptive statistics (with 95% confidence intervals) were used to summarize data relevant to recruitment, attrition, questionnaire completion rates and completion of sessions.

Magnitude of change in outcome measures was examined using analyses of variance (ANOVA). The analysis was conducted on a per protocol basis and was presented using summary statistics. Standard deviations (with 95% confidence

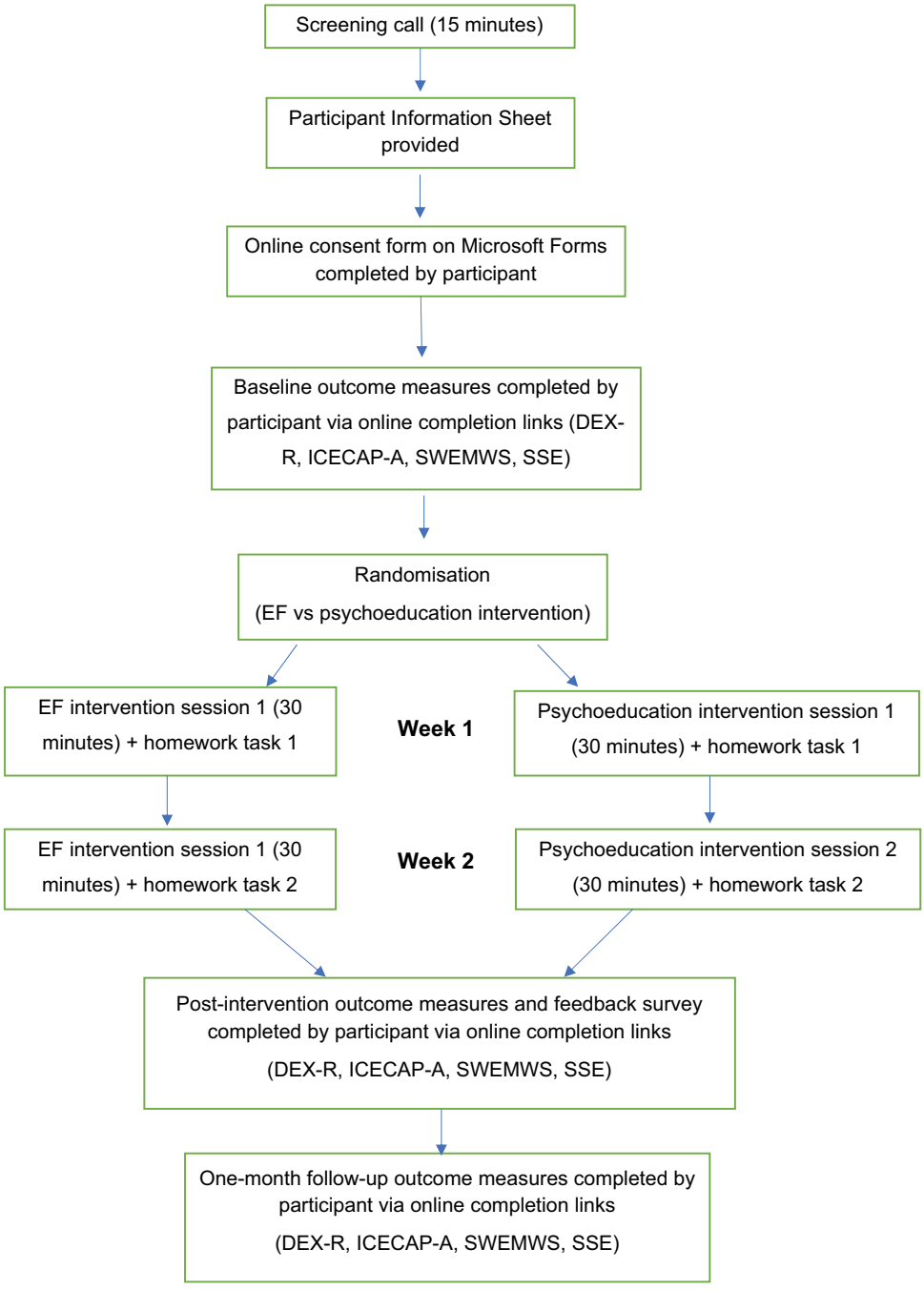

Figure 3. Timeline of study procedure.

intervals) of potential primary outcome measures were estimated, to inform power and sample size calculations for a future RCT and determine the appropriateness of the outcome measures selected.

Quantitative data from the feedback survey were summarized using descriptive statistics (means and standard deviations). Open text responses concerning participants' responses to the intervention and involvement in the study were content analyzed through the process outlined by Erlingsson and Brysiewicz (44) to determine the frequency of positive and negative words participants use to describe their experiences, as well as group similar feedback points into themes. The steps taken were gaining a general understanding of the written feedback, dividing the text into smaller meaning units, coding the meaning units, and lastly grouping the codes into categories.

Results

Recruitment and adherence

The first participant entered the study on 12 June 2022, the last on 23 November 2022, and the final follow-up measure was completed on 16 January 2023. The flow of participants

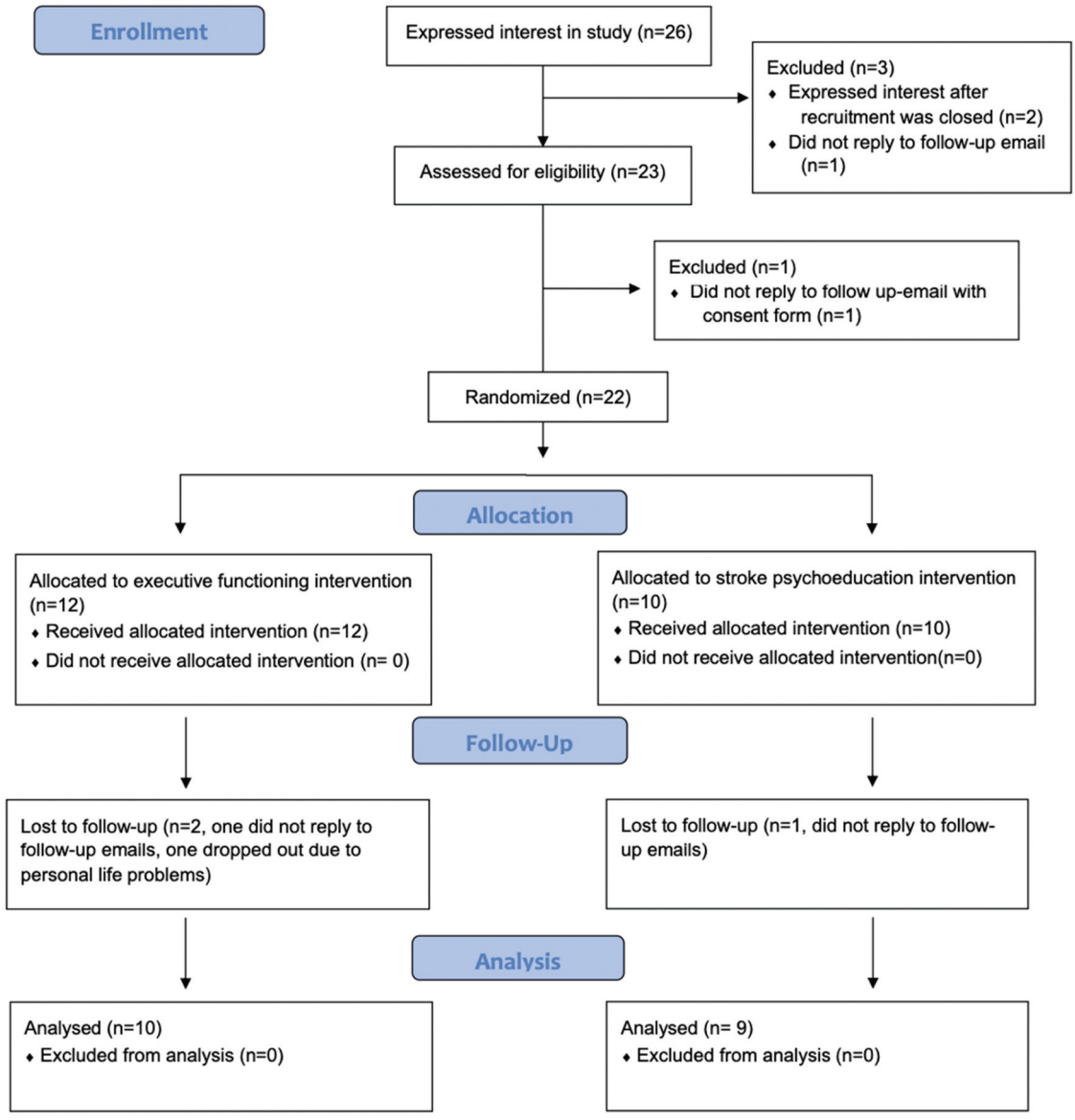

Figure 4. CONSORT flow diagram of participants included in each phase of the study.

through the study can be seen in the CONSORT diagram (Figure 4). The study recruitment rate was 3.67 participants per month. Two of the three public healthcare stroke services that were participant identification centers recorded the number of participants they had approached with information about the study, with 93 stroke survivors being offered the opportunity to take part. In total, 4 potential participants were identified through public healthcare recruitment, one of whom could not be contacted after the screen call, and three of whom entered the study. Ten participants were identified through a university research database, and nine through two national stroke charities. Therefore, 95.83% of screened individuals were randomized.

Rates of compliance were high, with 84% of participants in the EF group and 90% of participants in the stroke psychoeducation group completing the study and outcome measures at baseline, post-intervention, and follow-up, and an overall drop-out rate of 13.64%. All participants who completed the intervention reported that they had watched both videos for their condition. Two participants, one from each group, reported not completing either of the two homework tasks. Six of nine participants in the stroke psychoeducation group and seven of ten participants in the executive functioning group requested to receive the materials from the other intervention, as well. Participants completed the post-intervention questionnaires an average of 27.21 (SD = 16.49) days after baseline, though the intended completion time was 14 days post baseline. The one-month follow-up questionnaires were completed in line with the intended timeline, with participants completing them on average 32.42 (SD = 20.34) days post-intervention. There were no significant group differences in the number of days between completing baseline and post-intervention questionnaires [$t\ (17) = -1.096$, $p = 0.289$)], with participants in the EF group completing the post-intervention questionnaires an average of 23.3 (SD = 8.03) days after completing the baseline, and the psychoeducation group an average of 31.56 (SD = 22.34) days after baseline. There was

a significant outlier in the psychoeducation group, who completed the post questionnaires 89 days after baseline. There was a significant group difference in the number of days between completing the post-intervention and follow-up questionnaires [t (17) = 2.254, $p = 0.047$], with participants in the EF group completing the follow-up questionnaires an average of 41.1 (SD = 24.7) days after completing the post-intervention ones, and the psychoeducation group, an average of 22.78 (SD = 6.70) days after the post-intervention questionnaires.

Support requirements to complete outcome measures

Consistent with the protocol, up to two reminders were sent to participants per questionnaire set. Fifteen of the 22 participants (68%) required at least one reminder. In total, 11 reminders were sent for the baseline measures, 11 for the post-intervention measures, and 9 for the follow-up measures. All participants were offered the option of receiving one or two reminders a week to watch the videos and complete the tasks, but only two participants accepted the offer. One participant needed more support to complete the questionnaires and was sent separate e-mails with links for each questionnaire rather than all links together in one e-mail.

None of the participants required individual support to complete the questionnaires. The average completion times for the questionnaires were 95 seconds (SD = 115) for the SWEMWS, 258 seconds (SD = 216) for the SSE, 66 seconds (SD = 81) for the ICECAP-A, 376 seconds (SD = 257) for the DEX-R, and 314 seconds (SD = 200) for the feedback questionnaire. Therefore, the average amount of time spent completing the full set of questionnaires per timepoint was 18.48 minutes.

Baseline demographics

The screening data could not be retrieved for one participant in the stroke psychoeducation group. Baseline background measures were analyzed for the remaining 18 participants who completed the study, whereas the baseline questionnaire data were analyzed for all 19 participants. No significant baseline group differences were found (see Table 1).

Feedback data

There were no significant group differences in satisfaction ratings of each condition or homework tasks. No harms or adverse effects were reported by participants in either group. Participants in the EF group reported that homework took them an average of 48.67 minutes to complete, whereas those in the psychoeducation group reported an average of 23.13 minutes. Participant ratings are summarized in Table 2.

One participant in the EF group provided scores of '0' (on a scale of 0–5) for the usefulness and relevance of the intervention and homework task and provided feedback that the homework took too long to complete. One participant in the psychoeducation group rated the intervention as 2 out of 5, and the homework tasks as 0.67 out of 5, and provided feedback that although the videos offered lots of relevant and informative material, which helped them properly understand and relate to the content, they were unable to execute the homework task because they found it difficult to talk about stroke and felt that it would cause them distress, due to the recency of the event. Another participant in the psychoeducation group rated both the intervention and homework as 2 out of 5, but provided feedback that they had found it extremely interesting and stated that there was nothing they did not like about the intervention.

Eight participants in the EF group provided qualitative feedback about the intervention. Two reported liking that the concepts were familiar (e.g. 'Reinforced the mechanisms I have adopted since my stroke'), three fed back that the content was relevant (e.g. 'I can see how it is useful to use the techniques and the suggestions were all good'), two that the content was practical (e.g. 'Clear instructions and sensible, practical things to try out'), two that it was structured

Table 1. Differences between baseline characteristics of participants in the two treatment arms, separately.

Variable	Executive Functioning	Stroke psychoeducation	Group differences
N	10	8	
Female, n (%)	3 (30%)	4 (50%)	$X^2_1 = .748$, $p = 0.387$
Age, mean (SD)	56.5 (15.76)	57 (18.87)	t (16)=−.061, $p = 0.952$, d= −.029
Time since stroke, months (SD)	86.80 (127.66)	53.13 (66.29)	t (16)=.721, $p = 0.483$, d = .320
Type of stroke	7 Ischaemic, 3 haemorrhagic	5 Ischaemic, 3 haemorrhagic	
Ethnicity	9 White, 1 Asian	7 White, 1 Asian	
Education (% with university degree)	70%	100%	

Table 2. Descriptive statistics for participants' responses to the likert scale items of the feedback questionnaire.

Item	Executive Functioning		Stroke Psychoeducation	
	N	Mean (SD)	N	Mean (SD)
Relevance of Videos (0 = not relevant at all, 5 = very relevant)	10	3.4 (1.42)	9	4 (1.22)
Usefulness of Videos (0 = not useful at all, 5 = very useful)	10	3.4 (1.5)	9	3.89 (1.27)
Ease of Engagement with Videos (0 = not easy at all, 5 = very easy)	10	4.2 (1.23)	9	4 (1.32)
Relevance of Homework (0 = not relevant at all, 5 = very relevant)	10	3.5 (1.51)	9	3.56 (1.33)
Usefulness of Homework (0 = not useful at all, 5 = very useful)	10	2.9 (1.45)	9	3.67 (1.32)
Ease of Engagement with Homework (0 = not easy at all, 5 = very easy)	10	4 (1.25)	9	3.33 (1.58)
View on intervention length (0 = too short, 5 = too long)	10	3.2 (0.78)	9	2.55 (0.72)

(e.g. 'Break down into steps. Similar to writing computer code'), and one that they liked the level of detail ('I liked the level of detail required of us to create and implement our goals'). Four participants also provided feedback about what they did not like. Two people noted that the recommendations may be too ambitious or require skills that are too difficult for stroke survivors (e.g., strategies to manage concentration or use task chunking). One person felt that the format was too similar to a lecture, and another stated that the window size for the video was too small.

All nine participants in the stroke psychoeducation group provided written feedback. Three noted that the information presented was relevant (e.g. 'Lots of relevant informative information helped me to properly understand/relate'), clearly presented (e.g. 'Clear presentation of the brain and the function of its different parts'), two noted that it was useful to be able to share the facts to help others, one person liked that the information was on the presentation, as well as covered by a speaker, two felt that it normalized their experience (e.g., 'I felt the intervention took into account what had happened to me'), one felt that the homework task was relevant ('The homework allows the learning to bed in'), and one noted that the content was interesting. Two participants provided feedback on what they did not like, as well. One person noted that they struggled to find someone to talk about the information with, which was part of the homework task, although the alternative of writing out notes for themselves had been offered. The other person noted that talking about stroke with others felt difficult, as it brought up memories of the traumatic experience.

Outcome measures descriptive statistics

Normality assumptions were met for the DEX-R (39), ICECAP-A (40), SWEMWS (41), and SSE (42). Preliminary analyses indicated a significant Time x Group interaction [$F(2,34) = 4.224$, $p = 0.023$, $\eta 2 = 0.097$] for the DEX-R (39). No other main effects were significant. Table 3 presents descriptive statistics for the four outcome measures at three timepoints across both groups, with confidence intervals and effect size estimates for the group main effect. A larger sample of participants is needed to establish reliable magnitudes of change or measure group differences. All four effect size indicators suggest a small effect size.

Discussion

We aimed to investigate the feasibility and acceptability of a randomized controlled trial (RCT) of a brief asynchronous goal management telerehabilitation intervention compared to an asynchronous online psychoeducation active control.

Feasibility indicators

Our findings support the feasibility of investigating the test and control conditions. There was good adherence to most aspects of the trial protocol and procedures, apart from questionnaire data being returned with longer delays than anticipated. The recruitment rate was acceptable, though differed markedly between recruitment sites, with most participants identified through a university database. Recruitment through public healthcare stroke services yielded a low number of participants. This may reflect features of the peri-pandemic context. During the COVID-19 pandemic services moved to hybrid delivery limiting staff access to printers and ability to provide printed study information to patients. Additionally, staff reported limited capacity to provide information about the study to patients due to needing to prioritize other aspects of clinical care which meant that the majority of information sheets were sent in bulk with administrative letters, possibly affecting interest in participation.

The screening process was highly efficient, with all participants who were screened being found eligible for participation. This may reflect the use of broad eligibility criteria and explicit information about these criteria in all study materials, leading only individuals likely to be eligible to express interest in taking part. All participants who were randomized were provided intervention resources in line with their allocation. All 19 participants who completed the feedback questionnaire confirmed that they could access the resources they were emailed. The drop-out rate of 13.64% was slightly higher than the median of 6% reported by a systematic review of stroke rehabilitation trials (45), but there was no indication

Table 3. Descriptive statistics for the four repeated measures at the three time points.

Time	Executive Functioning			Stroke Psychoeducation			
	N	Mean (SD)	95% CI	N	Mean (SD)	95% CI	Group η2
The Dysexecutive Questionnaire Revised (DEX-R)							
Pre	10	42.8 (27.80)	24.878–60.722	9	40.22 (25.76)	21.331–59.114	0.010
Post	10	34.5 (21.97)	19.466–49.534	9	40.11 (23.14)	24.264–55.958	
Follow-up	10	34.5 (18.03)	19.861–49.139	9	44.56 (25.63)	29.124–59.987	
The Stroke Self-Efficacy Questionnaire (SSE)							
Pre	10	31.2 (6.56)	27.351–35.048	9	31.33 (4.72)	27.277–35.390	0.033
Post	10	32.4 (5.82)	28.178–36.622	9	29.44 (6.86)	24.995–33.894	
Follow-up	10	33.8 (4.61)	29.357–38.243	9	32.26 (6.68)	25.872–35.239	
ICEpop Capability measure for Adults (ICECAP-A)							
Pre	10	15.9 (2.6)	14.021–17.779	9	15.67 (3.04)	13.686–17.648	0.002
Post	10	16.5 (3.14)	14.487–18.513	9	16.56 (2.88)	14.434–18.677	
Follow-up	10	16.4 (3.2)	14.209–18.591	9	15.89 (3.37)	13.580–18.198	
Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMWS)							
Pre	10	26.7 (4.52)	23.744–29.656	9	25.22 (4.32)	22.107–28.338	0.010
Post	10	26.1 (4.86)	22.741–29.459	9	25 (5.22)	21.459–28.541	
Follow-up	10	25.9 (4.46)	22.640–29.160	9	25.89 (5.33)	22.453–29.325	

that participants dropped out due to factors relating to the interventions. However, two of the three participants who dropped out did not reply to follow-up contact attempts, and therefore factors relating to the intervention cannot be ruled out as a reason for drop-out in this study.

All participants completing the feasibility trial provided full datasets with no missing outcome measure data, suggesting that collecting data through online questionnaires was highly feasible and acceptable for the stroke survivors who took part. All participants were able to access online outcome measures, although the post-intervention questionnaires were returned later than planned on average. A large number of reminders were emailed to facilitate outcome measure completion. Reminder systems are established in this population and well-received (46), and likely to be an important element in a full trial. Our protocol specified one reminder a week, but more frequent reminders may have reduced delays in outcome measure completion.

As is customary for a feasibility trial, the study aims, lack of hypotheses regarding efficacy, combined with the small sample size means conclusions cannot be drawn about intervention efficacy. An interaction was observed between group and time on the DEX-R (39) self-report measure of executive functioning. This might suggest positive change for participants in the executive functioning group, though the small effect size and wide confidence interval indicates the need to replicate the finding in a fully powered trial. Since this is a feasibility study with a small sample size, the effect sizes should be interpreted with caution, as they may not be reliable indicators of true intervention effects. However, based on the observed trends, the DEX-R (39) and SSE (42) appeared to be the most promising measures for detecting change and may be suitable as primary outcomes in a future trial. The ICECAP-A (40) and SWEMWS (41) showed minimal change, suggesting they may be better suited as secondary outcomes.

Acceptability indicators

Positive quantitative ratings of usefulness, relevance, and ease of use for the executive functioning and stroke psychoeducation conditions suggest that the content was well-received by participants. Qualitative feedback was also consistent with this. Our findings are consistent with other studies in finding that most participants in technology-based cognitive rehabilitation intervention trials report finding these interventions acceptable (6,47). One participant in each group reported not completing the homework tasks, suggesting that for some people the videos were perceived as more relevant or important than the associated homework, or possibly that completing the tasks was perceived as more time-consuming or effortful, compared to watching the videos. This, combined with the two participants feeding back that they found it difficult to discuss the information with other people, may suggest the homework tasks could be modified to be simpler and more flexible. The alternative of writing the information down as opposed to talking to someone else about it was offered, but it is possible that this was not made sufficiently explicit in the instructions.

Our study recruited a large proportion of participants with university degrees, and it would be important for future research to ensure generalizability to the wider stroke population. The median age of participants across groups in our study was 60 years, which is relatively young compared to the median age for a first stroke of 68 for men and 73 for women in the UK (48). This could point toward our sample being unrepresentative of the wider target population. However, it is also possible that this is a representative sample of a specific subgroup of stroke survivors who might engage with and benefit from this type of intervention, as higher education and younger age are key predictors for experience with technology and attitudes toward computers (49,50). A quarter of strokes in the UK occur in people of working age (48). As cognitive dysfunction can significantly impair return to work (51), and executive functioning rehabilitation plays a key role in re-adaptation to daily life, exploring the extent to which working-age stroke survivors benefit from this intervention would be important.

Using online outcome measures was a straightforward way to achieve blinding of outcome collection. For blinding in a full trial, it will also be important to ensure that data analysis is performed by a member of the research team not involved in recruitment, intervention delivery, or data collection.

Providing intervention materials for both interventions on request at the end of the study may have contributed to participant engagement with randomization. There was little difference in dropout rate across groups. Two participants dropped out from the executive functioning group and one from the stroke psychoeducation group suggesting that participants were not more likely to discontinue one condition than the other. This is further corroborated by similar participant satisfaction ratings for both interventions. Most participants requested the materials from the other condition, suggesting good engagement with the material and finding it useful.

Limitations

One limitation of the current study is that it exclusively used self-report outcome measures. The post-intervention questionnaire data was also collected, on average, later than intended in the protocol. Another limitation is that the interventions are relatively brief, although the fact that the participants could watch the recordings multiple times may have compensated for brevity, to a degree. Preliminary evidence from a review of a small number of studies suggests that there is a link between the time and intensity of stroke computerized cognitive rehabilitation and the degree to which cognitive benefits are observed (52). We also only included participants who had access to the necessary technological equipment (computer or tablet, as well as access to the internet). Although there is evidence that as many as 94% of people in the UK now have access to the internet (53), 21% of them only do so via a smartphone, which due to the small screen size would not have been suitable for our intervention. Therefore, it may have been beneficial to have the option of providing the necessary equipment to potential participants.

Future research and conclusions

Our results suggest that the brief asynchronous executive functioning telerehabilitation intervention and stroke psychoeducation control would be feasible and acceptable to research in a full trial. Future research, in an appropriately powered RCT, is needed to determine the efficacy of the executive functioning intervention over and above alternative treatment options and natural

recovery. A full trial would need to account for slow recruitment rates, as well as use a variety of recruitment sources. The use of a research database of stroke survivors yielded a relatively high number of participants, and therefore it is recommended that a full future trial utilizes this recruitment source. Although public healthcare recruitment yielded a low number of participants, it would be important to retain this recruitment avenue in a full trial, to maximize the representativeness of the study sample. As this intervention requires a level of computer literacy, it will be important to test the intervention on a more representative sample of stroke survivors, to identify specific subgroups most likely to engage with and benefit from the intervention. It is possible that the COVID-19 pandemic impacted public healthcare recruitment, as the staff from the services which acted as Participant Identification Centres were working in a hybrid format, which limited their access to printers. This meant that information about the study was provided to participants through less individualized avenues (e.g., along with appointment letters), which may have understandably impacted the willingness of potential participants to take part, resulting in a low conversion rate. In a full trial it may be beneficial to supply public healthcare stroke services staff with printed copies of the Participant Information Sheet, as well as have a member of the research team be physically present in the services, to answer any questions from staff, as well as speak with potential participants. Research has underlined the importance of highlighting the contributions of trial recruiters by updating them through regular newsletters and the research team having a presence at research sites (54), and therefore it will be important to prioritize this when recruiting through the public healthcare services in a future trial. One limitation of the current study is that it exclusively used self-report outcome measures. It would be useful to consider supplementing self-report questionnaires with clinician-administered and informant outcome measures in a full trial. As the intervention targets EF, the use of neuropsychological tests such as the Trail Making Test Form B (55), the Stroop Test (56), and Digit Span (57) could be considered. More frequent reminders (two or three per week) should be employed to hasten questionnaire completion times.

This research has important clinical implications, as the provision of a remote, asynchronous EF intervention could allow stroke survivors to access cognitive rehabilitation that may have otherwise not been available to them. As this intervention focuses on adaptive skills, should it be found to be effective in a full trial, it could help stroke survivors re-adapt to life in the community and facilitate their recovery.

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