Exploring the utility of analogies in motor learning after stroke: a feasibility study

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Individuals who have experienced a stroke need to (re)learn motor skills. Analogy learning has been shown to facilitate motor learning in sports and may also be an attractive alternative to traditional approaches in therapy. The aim of this study was to assess the feasibility and utility of analogies to improve the walking performance in long-term stroke survivors. Three men aged 76, 87 and 70 years who were 6, 1 and 3 years poststroke, respectively, presented with different walking deficits. An analogy, targeted at improving the walking performance was designed with the help of each participant. During a 3-week intervention period, the analogy was practiced once weekly under supervision and daily at home. To assess feasibility, a structured interview was conducted at the end of the intervention period. To assess utility, walking performance was assessed using the 10-Metre Walking Test. All three participants were supportive of the feasibility and benefits of analogy learning. Two of the participants had a meaningful improvement on the 10-Metre Walking Test (0.1 and 0.3 m/s). The third participant did not improve most likely because of medication issues during the week of the retest. Developing analogies in therapy is a creative and challenging process, as analogies must not only guide the correct movement pattern, but also be meaningful to the individual. However, as participants were supportive of the use of analogies, and positive trends were seen in walking speed it seems worthwhile to pursue the use of analogies in future research. *International Journal of Rehabilitation Research* 00:000–000 © 2014 Wolters Kluwer Health | Lippincott Williams & Wilkins.

Introduction

Stroke survivors often need to deal with severe disabilities and as a result, they may face a long and intensive rehabilitation programme. The main aim of rehabilitation is to facilitate the recovery of skills involved in daily living so that patients can return home and participate in society. To facilitate motor learning therapists tend to provide explicit movement instructions outlining the precise steps underpinning skilled movement production (Johnson \textit{et al.}, 2013). However, for stroke survivors, these explicit instructions may be hard to understand and remember because of cognitive deficits that may affect memory, attention and information processing (Hochstenbach \textit{et al.}, 1998).

A number of motor learning strategies have been developed to minimize working memory involvement and the accrual of explicit rules, including dual-task learning, errorless learning and analogy learning (Masters and Poolton, 2012). These strategies originated from the world of sports but are receiving recent attention in the context of rehabilitation (McCulloch, 2007; De Werd \textit{et al.}, 2013). The aim of the current research was to initiate enquiry into the possibility of applying an approach using analogy learning within poststroke rehabilitation.

Analogy learning applies one over-arching rule to integrate the complex rule structure of the to-be-learned skill into a simple biomechanical metaphor that can be reproduced by the learner (Liao and Masters, 2001). For example, the analogy of ‘reaching your hand into a cookie jar’ has been used to describe the appropriate wrist snap required to impart backspin on a basketball during the performance of a free-throw (Lam \textit{et al.}, 2009). Analogy learning may be a promising strategy for the rehabilitation of stroke survivors as it reduces the amount of technical information (explicit rules) processed by the working memory system during motor learning (Lam \textit{et al.}, 2009). However, current research is limited to healthy populations and it is unclear how therapists and patients experience the use of analogies in rehabilitation.

Before a larger trial is set up to evaluate the potential efficacy of analogy learning in stroke rehabilitation, an essential preliminary step is to explore whether analogy learning is feasible and how it might be used within the therapeutic setting (Craig \textit{et al.}, 2013). The main aims of the current pilot study were (a) to explore the feasibility of developing and applying personalized analogies to improve walking in long-term stroke survivors and (b) to explore potential benefits to walking performance.
Because of the exploratory nature of this research a case series was adopted.

**Case description**

This study included three randomly selected male volunteers from a nonprofit exercise group called ‘Action After Stroke’, based at the University of Exeter, UK. All were in the chronic phase of recovery (at least 6 months after stroke), joined the group sessions every week and experienced problems with motor skills during activities in daily life. No participant had serious additional disorders to the locomotor (musculoskeletal) system (e.g. severe rheumatic disorders) or received other healthcare treatments (e.g. physiotherapy). After providing written informed consent, participants were taken through an intake assessment (Table 1). None of the three participants had severe cognitive impairments (mini–mental state examination > 26) (Folstein et al., 1975). Participants 1 and 2 were able to walk independently and safely (Rivermead Mobility Index: 12/15), whereas participant 3 was wheelchair dependent and needed supervision during walking (Rivermead Mobility Index: 4/15; Collen et al., 1991). Participant 2 used a cane for indoor walking and a wheeled walker for outdoor walking.

**Intervention and measurements**

The ethics review board at the University of Exeter approved the study before commencement, and all participants gave written informed consent. The total study period was 6 weeks and consisted of a baseline period of 3 weeks to obtain a stable measure of subjective walking performance and a 3-week analogy learning intervention. During the entire study period participants attended the Action After Stroke group twice a week, with each session lasting for 1–1½ h. No additional intervention was provided; the measures and intervention of this study were embedded in the Action After Stroke sessions. The baseline phase started with the intake assessment where general information about the study design was provided, and participants were also asked to describe any specific movement or skill deficits they would like to improve (see Table 2).

At the end of the baseline phase each participant performed the 10-Metre Walking Test (10MWT) to assess walking performance (Perera et al., 2006). The 10MWT is a physical performance test validated for a stroke population, which evaluates the walking speed in m/s over a 10-m distance. Meaningful changes in the 10MWT of above 0.06–0.14 m/s have been described by Perera et al. (2006) and the minimal clinical important difference of the 10MWT has been set at 0.16 m/s (Tilson et al., 2010). After baseline, participants had an individual session with a physiotherapist familiar with the concept of analogy learning (L.-J.J., F.t.L.H.) where they were taught the principles behind analogy learning. Together the therapist and participant then worked to design an analogy (supported by M.K., S.M.B., M.R.W., V.A.G.) using a metaphor that was familiar to the participants.

The selected analogies were practiced together with a therapist, which required 10 min of their regular Action After Stroke sessions. Participants were asked to use the analogy during walking and try to integrate it in their performance. The therapist supported the participants by repeating the analogy but no other instructions were given. No physical guidance was provided. All participants received the same amount of individually guided practice time with a therapist (10 min per session with a maximum of 12 sessions). Participants were encouraged to use the analogy outside of the guided sessions during every day walking. Participant 3 who was wheelchair depended was supervised by his carer or wife when practicing at home.

At the end of this period, a structured interview was completed to assess the feasibility of the intervention, and the 10MWT repeated. The structured interview asked a variety of questions to enable the participants to describe their personal experiences of the intervention process. (The feasibility questionnaire and participant responses are available from the authors on request.)

**Outcomes**

**Feasibility**

All three participants completed the entire intervention period and attended at least 10 out of 12 sessions. They reported that there was enough supervision during the training and it was clear how to use the analogies. For participants 2 and 3 a feasible, personalized analogy was found within one session, whereas for participant 1 an additional session was needed (Table 2). All three participants agreed that their analogy was meaningful.

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**Table 1 Participant demographic information**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Analogy</th>
<th>Goal(s)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Imagine you are walking over a frozen lake</td>
<td>Improving lifting and placing of foot</td>
</tr>
<tr>
<td>2</td>
<td>Imagine you are following footsteps in the snow</td>
<td>Creating a step-through gait</td>
</tr>
<tr>
<td>3</td>
<td>Imagine you are kicking a football in front of you</td>
<td>Walking more fluently, without constantly thinking</td>
</tr>
</tbody>
</table>

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**Table 2 Analogies and goals**
for them, however the way the participants experienced the analogy training did differ in some aspects. For example, participant 1 reported that the analogy training was difficult, as he ‘needed to think a lot’, which was not the case for participants 2 and 3. Participant 1 also found it challenging to visualize the analogy, as it was hard for him to ‘change fixed ideas’. Participant 3 also stated difficulties with visualizing ‘because the affected leg was not the one he used to kick with’. They all reported that they had experienced some improvements in walking and they would recommend analogy training to others. No adverse side effects were reported.

Utility
Two of the three participants improved on the 10MWT (Fig. 1). According to Perera et al. (2006), the improvement of participant 1 can be interpreted as a small meaningful change (above 0.06 m/s) and the improvement of participant 2 is a substantial meaningful change (above 0.14 m/s). Because of an unexpected incident (pain in the arm and hand) in the second week which was unrelated to the intervention, participant 3 was exposed to additional medication (tramadol), which negatively affected his post-training 10MWT performance.

Discussion
There has been recent interest in the application of different motor learning strategies from the world of sport to therapy practice (Kleynen et al., 2013), however, this is the first study to apply analogy learning in rehabilitation after stroke. The aim of this study was two-fold: (a) to assess the feasibility of developing and using personalized analogies and (b) to explore potential benefits to walking performance of analogy learning for stroke survivors who were in the chronic phase of their rehabilitation.

Feasibility of developing and using personalized analogies
Importantly, we were able to find walking analogies for each participant within a relatively short time. The developed analogies seem to need to fulfil two important criteria: (a) they should lead to a biomechanically correct adaptation of the movement and (b) the metaphor used should contain an instruction or image that is meaningful to the participant. In one case, adjustments were necessary to develop a suitable analogy. Participant 1 originally came up with his own analogy to help improve his foot lift and placement; ‘Imagine you are stepping over a rowing machine’. This was meaningful to him because he had previously tripped over one in the gym in which the Action After Stroke group met. However, this analogy was only related to part of the desired movement improvement; while it helped with his foot lift, his foot placement was still unstable. Therefore we worked on the ‘Imagine you are walking over a frozen lake and do not want to break the ice’ analogy to guide both the lifting and controlled placement of his foot while stepping.

The structured interview revealed that in general the participants were positive about the analogy intervention, and felt that it would probably have been more useful in the early stages following their stroke. Indeed participant 1 felt that it was hard to change the movement patterns that he had embedded in the 6 years following his stroke. It is possible therefore that analogy learning might be more effective in improving motor skill in the early, acute or subacute stages of rehabilitation before a certain pattern has been adapted. Future research is needed to test this tentative hypothesis.

The fact that participants suggested that using the analogy was cognitively demanding was surprising. In research with young, healthy athletes, analogy learning has been shown to promote implicit learning. Implicit motor learning strategies are hypothesized to circumvent the information processing of declarative (explicit) knowledge relating to the motor skill, and previous research has revealed that compared with learning through explicit instructions, analogy learning requires fewer attentional resources (Lam et al., 2009). However, these results are based on randomized control studies in sports, where one group is given a ‘standard’ analogy for a particular movement pattern and the other group is provided with a list of explicit instructions. We did not employ a control group in this feasibility study, therefore cannot discuss whether or not the typically found advantage of analogy learning in the sporting literature applies in therapy.

Utility of developing and using personalized analogies
Meaningful improvements in walking speed (10MWT) were gained by two of the three participants. Participant
was exposed to additional medication (tramadol), which influenced his daily activities, including walking. Although we can report anecdotally that his performance in week 2 was perhaps the most improved of all three participants, we have no data to support this, as we unfortunately only assessed performance at the 3-week measuring point. No multiple baseline measures were performed for the 10MWT, which makes the interpretation of the changes difficult; however, given that the participants were in the chronic phase of recovery, the results are still generally supportive of the (potential) efficacy of analogy learning in stroke rehabilitation.

**Conclusion**

Analogy learning might be a feasible and useful intervention in therapeutic settings. Benefits were evident after only a short training period, despite participants being in the chronic phase of recovery. Future studies are needed to investigate the influence of using analogies on objective gait measures and subjective outcomes that might be related to other therapy aims.

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**Conflicts of interest**

There are no conflicts of interest.

**References**


