JGG 2024;72:155-159
doi: 10.36150/2499-6564-N605

Can analogy instructions help older people (re)learn activities of daily living?

Tina van Duijn[1-3], Liis Uiga[1,4], Rich S.W. Masters[1]

[1] Te Huataki Waiora School of Health, University of Waikato, Hamilton, New Zealand; [2] School of Physical Education, Sport and Exercise Sciences, University of Otago, Dunedin, New Zealand; [3] School of Sport, Exercise and Rehabilitation, University of Technology Sydney, Sydney, Australia; [4] Department of Sport and Exercise Sciences, Faculty of Science & Engineering, Manchester Metropolitan University, Manchester, UK

Objective. Motor analogies may be a useful tool for helping older people to learn or relearn complex sequences of movements, such as those involved in activities of daily living. Rather than provide explicit movement instructions, an analogy can be used to relate the to-be-learned skill to a familiar concept. This study tested whether a motor analogy may be a useful tool for helping older people to learn an activity involving a complex sequence of movements.

Methods. Twenty-four older adults learned to tie a bowline knot, either by traditional explicit instructions or by a 'rabbit' story analogy. Participants were asked to tie the knot as rapidly and correctly as possible. After one year, a delayed recall test of the movement sequence was conducted.

Results. Analysis revealed no significant differences between the groups with respect to reaction time ($p = .66$), movement time ($p = .80$), or movement fluency ($p = .22$). After one year, participants in the explicit group required significantly fewer cues to recall the knot compared to participants in the analogy group ($p = .003$).

Conclusions. Story analogies are allegorical and may not be superior to explicit instructions when it comes to helping older adults to learn, and retain, complex sequences of movements.

Key words: activities of daily living, older people, analogy instruction, knot-tying, skill learning, movement sequence

Received: December 21, 2022
Accepted: June 3, 2024
Published online: July 31, 2024

Correspondence
Tina Van Duijn
E-mail: tinavanduijn@gmail.com

How to cite this article: van Duijn T, Uiga L, Masters RSW. Can analogy instructions help older people (re)learn activities of daily living? Journal of Gerontology and Geriatrics 2024;72:155-159. https://doi.org/10.36150/2499-6564-N605

INTRODUCTION

Many activities of daily living, such as preparing a cup of tea or tying a lace, consist of complex sequences of movements that need to be remembered, adapted and executed in the correct order. The information processing demands of such activities are high. For older adults, who often have difficulty processing information [1], learning or relearning complex sequences of movements is arguably the most frustrating (and often anxiety provoking) challenge to overcome in order to live independently.

Motor analogies may be a useful tool for helping older people to learn or relearn activities of daily living [2,3]. Not only has it been argued that learning by analogy can lead to more rapid understanding of a concept [4], but also that 'what' is learned is retained more effectively over time [5]. Rather than explicitly describe how to execute movements, motor analogies compare the to-be-learned movement to a relevant concept with which the individual is already familiar [4]. For example, the movements necessary for putting a golf ball are captured by the pendulum of a grandfather clock [6]. Physiotherapists provide on average one explicit instruction every 14 seconds during gait rehabilitation for stroke patients, which can be very demanding for older adults to process and use [7]. Motor analogies may provide a less demanding alternative to explicit instructions [8].

Evidence suggests that motor analogies are useful for teaching older adults gross movements, such as walking [2,9,10]. However, no study to our knowledge has examined the efficacy of motor analogies when older adults learn more cognitively demanding combinations of movements, as is the case for many activities of daily living, nor has long-term recall of such movements been investigated. Activities of daily living are generally performed in an uncontrolled environment full of distraction, under psychological stress, or while multitasking. Some must be performed with minimal time for recall, processing and movement planning (e.g., landing safely during an unexpected fall). Ability to execute a movement quickly on demand is an additional challenge for this demographic who often exhibit limited capacity for processing information [11].

This pilot study aimed to assess whether movements can be learned by older people through analogy instruction in a short amount of time, and whether these movements can be processed and executed quickly. Participants were instructed to learn a novel task (tying a bowline knot) by either analogy or explicit instructions. After practice, they attempted to tie the knot in a series of trials, as quickly as possible. To assess information processing requirements, we implemented a "counting" condition in which a backward counting task was performed while waiting for the 'go' signal. Backward counting occupies some working memory resources and therefore impedes pre-movement motor processing, which slows down response time in tasks with high processing demands [12]. We also attempted to examine whether motor analogies impact long-term recall of a learned motor skill by asking participants to complete the knot-tying task one year later.

Motor planning speed is hypothesized to benefit from analogy instructions, based on previous research showing less verbal-cognitive engagement during motor preparation [13], and fewer explicit rules being reported [14], which have both been associated with more implicit motor control [15]. We hypothesised that older adults would learn the knot-tying task more effectively with analogy instructions than explicit instructions (i.e., faster reaction and movement times in both counting and no-counting conditions) and that recall of the sequence of movements would be better.

MATERIALS AND METHODS

Transparency and openness

This study's design and its analysis were not pre-registered. All deidentified data and research materials are available on an Open Science Framework repository: https://osf.io/up9vm/?view_only=540599b945a1406392f0fa986b8fe3ec. Data were analysed using SPSS statistics, version 27.

Participants

The study protocol was approved by the institute's human research ethics committee. Convenience sampling yielded 24 older adults (4 males, age range: 65-81 years, mean age = 73.4 years, SD = 5.1 years) who consented to take part in the study. No inferential goal was used in determining sample size. Participants were included in the study if they were 65 years of age or older, healthy, had full movement capability in their upper body, with no neurological disorders and normal cognitive functioning. Participants were excluded from the study if they had significant sailing experience or had other pastimes that involved tying knots (e.g., climbing, boy scouts / girl guides, etc). Instruction groups were matched for age and gender (analogy group: 2 males, 10 females, mean age = 72.8 years, SD = 5.0 / explicit group: 2 males, 10 females, mean age = 72.6 years, SD = 4.8). As no participant was able to complete any part of the knot before practicing, no pre-practice test was conducted.

Procedure

Participants were asked to learn to tie a bowline knot, which requires a specific series of movements to be executed in the correct order. Participants viewed a video demonstration of the knot being tied and then were allocated (ensuring matching of age and gender) to a group that received explicit instructions about how to tie the knot or to a group that received 'rabbit' analogy instructions (shown in Figure 1). The information content of the sets of instructions (i.e., number of words/sentences) was matched. The video sequence and instructions were repeated as often as needed while participants practiced with a piece of rope until they were confident that they could perform the knot by themselves. Before initiating the test trials, each participant was required to complete the knot correctly on three consecutive occasions without help. During the test trials, participants in each group were asked to perform the knot-tying task as rapidly and correctly as possible during a no-counting condition (3 repetitions) and a counting condition (3 repetitions). The order of conditions was counterbalanced. In both conditions, a laptop was used to present a visual "go" signal at quasi-random intervals (between 9-15 seconds after the researcher started the trial). During the no-counting condition, participants were required to start tying the knot as quickly as possible as soon as they saw the signal. In the counting condition, participants were prevented from processing motor commands prior to the "go" signal by counting backwards in 3's (from a starting number given by the experimenter) until the "go" signal was presented, after which they attempted to tie the knot as quickly as possible. Counting stopped once the "go" signal appeared. Participants' movements were filmed by a canon EF-S Camera with high-speed video function (50fps) set up diagonally behind them.

We also conducted a one-year delayed recall test of how well the participants remembered the movement sequence. Drop-out due to changes in health or living situation (n = 2), loss of contact (n = 8) or voluntary withdrawal from the study (n = 2) resulted in n = 12 remaining participants. These included 5 participants in the analogy group (2 males, mean age = 74.2 years, SD = 4.3) and 7 participants in the explicit group (0 males, mean age = 72.7 years, SD = 4.9). During the one-year delayed recall test, participants were asked to try and perform the knot, or any part of it that they remembered, without help. If they did not succeed, they were provided with an instruction or cue (explicit instructions or rabbit analogy instructions) for the next step of the knot, and so on until they recalled how to tie the knot. The number of instructions the participant was given before they completed the knot was counted.

Measurements

Using a frame-by-frame video player (Lightworks, EditShare, EMEA 2019), we measured reaction time (i.e., time between 'go' signal and movement onset) and execution speed (i.e., time between movement onset and completion). The reaction time and movement time of the fastest trial were used for analysis, as we had reason to assume that slower trials were impacted by distractions not connected to the task itself (e.g., participant speaking, or missing the signal due to having their eyes closed). Movement fluency was assessed by two independent raters (between-rater ICC = .737) on a scale ranging from not fluent at all (1) to extremely fluent (10). Ratings of both raters were averaged. Video footage from the delayed recall test was assessed by one researcher. The number of instructions given to each participant before they managed to complete the knot correctly was counted. As all participants were complete novices at the knot-tying task, no assessments of pre-practice performance were possible, and the two groups were considered equal in terms of initial skill level.

Statistical analysis

To investigate reaction time, movement time and fluency, 2 (Group: Analogy, Explicit) x 2 (Counting: With, Without) mixed measures ANOVAs with repeated measures on the second factor were conducted. Post-hoc comparisons were conducted using t-tests. Due to limited sample size (n = 12) in the delayed recall test, a Mann-Whitney-U test was used to compare the number of rules that participants were given before they were able to perform the full bowline knot. Statistical significance was set at $p < .05$.

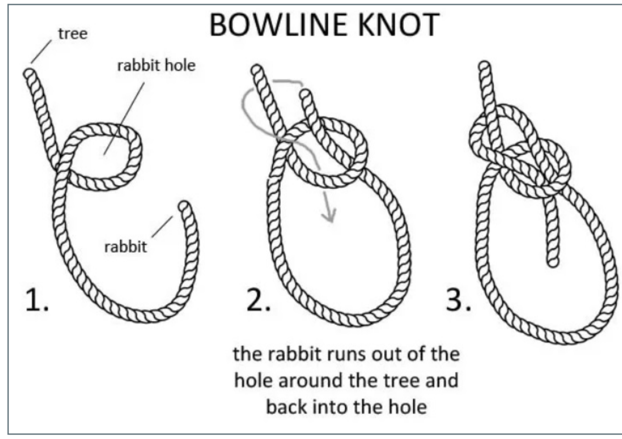

Figure 1. Description of the bowline knot by the rabbit analogy (Source: https://hikersforlife.com/blog/bowline).

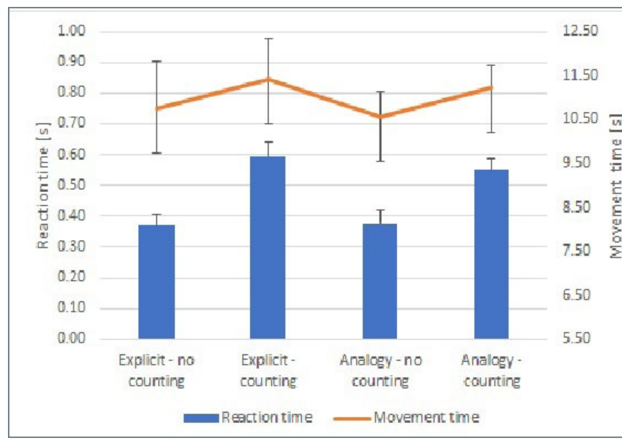

Figure 2. Reaction and movement times as a function of instruction groups and conditions.

RESULTS

Learning phase (24 participants)

Reaction time

A main effect was evident for Counting, $F(1,22) = 60.26$, $p < .001$, partial $\eta 2 = .73$, observed power =

1.00). Reaction times were higher in the Counting condition (M = 0.57 sec, SD = 0.14 sec.) compared to the No-counting condition (M = 0.37 sec, SD = 0.13 sec.) (see Figure 2). A main effect was not evident for Group, F(1,22) = 0.13, p = .72, partial $\eta 2$ = .006, observed power = .06, and there was no Group by Counting interaction, F(1,22) = 1.01, p = .33, partial $\eta 2$ = .04, observed power = 0.16.

Movement time

A main effect was not evident for Counting, F(1,22) = 2.47, p = .13, partial $\eta 2$ = .10, observed power = .32, or Group, F(1,22) = 0.03, p = .86, partial $\eta 2$ = .00, observed power = .05. A significant interaction between Group and Counting was not found, F(1,22) < 0.001, p = .995, partial $\eta 2$ = < 0.001, observed power = 0.05 [*].

Movement fluency

A main effect was not evident for Counting, F(1,22) = .68, p = .42, partial $\eta 2$ = .03, observed power = .12, or Group, F(1,22) = 1.41, p = .25, partial $\eta 2$ = .06, observed power = .21. A significant interaction between Group and Counting was not found, F(1,22) = .35, p = .56, partial $\eta 2$ = .02, observed power = .09.

Delayed recall (12 participants)

In the delayed recall test, all participants who received analogy instructions required the maximum number of cues in order to remember how to tie the knot (M = 5, SD = .00), whereas participants who received explicit instructions required significantly fewer cues (M = 3.43, SD = 0.79, U < .001, z = -2.93, p = .003).

DISCUSSION

This study's hypothesis was that older people who were taught to tie a bowline knot via a "rabbit" story analogy would exhibit faster reaction time, movement time and movement fluency than older people who were taught by explicit instructions. The results revealed no significant differences between the analogy and explicit instruction groups for reaction time, movement time or movement fluency, and delayed recall was worse in the analogy group compared to the explicit group. This indicates that analogy instructions may not be superior to explicit instructions for promoting learning and execution by older people learning a knot-tying task.

These findings are surprising, given the efficacy of analogies for teaching concepts [16] and that motor analogies have been shown to be effective for teaching gross movements to older adults (e.g., walking, table tennis [3,8]). However, previous motor learning studies have typically utilised a "simple biomechanical metaphor" to capture the relevant movement concepts [4], whereas, this study is the first to utilise an analogy more akin to an Ovidian allegory (i.e., a story analogy). It is likely, in our view, that the 'rabbit' analogy failed to lower the information processing demands associated with performing the knot-tying task. Not only did older adults have difficulty remembering the (story) analogy but also is it likely that the association between each component of the story and the movements that it represented was not strong, which might explain why long-term recall was worse compared to explicit instructions.

The fact that the analogy did not seem to positively affect motor learning and performance may also be due to difficulties in applying the analogy to a complex sequence of movements. Learning by analogy requires mapping the relational structure of one situation (e.g., a rabbit running around a tree) onto another situation (e.g., the rope being laid around a pole), which is cognitively challenging [17]. It is possible that age may impact how well participants can perform the concept mapping necessary to learn movements by analogy. Therefore, the rabbit analogy may have been too abstract for participants to learn effectively.

CONCLUSIONS

When it comes to helping older adults to learn or relearn, and retain, complex sequences of movements, it seems that 'rabbiting on' about it may only tie them in knots.

Acknowledgements

We would like to thank Dr. Sana Oladi for her help with the data collection.

Conflict of interest statement

The authors report there are no competing interests to declare.

Funding

This work was supported by the University of Waikato Strategic Investment Fund [2018#59] and by Freemasons New Zealand [grant number 106555]. The sponsors played no role in any of the design, conduction, or preparation of this article.

Author contributions

TvD: was responsible for conceptualisation, methodology, resources, investigation, formal analysis, data curation, writing - original draft; LU: was involved in conceptualisation, methodology, investigation, formal

* The fact that there was a significant effect of Counting on reaction time, but not on movement time, supports the notion that preparatory motor planning was suppressed by the Counting condition.

analysis, writing - review & editing, funding acquisition; RM: was involved in conceptualisation, methodology, formal analysis, writing - review & editing, funding acquisition, supervision. All authors have contributed substantially to the work and approve the content and form of the present manuscript.

Ethical consideration

The protocol for the research project has been approved by the University of Waikato Ethics Committee (Application Number 2018#59) and it conforms to the provisions of the Declaration of Helsinki (as revised in Brazil 2013).

References

1. Hoyer WJ, Verhaeghen P. Memory aging. In: Birren JE, Schaie KW, Eds. Handbook of the psychology of aging. 6th ed. London: Academic Press 2006, p. 209-232. https://doi.org/10.1016/B978-012101264-9/50013-6
2. Kleynen M, Beurskens AJ, Olijve H, et al. Application of motor learning in neurorehabilitation: a framework for healthcare professionals. Physiother Theory Pract 2020;36:1-20. https://doi.org/10.1080/09593985.2018.1483987
3. Tse ACY, Wong TWL, Masters RSW. Examining motor learning in older adults using analogy instruction. Psychol Sport Exerc 2017;28:78-84. https://doi.org/10.1016/j.psychsport.2016.10.005
4. Liao CM, Masters RSW. Analogy learning: a means to implicit motor learning. J Sports Sci 2001;19:307-319. https://doi.org/10.1080/02640410152006081
5. Orvis J, Sturges D, Rhodes S,et al. A mailman analogy: retaining student learning gains in alkane nomenclature. J Chem Educ 2016;93:879-885. https://doi.org/10.1021/acs.jchemed.5b00551
6. Vine SJ, Wilson MR. Quiet eye training: effects on learning and performance under pressure. J Appl Sport Psychol 2010;22:361-376. https://doi.org/10.1080/10413200.2010.495106
7. Johnson L, Burridge J, Demain S, et al. Comparing the impact of an implicit learning approach with standard care on recovery of mobility following stroke: protocol for a pilot cluster randomized controlled trial. J Med Internet Res 2019;21:1-10. https://doi.org/10.2196/14222
8. Kleynen M, Jie LJ, Theunissen K, et al. The immediate influence of implicit motor learning strategies on spatiotemporal gait parameters in stroke patients: a randomized within-subjects design. Clin Rehabil 2018;33:619-630. https://doi.org/10.1177/0269215518816359
9. Jie LJ, Kleynen M, Meijer K, et al. The effects of implicit and explicit motor learning in gait rehabilitation of people after stroke: protocol for a randomized controlled trial. JMIR Res Protoc 2018;7:e142. https://doi.org/10.2196/resprot.9595
10. Mak TCT, Capio CM, Wong TWL. Effects of single-task, dual-task and analogy training during gait rehabilitation of older adults at risk of falling: a randomized controlled trial. Int J Environ Res Public Health 2022;20:315. https://doi.org/10.3390/ijerph20010315
11. Glisky E. Changes in Cognitive Function in Human Aging. In: Brain aging: models, methods, and mechanisms. Boca Raton (FL): CRC Press/Taylor & Francis 2007, Chapter 1, pp. 3-20. PMID: 21204355
12. Hick WE. On the rate of gain of information. Q J Exp Psychol 1952;4:11-26. https://doi.org/10.1080/17470215208416600
13. van Duijn T, Hoskens MCJ, Masters RSW. Analogy instructions promote efficiency of cognitive processes during hockey push-pass performance. Sport Exerc Perform Psychol 2019;8:7-20. https://doi.org/10.1037/spy0000142
14. Bobrownicki R, MacPherson AC, Coleman SGS, et al. Re-examining the effects of verbal instructional type on early stage motor learning. Hum Mov Sci 2015;44:168-181. https://doi.org/10.1016/j.humov.2015.08.023
15. Masters RSW, van Duijn T, Uiga L. Further advances in implicit motor learning. In: Hodges NJ, Williams AM, Eds. Skill acquisition in sport. 3rd ed. London: Routledge 2020, p. 77-96.
16. Gentner D. Structure mapping: a theoretical framework for analogy. Cogn Sci 1983;7:155-170. https://doi.org/10.1016/S0364-0213(83)80009-3
17. Holyoak KJ, Gentner D, Kokinov BN. Introduction: the place of analogy in cognition. In: Gentner D, Holyoak KJ, Kokinov BN, Eds. The analogical mind: perspectives from cognitive science. Cambridge, MA: MIT Press 2001, p. 1-19. https://doi.org/10.7551/mitpress/1251.001.0001