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Home-based interventions improve trained, but not novel, dual-task balance performance in older adults: A randomized controlled trial

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ABSTRACT

The purpose of this study was to compare the efficacy of four different home-based interventions on dual-task balance performance and to determine the generalizability of the four trainings to untrained tasks. Sixty older adults, aged 65 and older, were randomly assigned to one of four home-based interventions: single-task motor training, single-task cognitive training, dual-task motor-cognitive training, and dual-task cognitive–cognitive training. Participants received 60-min individualized training sessions, 3 times a week for 4 weeks. Prior to and following the training program, participants were asked to walk under two single-task conditions (i.e. narrow walking and obstacle crossing) and two dual-task conditions (i.e. a trained narrow walking while performing verbal fluency task and an untrained obstacle crossing while counting backward by 3 s task). A nine-camera motion capture system was used to collect the trajectories of 32 reflective markers placed on bony landmarks of participants. Three-dimensional kinematics of the whole body center of mass and base of support were computed. Results from the extrapolated center of mass displacement indicated that motor-cognitive training was more effective than the single-task motor training to improve dual-task balance performance ($p = 0.04$, $ES = 0.11$). Interestingly, balance performance under both single-task and dual-task conditions can also be improved through a non-motor, single-task cognitive training program ($p = 0.01$, $ES = 0.13$, and $p = 0.01$, $ES = 0.11$, respectively). However, improved dual-task processing skills during training were not transferred to the novel dual task ($p = 0.15$, $ES = 0.09$). This is the first study demonstrating that home-based dual-task training can be effectively implemented to improve balance performance during gait in older adults.

1. Introduction

A number of studies have attempted to determine the most effective intervention to improve dual-task balance performance in older adults [1–3], as an impaired ability to maintain balance while simultaneously performing cognitive tasks is associated with increased risk of falling [4,5]. To date, it is evident that dual-task training is more effective in improving dual-task balance and gait performance than single-task training [1,2,6]. Van het Reve and de Bruin [6] reported improvement in dual-task gait following dual-task motor-cognitive training, not single-task motor training, in healthy older adults. Silsupadol et al. [1,2] investigated the efficacy of three different training programs in older adults with balance impairment: single-task motor training, dual-task motor-cognitive training with fixed-priority instructions (equal-task emphasis), and dual-task motor-cognitive training with variable-priority instructions (alternating-task emphasis). It was found that only older adults in the dual-task training groups significantly improved their dual-task balance and gait performance, with the variable-priority group demonstrating greater improvements than the fixed-priority group. However, the implementation of these interventions into the community or home-based environment remains a challenge.

Most dual-task training studies have been conducted in a laboratory, or a controlled research setting, often with supervision by therapists or research assistants, though home-based training

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programs have been shown to be effective [7], feasible [8], and more desirable [9]. Older adults who received single-task home-based speed-of-processing training improved their processing speed equivalently to those who received laboratory-based training [8]. Furthermore, a single-task home-based strength and balance program was effective in improving strength and balance under single-task conditions in older adults [7]. To our knowledge, however, there are no studies that have examined the efficacy of dual-task home-based training on balance and gait.

Another important impediment to the intervention implementation is that transfer of dual-task training effects to novel dual-task conditions is not apparent. This lack of transfer might be due to the high specificity of the tasks chosen for the training [2]. Li et al. [10] found that a non-specific cognitive–cognitive task (i.e. two visual-discrimination tasks) improved standing balance performance in healthy older adults. However, changes in dual-task gait performance have not been clearly demonstrated.

Therefore, this study aimed to address these gaps in the literature by conducting a home-based program designed to improve dual-task performance with a broader transfer-of training effects in older adults. The purpose of this study was twofold: 1) to examine the effect of home-based interventions (i.e. single-task motor training, single-task cognitive training, dual-task motor-cognitive training, and dual-task cognitive–cognitive training) on dual-task performance in older adults. We hypothesized that home-based dual-task training would be feasible and effective in improving dual-task balance performance. Based on previous laboratory-based training studies [1,2,6], we postulated that the home-based dual-task training programs would be more effective than the home-based single-task training programs, with the dual-task motor-cognitive training demonstrating the greatest effectiveness; 2) to determine the generalizability of the four trainings to novel tasks. As broader non-specific task contexts generalize to novel dual-task conditions [10,11], we hypothesized that the dual-task cognitive–cognitive training would demonstrate the greatest generalizability to novel dual tasks.

2. Methods

2.1. Participants

Sixty community-dwelling adults aged 65 years old or older were recruited through flyers posted in the university and the surrounding communities, including the hospital, temples, and community centers. Inclusion criteria included the ability to walk at least 10 m without any assistive device, normal cognitive function based on the Mini-Mental State Examination-Thai [12], and willingness to exercise unsupervised at home. Participants were excluded if they had any significant diseases that impact gait, such as Parkinson's disease, severe osteoarthritis, or depression (based on the Geriatric Depression Scale) [13]. The study was approved by the University's research ethics committee (Number 557/2014). Written informed consent was obtained from all participants prior to enrollment in the study.

2.2. Randomization

Eligible participants were randomly assigned to one of four training groups according to a computer-generated list, with stratification by education level, using a permuted-block randomization design. The four training groups included: 1) single-task motor training (SM); 2) single-task cognitive training (SC); 3) dual-task motor-cognitive training (MC); and 4) dual-task cognitive–cognitive training (CC). The allocation sequence was carried out by a person external to the study, and concealed in opaque, sealed envelopes.

2.3. Intervention

Based on previous studies demonstrating balance and cognitive improvement following 5–25 h of training [1,2,10], older adults in this study participated in a 12-session (4 supervised and 8 unsupervised) training program, with 60 min per session, three times a week for four weeks in their homes. Each participant was visited weekly by the physical therapist to individually prescribe exercises, increase difficulty, as well as ensure safety and compliance [14]. Participants also received a booklet with instructions for each exercise prescribed. The booklet described exercises with detailed photographs, environmental requirements, and prioritization instructions for the dual-task training groups. Additionally, participants used the booklet to keep a record of their training and log any adverse events during the four weeks.

Across 12 sessions, the participants in the SM group received only balance training following Gentile's taxonomy of movement tasks, which progressed from stance activities, to stance activities plus hand manipulation, then gait activities, and finally gait activities plus hand manipulation [15]. Examples of balance activities included standing with a narrow base of support, semi-tandem stance with arm alternation, walking with a reduced base of support (narrow walking), and gait activities with arm alternation.

The participants in the SC group completed a variety of cognitive tasks over 12 sessions of training. The cognitive tasks predominantly focused on cognitive domains that were relevant to gait, such as visuospatial skills, executive function (e.g. planning and problem solving), attention, and working memory. Examples of cognitive training included calculation, verbal fluency, and the Stroop color-word task.

The participants assigned to the MC group received the same exercises as the SM group while simultaneously performing cognitive tasks as those in the SC group. During each session, participants were randomly instructed to vary focus on balance tasks, cognitive tasks, or equally emphasize both tasks. In order to confirm that participants were able to shift attention between balance and cognitive tasks, both balance and cognitive performance were recorded during the home visits. For example, during the narrow walking while performing verbal fluency task, the numbers of missteps and correct responses were recorded across the three prioritizations.

Lastly, the participants in the CC group received the same set of tasks as the SC group while practicing two of the cognitive tasks simultaneously. During each session, participants were randomly instructed to vary focus on one or the other cognitive task, or equally emphasize both tasks. The performances of both cognitive tasks were recorded during the home visits.

2.4. Procedures

Demographic information was collected for each participant including age, education level, sex, body mass index, physical activity level, medication use, history of falls and imbalance in the past year. Balance performance was assessed using the Berg Balance Scale and balance-related self-efficacy in daily activities was performed using the Activities-specific Balance Confidence Scale.

At baseline and after training, participants were first asked to perform the cognitive tasks while seated, including the verbal fluency task and the counting backward by 3 s task. Participants were then instructed to walk at their preferred pace for six meters under two single-task conditions (i.e. narrow walking and obstacle crossing) and two dual-task conditions (i.e. narrow walking while performing the verbal fluency task and obstacle crossing while performing the counting backward by 3 s task). The narrow walking while performing the verbal fluency task served as the trained task, whereas the obstacle crossing while performing the counting backward by 3 s task was the novel task. These two conditions were chosen as they are tasks often encountered in daily life and have been used in the dual-task literature [16–18]. Furthermore, since both walking tasks rely upon visual processing, non-visual cognitive tasks were utilized to avoid structural attentional interference.

For the narrow walking task, participants were asked to walk between two strips of tape, normalized to each participant as 50% of their anterior superior iliac spine width [2]. For the obstacle crossing task, participants were instructed to step over three obstacles (10% body height) [19–21], which were placed at the 2-m, 3-m, and 4-m mark. For the narrow walking while performing the verbal fluency task, participants were asked to walk while enumerating as many words as possible from a category. For the obstacle crossing while performing the counting backward by 3 s task, participants were asked to count backward by 3 s from a randomly given number ranging from 45 to 99 while walking over the obstacles. All participants were required to complete three trials for each condition. An average of the three trials was used for analysis.

A nine-camera motion capture system (Vicon Motion Systems Ltd., Centennial,CO,USA) with a set of 32 reflective markers was used to capture whole-body motion [20]. Three dimensional marker trajectory data was collected at a sampling rate of 60 Hz, and filtered using a fourth-order Butterworth low-pass filter with a cutoff frequency of 8 Hz. The location of the whole body center of mass (CoM) was computed as the weighted sum of thirteen body segments [20]. The configurations of both feet were used to define the boundary of the base of support (BoS) [22].

2.5. Outcomes

Previous research demonstrated that the CoM to BoS distance at heel strike in the gait cycle can distinguish between healthy young adults, healthy older adults, and elderly fallers [22]. The primary outcome measure for this study was the extrapolated center of mass (XcoM) to BoS distance (XcoM-BoS distance) at heel strike under single-task and dual-task conditions. The XcoM accounts for both the CoM position and velocity. The XcoM-BoS distance, which is indicative of balance ability, is the shortest distance from the XcoM to the boundary of the BoS. When the XcoM is within the BoS, a larger distance indicates better balance maintenance during walking. Alternatively, when the XcoM is outside the BoS, a smaller distance indicates greater balance during gait [22]. A positive value indicated that the XcoM is within the BoS and a negative value indicated that the XcoM is outside the BoS [23]. The secondary outcome measures included gait parameters (i.e., gait speed, stride length, step width, rate of missteps) for all walking tasks and rate of verbal response. The outcome measures at baseline and the end of training were analyzed by an assessor who was blind to group

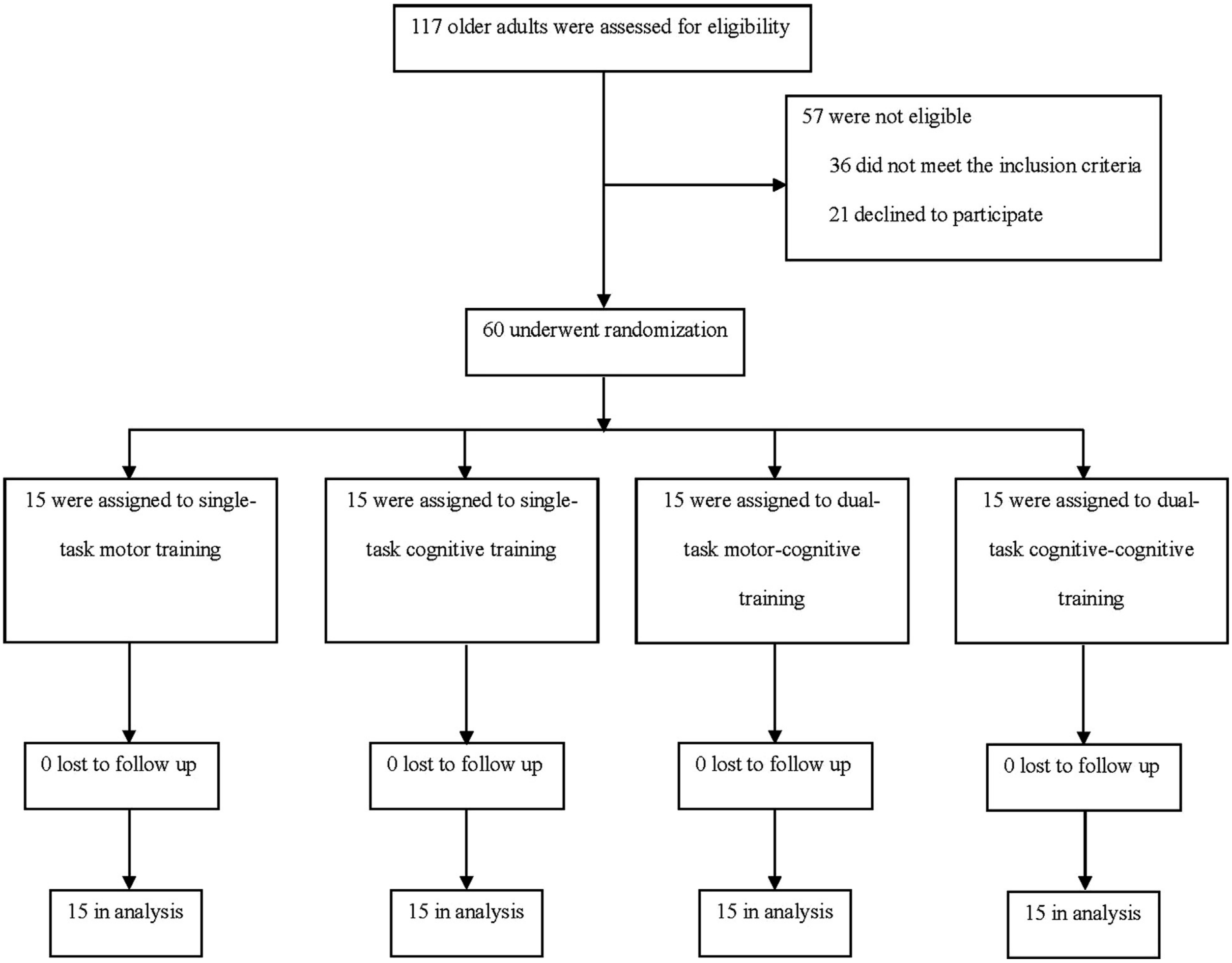

Fig. 1. The flow of participants through the study.

assignment. All calculations were performed using custom written programs in MATLAB R2013a (Mathworks Inc.,Natick, MA, USA).

2.6. Sample size

The sample size was calculated based on Silsupadol's study [1]. With a power of 0.8, an effect size of 0.27, and a 0.05 alpha level, the estimated sample size was 44. With an estimated attrition rate of approximately 20%, 60 individuals were recruited into this study.

2.7. Statistical analysis

The differences in baseline characteristics among intervention groups were examined using a one-way analysis of variance (ANOVA). The effect of interventions on outcome measures was analyzed using a three-way mixed-effects ANOVA with the Bonferroni correction, with group (i.e. SC, SM, MC, and CC) as the between-subjects factor and time (i.e. pre-training and post-training) and testing condition (i.e. narrow walking, obstacle crossing, narrow walking while performing the verbal fluency task, and obstacle crossing while performing the counting backward by 3 s task) as within-subject factors. Partial Eta squared values were reported as measures of effect size (ES). SPSS v19.0 (IBM Inc., Armonk, NY, USA) was used for all statistical analyses.

3. Results

3.1. Baseline characteristics

One hundred and seventeen older adults were recruited for the study, 36 did not meet the inclusion criteria and 21 declined to participate. Sixty eligible older adults were randomly assigned to one of four training groups (Fig. 1). All participants completed the training program, with no reported adverse events. The mean compliance rate of the training sessions was 97.6%. The process of recruitment began in August 2014, and the post-intervention testing was completed in July 2015. Participant characteristics at baseline are presented in Table 1. There were no significant differences between groups in any baseline characteristics.

3.2. Effect of interventions on gait parameters

The results of the mixed-effects ANOVA showed that there was a significant group x time x testing condition effect for the XcoM-BoS distance at heel strike ($F_{6.24,114.30} = 2.78$, $p = 0.01$,$ES = 0.13$) and gait speed ($F_{6.70,120.53} = 3.33$,$p = 0.003$,$ES = 0.16$) (Table 2). Follow-up analyses revealed that under narrow walking and narrow walking while performing verbal fluency task conditions, participants in the SC and MC groups significantly improved their XcoM-BoS distance ($p = 0.01$,$ES = 0.13$; $p = 0.01$,$ES = 0.11$ for SC group, respectively; $p = 0.004$,$ES = 0.14$; $p = 0.03$,$ES = 0.09$ for MC group, respectively) and increased gait speed ($p = 0.02$,$ES = 0.35$; $p = 0.01$, $ES = 0.12$ for SC group, respectively; $p = 0.01$,$ES = 0.13$; $p = 0.02$, $ES = 0.09$ for MC group, respectively) after training. However, participants in the SM group significantly decreased their XcoM-BoS distance ($p = 0.01$,$ES = 0.42$; $p = 0.02$,$ES = 0.10$ respectively) and gait speed ($p = 0.047$,$ES = 0.07$; $p = 0.02$,$ES = 0.09$ respectively) after training. No significant differences in the XcoM-BoS distance and gait speed after training were found for the CC group. These training effects were not found under obstacle crossing and obstacle crossing while performing the counting backward by 3 s task conditions.

There were significant group x time interactions on stride length ($F_{3,48} = 9.31$,$p < 0.001$,$ES = 0.37$) and step width ($F_{3,51} = 3.36$, $p = 0.03$,$ES = 0.17$)(Table 2). Participants in the MC group significantly increased their stride length after training ($p = 0.001$, $ES = 0.20$); however, participants in the SM group significantly decreased their stride length after training ($p = 0.001$,$ES = 0.19$). Only participants in the SM group significantly decreased their step width after training ($p = 0.001$,$ES = 0.21$). These training effects were not found for the SC and the CC training groups.

3.3. Effect of intervention on rates of verbal response

A significant time x testing condition interaction was found for the rates of verbal response ($p < 0.001$,$ES = 0.16$). Follow-up analyses revealed that after training, participants in all groups significantly increased their rates of verbal response in all testing conditions. However, the amount of improvement for the narrow walking while performing the verbal fluency task was greater than the other testing conditions (Fig. 2).

4. Discussion

In support of our first hypothesis, this randomized controlled trial provides evidence that home-based dual-task training was effective in improving dual-task balance performance in older adults. We found that dual-task motor-cognitive training was superior to single-task motor training in improving balance performance under a practiced dual-task condition (narrow walking + verbal fluency). These results are consistent with previous studies which have demonstrated improving dual-task performance only after dual-task training [2,24]. These findings support the Task-Integration Hypothesis which states that performing two tasks at the same time requires the attentional-control and task co-ordination strategies between two tasks [25,26]. Participants in the MC groups could learn to co-ordinate and control their attention between the two tasks. Therefore, improvements in balance (increased XcoM-BoS distance and gait speed) under dual-task conditions were observed only following dual-task motor-cognitive training, not single-task motor training.

Table 1
Participant characteristics by intervention group.

Outcome measures	SM (n = 15)	SC (n = 15)	MC (n = 15)	CC (n = 15)
Age (years)	73.53 ± 5.94	72.40 ± 6.30	71.87 ± 4.57	74.73 ± 5.97
Education (years)	12.60 ± 3.49	11.16 ± 4.60	12.53 ± 4.12	14.27 ± 4.94
Mini-Mental State Examination-Thai	26.83 ± 2.04	29.50 ± 0.52	28.87 ± 1.13	28.93 ± 1.34
Geriatric Depression Scale	4.07 ± 2.28	3.33 ± 2.26	3.27 ± 1.98	2.20 ± 1.78
Activities-specific Balance Confidence Scale	71.94 ± 13.11	73.58 ± 15.51	72.74 ± 16.65	77.50 ± 19.80
Berg Balance Scale	52.27 ± 2.49	53.67 ± 1.54	53.87 ± 1.73	50.07 ± 1.94
Number of drugs taken per day	3.36 ± 1.60	2.27 ± 1.34	2.07 ± 1.91	2.67 ± 1.63
Number of falls in the past year	0.43 ± 0.76	0.43 ± 0.76	0.79 ± 1.19	0.27 ± 0.46

Table 2
Findings on gait parameters under four testing conditions at pre-training (pre), and the end of training (post) by intervention group.

Outcome measures	SM		SC		MC		CC	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
XcoM-BoS (m)								
Narrow walk	0.27 ± 0.10	0.23 ± 0.09*	0.27 ± 0.08	0.32 ± 0.07*	0.28 ± 0.08	0.33 ± 0.10*	0.30 ± 0.10	0.31 ± 0.13
Narrow walk + Verbal	0.19 ± 0.11	0.15 ± 0.07*	0.19 ± 0.08	0.24 ± 0.07*	0.18 ± 0.09	0.22 ± 0.11*	0.19 ± 0.09	0.22 ± 0.11
Obstacle	0.30 ± 0.09	0.30 ± 0.07	0.32 ± 0.08	0.34 ± 0.07	0.32 ± 0.07	0.36 ± 0.08	0.34 ± 0.11	0.36 ± 0.13
Obstacle + Count	0.26 ± 0.08	0.26 ± 0.06	0.27 ± 0.06	0.28 ± 0.08	0.24 ± 0.08	0.28 ± 0.07	0.29 ± 0.12	0.31 ± 0.13
Gait speed (m/s)								
Narrow walk	0.71 ± 0.16	0.64 ± 0.15*	0.76 ± 0.10	0.82 ± 0.13*	0.75 ± 0.16	0.85 ± 0.22*	0.78 ± 0.21	0.80 ± 0.26
Narrow walk + Verbal	0.50 ± 0.20	0.41 ± 0.11*	0.53 ± 0.17	0.62 ± 0.16*	0.49 ± 0.22	0.58 ± 0.26*	0.50 ± 0.21	0.57 ± 0.24
Obstacle	0.64 ± 0.15	0.66 ± 0.14	0.67 ± 0.13	0.71 ± 0.13	0.70 ± 0.13	0.76 ± 0.15	0.73 ± 0.20	0.75 ± 0.22
Obstacle + Count	0.53 ± 0.16	0.53 ± 0.13	0.55 ± 0.12	0.55 ± 0.13	0.52 ± 0.17	0.59 ± 0.16	0.60 ± 0.23	0.61 ± 0.24
Rate of missteps (/min)								
Narrow walk	80.93 ± 11.70	75.72 ± 18.42	78.95 ±17.26	86.70 ± 12.97	81.68 ± 16.78	82.05 ± 22.00	77.88 ± 14.60	85.88 ± 16.55
Narrow walk + Verbal	59.86 ± 16.51	55.27 ± 19.79	61.72 ±17.93	70.71 ± 14.61	59.30 ± 22.21	63.49 ± 23.91	58.35 ± 20.06	62.26 ± 19.49
Outcome measures	SM		SC		MC		CC	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Stride length (m)								
Narrow walk	0.98 ± 0.13	0.09 ± 0.17	0.92 ± 0.09	0.99 ± 0.09	0.95 ± 0.14	1.02 ± 0.15	0.96 ± 0.12	0.95 ± 0.15
Narrow walk + Verbal	0.95 ± 0.16	0.86 ± 0.16	0.88 ± 0.09	0.93 ± 0.07	0.88 ± 0.13	0.93 ± 0.15	0.86 ± 0.11	0.88 ± 0.13
Obstacle	1.00 ± 0.07	0.95 ± 0.12	0.96 ± 0.09	0.97 ± 0.11	0.97±0.11	1.04 ± 0.14	0.97 ± 0.11	0.98 ± 0.10
Obstacle + Count	0.98 ± 0.09	0.94 ± 0.09	0.97 ± 0.06	0.96 ± 0.08	0.93 ± 0.11	0.98 ± 0.10	0.97 ± 0.09	0.96 ± 0.09
Step width (m)								
Narrow walk	0.05 ± 0.02	0.03 ± 0.01	0.05 ± 0.02	0.05 ± 0.02	0.04 ± 0.02	0.03 ± 0.01	0.04 ± 0.02	0.05 ± 0.02
Narrow walk + Verbal	0.04 ± 0.02	0.04 ± 0.02	0.05 ± 0.03	0.04 ± 0.03	0.04 ± 0.02	0.03 ± 0.01	0.04 ± 0.02	0.04 ± 0.02
Obstacle	0.11 ± 0.04	0.09 ± 0.03	0.10 ± 0.02	0.11 ± 0.02	0.10 ± 0.03	0.10 ± 0.03	0.11 ± 0.03	0.11 ± 0.04
Obstacle + Count	0.12 ± 0.04	0.09 ± 0.04	0.11 ± 0.06	0.12 ± 0.04	0.10 ± 0.03	0.10 ± 0.03	0.12 ± 0.04	0.12 ± 0.04
Rate of verbal response (/min)								
Sit + Verbal	18.61 ± 6.24	19.74 ± 5.08	23.08 ± 5.20	25.17 ± 6.81	22.08 ± 5.78	23.76 ± 4.93	22.78 ± 5.49	26.66 ± 5.76
Narrow walk + Verbal	29.48 ± 10.50	35.02 ± 12.20	34.78 ± 7.96	46.05 ± 12.28	33.93 ± 9.12	39.73 ± 9.90	35.41 ± 13.49	42.03 ± 15.00
Sit + Count	11.90 ± 6.90	13.81 ± 6.49	17.34 ± 7.99	20.71 ± 9.63	15.01 ± 6.75	18.23 ± 8.73	23.35 ± 10.06	28.30 ± 11.76
Obstacle + Count	17.14 ± 7.43	19.91 ± 8.65	21.35 ± 7.58	24.82 ± 10.06	22.65 ± 8.67	22.79 ± 7.46	29.26 ± 9.39	29.84 ± 9.38

Note. * Significant difference from pre-training assessment, $p < 0.05$.

Interestingly, this study found that single-task non-motor cognitive training improved motor balance performance under single- and dual-task conditions. Specifically, participants in the SC group improved their balance performance under narrow walking and narrow walking while performing the verbal fluency task. Similar to the findings from Verghese et al. [27], the single-task cognitive training program was effective at improving gait under single-task conditions in older adults. This may be explained by the cognitive training program used in this study which focused on cognitive domains that were relevant to gait, such as visuospatial skills, working memory, attention, and executive functions [28]. Improvement under dual-task conditions following SC training may be due to the automatization of the cognitive tasks trained in this study. Based on the Task-Automatization Hypothesis, the verbal fluency task became automatized after practicing this task separately [29]. However, this effect was not observed for the CC group. Although we attempted to reduce the processing demand by using variable-priority instructions in the dual-task training program, the processing demand required to perform the dual-task cognitive–cognitive training may be still excessive. Thus, this excessive processing demand may prevent participants from learning the tasks.

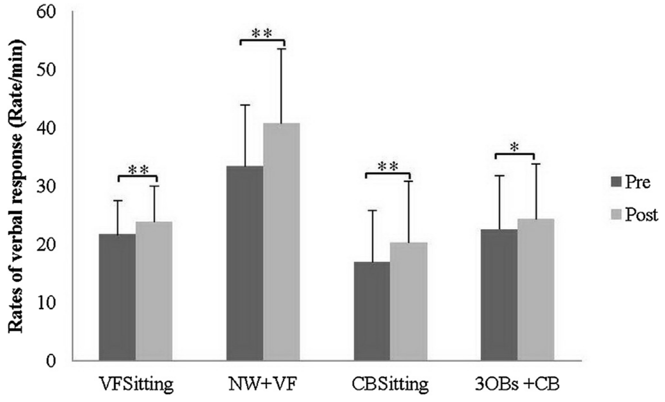

Fig. 2. The effect of testing conditions on rate of verbal response during pre- and post-training. VFSitting represents the rate of verbal fluency response during sitting; NW + VF represents the rate of verbal fluency response during narrow walking; CBSitting represents the rate of counting backward by 3 s responses during sitting; 3OBs + CB represents the rate of counting backward by 3 s responses during obstacle crossing (* $p < 0.05$, ** $p < 0.01$).

Contrary to our second hypothesis, there was no improvement on the novel dual-task (obstacle crossing + counting backward by 3 s). This result is consistent with Silsupadol et al.'s study [2] which found that the dual-task training is effective in improving walking performance under a practiced dual-task condition and this training effect did not generalize to a novel dual-task. The authors argue that the absence of transfer effects may be due to the influence of walking task contexts used for the trained task (continuous perturbations were employed for the narrow walking task) and the untrained task (one perturbation/obstacle was used for the obstacle crossing). In the current study, we attempted to eliminate the influence of different walking task contexts by using three obstacles so that the trained and untrained tasks were comparable. However, we still did not find transfer effects to a novel task after training. It may be possible that the gait tasks chosen for older adult are too difficult. Thus, additional research should carefully consider the potential importance of the task chosen.

Although this study provides a better understanding of the efficacy of home-based training in balance control during walking, there are a few limitations. First, we did not examine whether training-related improvements can be maintained. In this study, post-training assessments were assessed within 2 weeks of the final training session. Thus, future studies should examine the long-term retention of the training. Second, further research is needed to evaluate the efficacy of dual-task home-based training on improving functional mobility as mediators of fall risk. Third, determining the effectiveness of training across age levels merits further investigation. Finally, although the interaction of the center of mass and base of support can distinguish elderly fallers from healthy older adults and healthy young adults [22], there is yet no comprehensive research investigating the association between this outcome measure and actual fall risk.

5. Conclusion

This study shows that it is feasible to implement home-based dual-task training for older adults. Home-based motor-cognitive training offered advantages over the single-task motor training to improve dual-task balance performance. Interestingly, both single-task and dual-task balance performance can also be improved through a non-motor, single-task cognitive training. The present findings suggested that training programs should include cognitive tasks as part of fall prevention programs in the elderly population.

Conflict of interest

None.

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