Journal of Physiotherapy 65 (2019) 95–98

AUSTRALIAN PHYSIOTHERAPY ASSOCIATION

Journal of
PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Research

Goal-oriented instructions increase the intensity of practice in stroke rehabilitation compared with non-specific instructions: a within-participant, repeated measures experimental study

Tessa Hillig [a], Haotian Ma [a], Simone Dorsch [a,b]

[a] School of Allied Health, Australian Catholic University; [b] StrokeEd collaboration, Sydney, Australia

KEY WORDS

Stroke
Practice
Communication
Rehabilitation
Physical therapy

ABSTRACT

Questions: In stroke rehabilitation, do goal-oriented instructions increase the intensity of practice during therapy compared to a non-specific instruction? Is one type of goal-oriented instruction more effective at increasing the intensity of practice achieved by stroke survivors during therapy? **Design**: A within-participant, repeated measures experimental study. **Participants**: Twenty-four adults undertaking stroke rehabilitation at a metropolitan hospital as an inpatient or outpatient. **Intervention**: Participants were observed performing exercises across 3 days. On each day, they performed an exercise with a non-specific instruction ('do some [exercise]') as a baseline measure and the same exercise with one of three goal-oriented instructions, delivered in a randomised order. The three goal-oriented instructions were: 'do [exercise] 25 times' (instruction A), 'do [exercise] 25 times as fast as you can' (instruction B), and 'do [exercise] 25 times, as fast as you can, aiming for a personal best' (instruction C). The last instruction included verbal encouragement during the exercise. **Outcome measures**: The time taken to complete 25 repetitions under the baseline condition and each instruction was recorded and converted into repetitions per minute. **Results**: All of the goal-oriented instructions resulted in a significant increase in the rate of repetitions of the exercise being performed compared to the baseline measure: percentage increase from baseline (95% CI) was 62% (31 to 93) with instruction A, 116% (67 to 165) with instruction B, and 128% (84 to 171) with instruction C. Instruction C had a significantly greater effect than instruction A: mean difference in percentage increase 65% (95% CI 13 to 118). **Conclusion**: Goal-oriented instructions can result in significant increases in the rate of repetitions of exercise in stroke rehabilitation. The use of goal-oriented instructions is a simple, no-cost strategy that can be used to increase the intensity of practice in stroke rehabilitation. **Trial registration**: ACTRN12619000146190. **[Hillig T, Ma H, Dorsch S (2019) Goal-oriented instructions increase the intensity of practice in stroke rehabilitation compared with non-specific instructions: a within-participant, repeated measures experimental study. *Journal of Physiotherapy* 65:95–98]**

Introduction

Following a stroke, there is clear evidence that people who do larger amounts of task-specific practice achieve better activity outcomes. The first systematic review to suggest this dose-response relationship calculated that an additional 16 hours of therapy early after stroke could result in small to moderate improvements in activity.[1] A recent systematic review calculated that at least a 240% increase in usual therapy time is needed to produce significant improvements in activity outcomes.[2] In addition to increased time, it appears that a high intensity of practice (ie, a high number of repetitions) is required to improve activity outcomes.[3,4] Carey et al found that intensive finger tracking training (involving almost 7000 repetitions over 20 sessions) resulted in improved tracking accuracy and grasp and release function, and these improvements were accompanied by neuroplastic changes seen on functional magnetic resonance imaging.[3] Scrivener et al established that completing a higher dose of lower limb exercise repetitions (> 703 repetitions in the first week after stroke) resulted in faster recovery of unassisted walking and that the number of lower limb exercise repetitions completed in the first week could predict stroke survivors' walking speed at discharge from rehabilitation.[4]

Despite current literature and clinical guidelines recommending large doses of therapy after stroke, this is not being achieved in clinical practice.[2,5,6] A systematic review of activity during physiotherapy sessions found that therapy sessions are 50 minutes long and that stroke survivors are active for an average of only 60% of a session.[7] During these short therapy sessions, a stroke patient may perform as few as 32 repetitions of upper limb exercise,[6] 202 steps of walking practice, or 11 stand-ups.[8] These amounts of practice are unlikely to cause neuroplastic changes that are sufficient to improve clinical outcomes after stroke.

https://doi.org/10.1016/j.jphys.2019.02.007
1836-9553/

Strategies are needed to help achieve larger therapy doses within the rehabilitation setting. A scoping review of studies in which extra practice was done in stroke rehabilitation found that generally this was done with full supervision by extra staff.[9] This is not a sustainable solution in usual clinical settings, where lack of time is the most commonly cited reason for not being able to increase therapy dosages.[10] The authors of that scoping review suggest that the use of goal-oriented instructions could increase dosages of practice by increasing the intensity at which stroke survivors work within a session. However, the use of goal-oriented instructions to increase practice intensity does not appear to have been examined in stroke rehabilitation. There are studies that have examined the effect of modifying instructions in order to modify the speed of stroke survivors' task performance.[11–13] These studies have demonstrated increases in the speed of task performance in response to different instructions. However, they were not aiming to examine changes in intensity of practice and therefore only examined the change in speed of one repetition of a task. There are currently no studies that have investigated the effect of goal-oriented instructions on increasing the intensity of practice done over a sustained period. If using goal-oriented instructions has a significant impact on the intensity of practice achieved (ie, intensity in terms of rate of repetitions achieved) during a therapy session, this could increase therapy doses without additional staff, equipment, cost or time.

Therefore, the research questions for this within-participant, repeated measures experimental study were:

1. In stroke rehabilitation, do goal-oriented instructions increase the intensity of practice achieved by stroke survivors during therapy?
2. Is one type of goal-oriented instruction more effective at increasing the intensity of practice achieved by stroke survivors during therapy?

Method

Design

This was a within-participant, repeated measures experimental study. All participants received the same three instructions in randomised order while doing one of their usual lower limb exercises. Prior to receiving the instructions, participants were blinded from the types of instructions and the instruction order.

Participants, therapists, centres

The study was conducted in the stroke unit of a large metropolitan hospital. Patients admitted with a clinical diagnosis of stroke were screened for inclusion, and approached to participate if they met the following criteria: aged $\geq$ 18 years; inpatients with an expected length of stay likely > 1 week or outpatients expected to attend at least five more therapy sessions; able to perform 50 repetitions of a lower limb exercise without physical assistance (eg, sit to stand, tilt table strengthening exercises, stepping exercises); sufficient English to understand simple instructions; and adequate cognition to follow simple instructions. Patients were excluded if they did not require inpatient physiotherapy and/or were not medically stable enough to participate in rehabilitation exercises. All participants provided written informed consent before participating in the study. One researcher (SD) performed the block randomisation prior to the commencement of the study. Two researchers (TH and HM) performed participant recruitment and data collection.

Intervention

Data collection occurred during the participant's normal therapy sessions in the rehabilitation gym and spanned across 3 consecutive therapy days. The selected lower limb exercise was one that participants had been performing as part of their normal rehabilitation and could complete more than 50 times without verbal prompting or physical assistance. The selected exercise and environment set-up remained the same across the 3 days. A new baseline was measured each day to account for the potential learning effect and increased efficiency of performance over the 3 days. When possible, the data were collected at a similar time each day to reduce the risk of fatigue affecting task performance. Participants were given the baseline instruction first, and the time taken to complete 25 repetitions was recorded. Following the baseline instruction, participants were given one of the three goal-oriented instructions, and the time taken to complete 25 repetitions was recorded. The goal-oriented instructions were adjusted according to the lower limb exercise performed by the participant. Using sit to stand as an example, the instructions were as shown in Box 1.

Box 1. Format of instructions given to the participants, using sit to stand as an example exercise.

Baseline	'Do some sit to stands'
Instruction A	'Stand up and sit down 25 times'
Instruction B	'Stand up and sit down 25 times as fast as you can'
Instruction C	'Stand up and sit down 25 times as fast as you can. Aim for your personal best!' The researcher provided additional encouragement whilst the participant performed the exercise such as 'go, go, go!', 'over halfway there' and a countdown over the final 10 repetitions.

The instruction delivered on each day was dependent on the randomised instruction order the participant was allocated prior to starting data collection. There were six possible orders in which the three instructions could be delivered: ABC, ACB, BAC, BCA, CAB and CBA. If for example, a participant was allocated ABC, instruction A was delivered on Day 1, instruction B on Day 2 and instruction C on Day 3.

In order to test each instruction order four times, four blocks of the six possible orders were used. Hence, 24 participants were recruited for this study. Within each block, the order in which the six possible instruction orders appeared was randomised using the random number generator function on commercial spreadsheet software[a]. Participants were blinded to the instructions and the instruction order prior to data collection.

Outcome measures

The primary outcome measure was the rate at which repetitions were completed under each instruction. A stopwatch was used to time how long it took the participants to complete 25 repetitions under each instruction. A hand-held tally counter was used to count the number of repetitions. The results were converted into repetitions per minute. Preliminary data revealed significant variability in the amount of time taken to do different exercises; hence, rate of repetitions was chosen as the primary outcome rather than the time taken to complete 25 repetitions.

Data analysis

Preliminary analysis of data collected from a sample of 11 stroke survivors revealed that to have an 80% chance of detecting a 25% change in rate of repetitions with an alpha value of 5%, 20 participants were required. In order to test each order of instructions four times, it was decided to measure 24 participants.

All data analyses were performed using statistical software[b]. The mean difference and 95% CI between baseline and each goal-oriented instruction was calculated and the mean percentage increase in the repetition rate with each goal-oriented instruction was calculated relative to that day's baseline. To ascertain statistically significant differences between the instructions, repeated measures analysis of

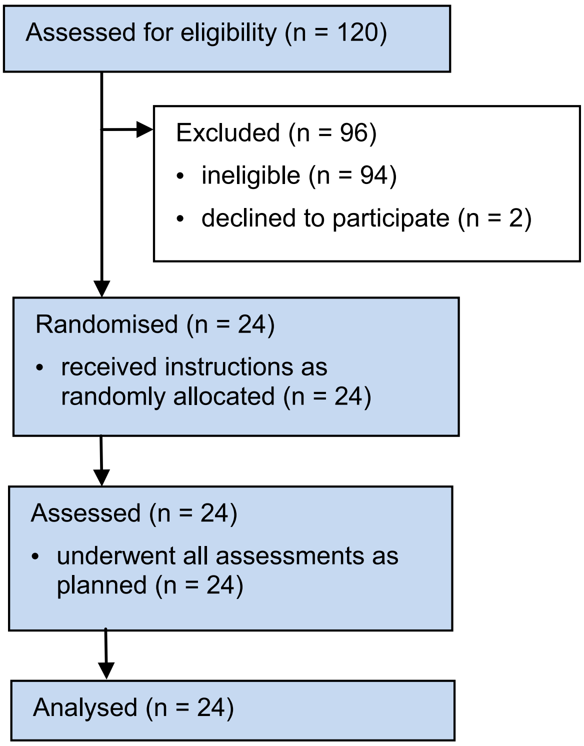

Figure 1. Flow of participants through the study.

variance (ANOVA) was applied to the percentage change. Bonferroni adjustment was used for multiple comparisons.

Results

Flow of participants through the study

The flow of the participants through the study is shown in Figure 1. A total of 120 stroke patients were screened for inclusion, of whom 24 participated in the study. Each of the six instruction orders was tested four times. All participants were administered their baseline and goal-oriented instructions in the allocated order. There were no dropouts. There were no adverse effects during the study. Participant demographic and clinical characteristics are reported in Table 1. The mean age of the participants was 70 years (SD 15). The average time after stroke was 70 days (SD 182). Most participants were moderately severely disabled, with 75% of the participants scoring 4 on the modified Rankin Scale.[14]

Change in rate of repetitions

Statistically significant increases in the number of repetitions completed per minute were observed for each instruction compared to its baseline (Table 2). Individual participant data are presented in Table 3, which is available on the eAddenda. The mean increase (95% CI) in repetition rate from baseline to the goal-oriented instruction was: 6 repetitions per minute (4 to 9) for instruction A; 13 repetitions per minute (9 to 16) for instruction B; and 15 repetitions per minute (12 to 18) for instruction C. Data on outcome measures were normally distributed as indicated by the Shapiro-Wilk test.

Percentage increase in rate of repetitions

Statistically significant differences in the percentage increases between the instructions were found, as determined by repeated measures ANOVA ($F(2,46) = 4.668$, $p = 0.014$). The mean percentage increase of each instruction from baseline is shown in Table 4. The greatest percentage increase was instruction C, with a mean increase of 128% (SD 85) from baseline.

Table 1
Characteristics of participants.

Characteristic	Participants (n = 24)
Age *(yr)*, mean (SD)	70 (15)
Gender, n females (%)	13 (54)
Type of stroke, n (%)	
left CVA	9 (38)
right CVA	12 (50)
brainstem	1 (4)
cerebellar	1 (4)
multiple CVA	1 (4)
Disability (Modified Rankin Scale), n (%)	
2	4 (17)
3	2 (8)
4	18 (75)
Time since stroke *(days)*, mean (SD)	70 (182)
Exercises used in the instructions, n (%)	
sit to stand	8 (33)
sit and reach	4 (17)
tilt table knee extension	6 (25)
stepping forward	3 (13)
bilateral calf raises	1 (4)
knee flexion with slide sheet	1 (4)
alternate foot taps	1 (4)

CVA = cerebral vascular accident.

Comparisons between goal-oriented instructions

Differences in the percentage increase in the rate of repetitions was compared pairwise between the three goal-oriented instructions, as presented in Table 5. Instruction C had a significantly greater percentage increase in repetition rate than instruction A, with a 65% mean difference (95% CI 13 to 118). No statistically significant differences were observed between instruction A and B, with a mean difference of 54% (95% CI –3 to 111), or instructions B and C, with a mean difference of 12% (95% CI –53 to 76).

Discussion

All goal-oriented instructions resulted in a large increase in the rate of repetitions of exercise compared to the baseline non-specific instruction. Participants increased their rate of repetitions by 62% to 128% when given the goal-oriented instructions. The most effective instruction was an instruction that encouraged speed and to achieve a personal best, 'Do [exercise] 25 times as fast as you can. Aim for your personal best!' with an increase of 128% over the baseline rate of repetitions. Goal-oriented instructions can therefore be used to increase intensity of practice in stroke rehabilitation.

Three other studies have examined the use of instructions in stroke rehabilitation to establish whether stroke survivors can increase their speed of task performance. Two studies measured movement speed, with participants asked to perform a reaching task at a comfortable speed and then with specific instructions that encouraged greater speed.[11,12] The first study measured a 30% increase in movement speed[11] and the second study measured a 14% increase in movement speed[12] in the respective reaching tasks. The third study measured walking speed with four different instructions about speed, and demonstrated a 26% increase in walking speed with the 'maximum speed' instruction.[13] The changes in single-task

Table 2
Repetitions per minute for baseline non-specific instructions and goal-oriented instructions, and difference (95% CI) between instructions (n = 24).

Instruction	Repetitions per minute mean (SD)		Between-group difference mean (95% CI)
	Baseline	Goal-oriented instruction	Goal-oriented instruction minus baseline
A	16 (11)	23 (13)	6 (4 to 9)
B	16 (9)	28 (12)	13 (9 to 16)
C	15 (7)	30 (11)	15 (12 to 18)

Table 4
Percentage increase from baseline in number of repetitions with goal-oriented instructions (n = 24).

Instruction	Percentage increase in repetitions *(%)*		
	Mean (SD)	Range	95% CI
A	62 (74)	−7 to 266	31 to 93
B	116 (117)	−15 to 500	67 to 165
C	128 (85)	32 to 416	84 to 171

performance with goal-oriented instructions in these three studies were statistically significant, but substantially lower than the changes in rate of repetitions found in the present study. In the present study, the smallest average increase in the rate of repetitions with any of the effective goal-oriented instructions was more than double the highest increase of 30% reported in the previous studies. However, the previous studies were investigating stroke survivors' capacity to increase the speed of a single performance of a task, whereas the current study was designed to examine a strategy for increasing the intensity of practice (ie, intensity in terms of rate of repetitions achieved) of a task over a sustained period. The clinical significance of the current study is that it shows that the use of goal-oriented instructions can result in stroke survivors increasing their intensity of practice over a sustained period, and this increase in intensity is large.

Importantly, this increase in practice intensity can be obtained without requiring extra time, staff, equipment or costs, and is therefore an effective and feasible strategy that can be implemented into current clinical settings. Lack of time is reported to be the greatest limitation to achieving larger dosages of therapy in rehabilitation after stroke.[10] Providing goal-oriented instructions that can more than double the rate of repetitions should result in more repetitions being performed in the available therapy time. It is therefore important for staff to be aware of and to carefully consider the instructions they use during therapy sessions. While this seems evident, observational studies have shown that therapists do not generally use communication that contains specific information.[15,16]

In the present study, there was no objective measure of change in quality of movement. This was a limitation because encouraging speed can potentially result in kinematic changes in task performance. However, one study found that instructions that emphasised speed in upper limb reaching tasks after stroke actually improved target accuracy and resulted in smoother movement.[11] It is possible that instructions that encourage speed may result in better movement strategies as well as increased intensity of practice. Subjectively, the researchers in our study did not observe any decrease in quality or perceived safety of the measured exercise or subsequent exercises with the increased intensity of practice. Another limitation was that the control condition (ie, the non-specific baseline instruction) was not randomised among the other randomly ordered interventions (ie, the goal-oriented instructions). Further research, with a control group that does not receive goal-oriented instructions and that examines the effect of goal-oriented instructions over a whole therapy session or a whole admission, could provide further evidence about the effect of goal-oriented instructions on intensity of practice and clinical outcomes in stroke rehabilitation.

It is well established in current literature that larger therapy doses are required to maximise activity outcomes after stroke, yet large doses of therapy are not being achieved in clinical practice. This study demonstrated that stroke patients can complete significantly greater intensities of practice in response to a goal-oriented instruction. Thus, clinicians can use goal-oriented instructions to help increase dosages of practice in stroke rehabilitation.

Table 5
Pairwise mean differences between instructions in the percentage increase in rate of repetitions (n = 24).

Instruction	Difference in percentage increase between instructions *(%)*
	Mean (95% CI)
B relative to A	54 (−3 to 111)
C relative to A	65 (13 to 118)
C relative to B	12 (−53 to 76)

What was already known on this topic: Following stroke, people who do larger amounts of task-specific practice achieve better activity outcomes. Despite this, many people undertaking stroke rehabilitation do not achieve high repetitions of their exercises.
What this study adds: Goal-oriented instructions can result in significant increases in the rate of repetitions of exercise in stroke rehabilitation. An instruction oriented to the goals of doing a specified number of repetitions, doing them as fast as possible, and aiming for a personal best, increases the number of repetitions more effectively than when only a target number of repetitions is included.

Footnotes: [a] Excel, Microsoft, USA. [b] SPSS v25, IBM, Australia.

eAddenda: Table 3 can be found online at DOI: https://doi.org/10.1016/j.jphys.2019.02.007.

Ethics approval: The South Western Sydney Local Health District Human Research Ethics Committee approved this study (HREC/17/LPOOL/86). All participants gave written informed consent before data collection began.

Competing interests: Nil.

Source(s) of support: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements: Nil.

Provenance: Not invited. Peer reviewed.

Correspondence: Simone Dorsch, School of Allied Health, Faculty of Health Sciences, Australian Catholic University, Sydney, Australia. Email: simone.dorsch@acu.edu.au

References

1. Kwakkel G, van Peppen R, Wagenaar R, Wood Dauphinee S, Richards C, Ashburn A, et al. Effects of augmented exercise therapy time after stroke: a meta-analysis. *Stroke*. 2004;35:2529–2539.
2. Schneider EJ, Lannin NA, Ada L, Schmidt J. Increasing the amount of usual rehabilitation improves activity after stroke: a systematic review. *J Physiother*. 2016;62:182–187.
3. Carey J, Kimberley T, Lewis S, Auerbach EJ, Dorsey L, Rundquist P, et al. Analysis of fMRI and finger tracking training in subjects with chronic stroke. *Brain*. 2002;125:773–788.
4. Scrivener K, Sherrington C, Schurr K. Amount of exercise in the first week after stroke predicts walking speed and unassisted walking. *Neurorehabil Neural Repair*. 2012;26:932–938.
5. Kimberley T, Samargia S, Moore L, Shakya J, Lang C. Comparison of amounts and types of practice during rehabilitation for traumatic brain injury and stroke. *J Rehabil Res Dev*. 2010;47:851–861.
6. Lang C, MacDonald J, Reisman D, Boyd L, Kimberley TJ, Schindler-Ivens SM, et al. Observation of amounts of movement practice provided during stroke rehabilitation. *Arch Phys Med Rehabi*. 2009;90:1692–1698.
7. Kaur G, English C, Hillier S. How physically active are people with stroke in physiotherapy sessions aimed at improving motor function? A systematic review. *Stroke Res Treat*. 2012.
8. Tyson S, Woodward-Nutt K, Plant S. How are balance and mobility problems after stroke treated in England? An observational study of the content, dose and context of physiotherapy. *Clin Rehabil*. 2018;32:1145–1152.
9. Stewart C, McCluskey A, Ada L, Kuys S. Structure and feasibility of extra practice during stroke rehabilitation: A systematic scoping review. *Aust Occup Ther J*. 2017;64:204–217.
10. Bayley M, Hurdowar A, Richards C, Korner-Bitensky N, Wood-Dauphinee S, Eng JJ, et al. Barriers to implementation of stroke rehabilitation evidence: findings from a multi-site pilot project. *Disabil Rehabil*. 2012;34:1633–1638.
11. Massie C, Malcolm M. Instructions emphasizing speed improves hemiparetic arm kinematics during reaching in stroke. *NeuroRehabilitation*. 2012;30:341–350.
12. Gauggel S, Fischer S. The effect of goal setting on motor performance and motor learning in brain-damaged patients. *Neuropsychol Rehabil*. 2001;11:33–44.
13. Nascimento L, Caetano L, Freitas D, Morais T, Polese J, Teixeira-Salmela L. Different instructions during the ten-meter walking test determined significant increases in maximum gait speed in individuals with chronic hemiparesis. *Braz J Phys Ther*. 2012;16:122–127.
14. Banks J, Marotta C. Outcomes validity and reliability of the modified Rankin scale: implications for stroke clinical trials: a literature review and synthesis. *Stroke*. 2007;38:1091–1096.
15. Stanton R, Ada L, Dean C, Preston E. Feedback received while practicing everyday activities during rehabilitation after stroke: an observational study. *Physiother Res Int*. 2015;20:166–173.
16. Durham K, Van Vliet P, Badger F, Sackley C. Use of information feedback and attentional focus of feedback in treating the person with a hemiplegic arm. *Physiother Res Int*. 2009;14:77–90.