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Effect of music-based multitask training on cognition and mood in older adults

Mélany Hars[1], Francois R. Herrmann[1], Gabriel Gold[2], René Rizzoli[1], Andrea Trombetti[1]

[1]Division of Bone Diseases, Department of Internal Medicine Specialties, Geneva University Hospitals and Faculty of Medicine, Geneva, Switzerland
[2]Division of Geriatrics, Department of Internal Medicine, Rehabilitation and Geriatrics, Geneva University Hospitals and Faculty of Medicine, Thônex, Switzerland

Address Correspondence to: Mélany Hars. Email: melany.hars@hcuge.ch

Abstract

Background: in a secondary analysis of a randomised controlled trial, we investigated whether 6 months of music-based multitask training had beneficial effects on cognitive functioning and mood in older adults.
Methods: 134 community-dwellers aged ≥65 years at increased risk for falling were randomly assigned to either an intervention group ($n = 66$) who attended once weekly 1-h supervised group classes of multitask exercises, executed to the rhythm of piano music, or a control group with delayed intervention ($n = 68$) who maintained usual lifestyle habits, for 6 months. A short neuropsychological test battery was administered by an intervention-blinded neuropsychologist at baseline and Month 6, including the mini-mental state examination (MMSE), the clock-drawing test, the frontal assessment battery (FAB) and the hospital anxiety (HADS-A) and depression scale.
Results: intention-to-treat analysis showed an improvement in the sensitivity to interference subtest of the FAB (adjusted between-group mean difference (AMD), 0.12; 95% CI, 0.00 to 0.25; $P = 0.047$) and a reduction in anxiety level (HADS-A; AMD, −0.88; 95% CI, −1.73 to −0.05; $P = 0.039$) in intervention participants, as compared with the controls. Within-group analysis revealed an increase in MMSE score ($P = 0.004$) and a reduction in the number of participants with impaired global cognitive performance (i.e., MMSE score ≤23; $P = 0.003$) with intervention.
Conclusion: six months of once weekly music-based multitask training was associated with improved cognitive function and decreased anxiety in community-dwelling older adults, compared with non-exercising controls. Studies designed to further delineate whether training-induced changes in cognitive function could contribute to dual-task gait improvements and falls reduction, remain to be conducted.

Keywords: *cognition, exercise, older people, mood, music*

Introduction

Physical exercise has been shown to postpone or even attenuate age-related decline in components of physical function—including gait and balance—but also to benefit cognitive functioning, brain plasticity being preserved even in later life [1–4].

Higher-level cognitive function has emerged, in old age, as a critical determinant of the ability to cope efficiently and safely with both basic and more elaborate everyday life activities, which often require to integrate multiple stimuli or concurrent tasks (e.g., for simple or dual-task walking) [5–8, 9]. Epidemiological evidence strongly supports that executive function, but also global cognitive function and mood, are closely linked to gait and falls in older adults, even in the absence of overt cognitive impairment [5, 6, 10–14]. This suggests that multimodal interventions targeting not solely physical but also cognitive processes may elicit improvements towards fall-risk reduction [6, 11, 15].

In a recent randomised controlled trial [16], we proposed a new promising way to improve dual-task gait performance and to reduce falls in older adults through a music-based multitask training intervention (i.e., Jaques-Dalcroze eurhythmics), a specific exercise regimen challenging both motor- and cognitive-related abilities. This program, which affords a greater commitment to dual- or multiple-task practice than other exercise forms (e.g., '3D interventions' using the Profane taxonomy [17]), highly relies on working memory, attention and executive function skills and is likely to engage multiple brain regions through a combination of music, rhythm and exercise [2, 18–20]. The present study investigated—in a secondary analysis of the randomised controlled trial—whether 6 months of music-based multitask training had beneficial effects on cognitive function and mood.

Methods

Trial design, flow of participants and procedures have been published previously [16]. Briefly, 134 community-dwelling older adults—aged 65 and over—at increased risk for falling (i.e., ≥1 falls after the age of 65 years, or balance impairment, or 1 or 2 criteria of physical frailty according to Fried) were randomised to either (i) an intervention group who attended structured music-based multitask exercise classes (intervention group, $n = 66$) or (ii) a control group with delayed intervention (control group, $n = 68$), for 6 months. The study was approved by the Geneva University Hospitals ethics committee. All participants provided informed written consent.

Group exercise classes were held once weekly for 1-h over 25 weeks. They consisted of varied multitask exercises of progressive difficulty, sometimes involving the handling of objects, performed individually, in pairs or more [21]. Basic exercises comprised walking following the piano music, responding directly or oppositely to changes in music's rhythmic patterns. Other exercises included quick reactions exercises and walking out of rhythmic patterns. The control group maintained their usual physical and social habits.

All participants underwent a short neuropsychological test battery administered by an intervention-blinded neuropsychologist at baseline and Month 6 that included: (i) the mini-mental state examination (MMSE) [22], (ii) the clock-drawing test [23] and (iii) the frontal assessment battery (FAB), including six subtests, each assessing executive functioning-related abilities [24]. The subtest scores and global score were considered independently for the FAB. Mood was assessed using the hospital anxiety and depression scale, a tool divided in two subscales measuring depression (HADS-D) and anxiety (HADS-A), which were considered independently [25].

Data were analysed using Stata version 11.0. The predefined primary analysis was by intention-to-treat, using the last observation carried forward (LOCF) imputation method. Analysis of covariance (ANCOVA) models were computed to assess between-group differences in change scores from baseline to Month 6. Multivariate models were built using a stepwise backward selection approach. Within-group changes were examined using paired *t*-tests for global test scores while McNemar's tests were used to test for changes in the number of participants with abnormal test score. Sensitivity analyses were conducted to assess the robustness of the results under alternative approaches for handling missing data, which included (i) per-protocol analysis on complete cases and (ii) mixed-effects regression analysis.

Results

Of the 134 participants who entered the trial, 22 dropped out at 6 months. Fifty-six (85%) and 54 (79%) intervention and control participants, respectively, completed the 6-month neuropsychological assessment, with no difference between groups in the number of missing data. Mean attendance rate at the exercise classes was 79%, and 83% (i.e., at least 21 classes) for participants who completed the 6-month intervention.

Complete characteristics of trial participants are presented elsewhere [16]. Baseline characteristics were well balanced between the two arms (Tables 1 and 2). Completers and non-completers did not differ in baseline sociodemographic or clinical measures.

At Month 6, the intention-to-treat analysis showed improvement in the sensitivity to interference subtest of the

Table 1. Baseline sociodemographic and clinical characteristics of the 134 trial participants

	Intervention group ($n = 66$)	Control group ($n = 68$)
Age, mean (SD) (years)	75 (8)	76 (6)
Female, *n* (%)	64 (97)	65 (96)
BMI, mean (SD) (kg/m^2)	26 (4)	27 (4)
Education level, *n* (%)		
Primary school	7 (11)	13 (19)
Middle school	45 (68)	45 (66)
High school	14 (21)	10 (15)
Home help services, *n* (%)	21 (32)	19 (28)
Fall(s) in previous 12 months, *n* (%)	37 (56)	37 (54)
Frailty components, *n* (%)[a]		
Unintentional weight loss	10 (15)	5 (7)
Exhaustion	20 (30)	15 (22)
Low physical activity level	0 (0)	1 (1)
Slow walking speed	10 (15)	9 (13)
Grip strength	27 (41)	33 (49)
Physical activity level, mean (SD) (kcal/week)	2336 (1036)	2714 (1370)
Timed Up and Go test, mean (SD) (s)	10 (3)	11 (3)
Self-rated health, mean (SD)[b]	3 (1)	3 (1)
Total number of medications, mean (SD)	4 (2)	3 (2)
Current use of psychotropic medication, *n* (%)	18 (17)	13 (19)
Medical condition, *n* (%)		
Arthritis of the lower limb	7 (11)	12 (18)
Central nervous system disorder	6 (9)	4 (6)
Dizziness or balance disorder	8 (12)	8 (12)
Osteoporosis	23 (35)	28 (41)
Peripheral nervous system disorder	7 (11)	5 (7)
Prosthesis (lower limb)	7 (11)	8 (12)
Cardiac rhythm disorder	5 (8)	1 (1)
Tendon rupture (lower limb)	1 (2)	1 (1)
Trouble with vision	14 (21)	10 (15)
Charlson comorbidity index, mean (SD) (score)[c]	1 (1)	1 (1)

SD, standard deviation; BMI, body mass index.
[a]According to Fried *et al.* [39].
[b]Five-point Likert scale ranging from 1 = excellent to 5 = bad.
[c]According to Charlson *et al.* [40].

Table 2. Baseline and change scores in neuropsychological outcome measures (intention-to-treat population)

Outcome measure	Intervention group (n = 66)		Control group (n = 68)		Adjusted between-group mean difference (95% CI)[d]	Effect,[e] P-value
	Baseline	Month 6	Baseline	Month 6		
Mood[a]						
HADS anxiety, mean ± SD	7.1 ± 4.0	6.2 ± 3.4*	7.3 ± 3.3	7.1 ± 3.5	−0.88 (−1.73 to −0.05)	0.039
≥8, n (%)	25 (38)	19 (29)	32 (47)	28 (41)		
HADS depression, mean ± SD	4.2 ± 3.2	3.9 ± 2.8	3.7 ± 2.6	3.4 ± 2.6	−0.03 (−0.73 to 0.66)	0.924
≥8, n (%)	11 (17)	6 (9)	5 (7)	6 (9)		
Cognitive function[b]						
MMSE, mean ± SD	25.9 ± 2.7	26.9 ± 2.1**	26.3 ± 3.0	26.7 ± 2.7	0.36 (−0.33 to 1.06)	0.305
<24, n (%)	14 (21)	3 (5) **	11 (16)	9 (13)		
Clock-drawing test, mean ± SD	8.8 ± 1.2	9 ± 1.3	8.6 ± 1.7	8.5 ± 1.6	0.34 (−0.10 to 0.77)	0.127
<8, n (%)	9 (14)	7 (11)	12 (18)	13 (19)		
FAB, mean ± SD	15.7 ± 1.9	15.8 ± 1.8	15.4 ± 2.4	15.7 ± 2.3	−0.05 (−0.53 to 0.44)	0.854
<12, n (%)	3 (5)	2 (3)	5 (7)	6 (9)		
Sensitivity to interference subtest, mean ± SD[c]	2.89 ± 0.5	2.94 ± 0.2	2.91 ± 0.3	2.83 ± 0.5	0.12 (0.00 to 0.25)	0.047

CI, confidence interval; SD, standard deviation; FAB, frontal assessment battery; HADS, hospital anxiety and depression scale; MMSE, mini-mental state examination.
[a]Lower scores indicate lower level of anxiety or depression.
[b]Higher scores indicate better performance.
[c]No significant difference found between groups for other FAB subtests.
[d]Between-group mean difference in change score, calculated as follow-up minus baseline scores, adjusted for baseline score of the outcome, age and baseline global cognition (except for MMSE outcome).
[e]Intent-to-treat analysis with missing values imputed using LOCF. ANCOVA on change score, adjusting for baseline score of the outcome, age and baseline global cognition (except for MMSE outcome).
*P < 0.015 for within-group change score from baseline.
**P < 0.005 for within-group change score from baseline.

FAB (adjusted between-group mean difference (AMD), 0.12; 95% CI, 0.00 to 0.25; P = 0.047) and reduced anxiety level (HADS-A; AMD, −0.88; 95% CI, −1.73 to −0.05; P = 0.039), in the intervention group, as compared with the non-exercising controls (Table 2). Within-group analysis for global test scores indicated an increase in MMSE score in the intervention group from baseline to Month 6 (from 25.9 ± 2.7 to 26.9 ± 2.1; t-test, P = 0.004), and a reduction in the number of intervention participants with impaired global cognitive performance (i.e., MMSE score ≤23) (McNemar's test, P = 0.003).

Per-protocol analysis, which excluded non-completers, replicated the intention-to-treat results but with only a trend for significant between-group difference for anxiety (P = 0.066). Result for sensitivity to interference remained consistent in both per-protocol (P = 0.011) and mixed-regression analysis (P = 0.024).

Discussion

This secondary intention-to-treat analysis of a randomised controlled trial results indicates that 6 months of once weekly music-based multitask training improved the sensitivity to interference, one aspect of executive function, reduced anxiety and benefited global cognitive function—also in individuals with obvious cognitive impairment (i.e., MMSE score ≤23)—in community-dwelling older adults at increased risk for falling.

The training regimen improved the executive-related sensitivity to interference process, assessed by the conflicting instructions task of the FAB, a task similar to the Stroop test which requires behavioural self-regulation to inhibit prepotent stimuli and select the appropriate one [24, 26, 27]. Both sensitivity analyses confirmed the robustness of this finding. Improvement in sensitivity to interference appeared to be independent of improvement in mood (data not shown). This result is in line with randomised controlled trial data documenting the benefits of physical exercise (e.g., aerobic exercise regimens) for executive function [28–31], but also of cognitive-motor interventions [3, 4, 6]. Music-based multitask training highly challenges the ability to resist to interference, especially through the performance of concurrent attention-demanding tasks (e.g., walking and manipulating objects) while attending multiple simultaneous stimuli (e.g., from music or partners). This may have implications for everyday life function since many situations require to selectively attend to goal-relevant information while blocking irrelevant stimuli or prepotent responses (e.g., for walking in complex and dynamic environments) [11, 15].

No significant change was found in other executive-related abilities. Further adequately powered trial, using a more comprehensive neuropsychological battery emphasizing executive function would be required to fully delineate to what extent music-based multitask training influences cognitive function, and to further elucidate whether cognitive changes correlate with improvements in dual-task gait performance and with falls. Furthermore, in line with previous reports highlighting the effects of particular training regimens and music on brain structural and functional plasticity, addressing whether music-based multitask training induces neural changes should help to gain more insight into beneficial effects and mechanisms associated with this specific training [2, 20, 29, 32, 33]. Planned studies are expected to contribute to the 'central benefit model' of exercise in falls prevention [15].

Based on the present data, music-based multitask training seems a promising strategy to improve global cognitive function in cognitively impaired older individuals. Since we based our diagnosis on MMSE alone, using an arbitrary cut-point, without taking into account potential confounding factors such as educational level or cultural factors [34], the results should be interpreted cautiously.

While an overwhelming research has shown that physical exercise and music-experience can help alleviate depression disorders, effects on anxiety have been less studied [35–38]. Reduction in anxiety level is in line with the few well-designed randomised controlled trials describing an anxiolytic effect of physical exercise in relatively healthy older adults [38]. With regard to the non-exercising control group, a potential unbalanced socialisation effect might, in part, explain the demonstrated improvement in anxiety level.

Several limitations should be considered. First, as stated above, the trial was not formally designed nor powered to detect between-group differences in neuropsychological outcomes. Second, the only once weekly for 6 months sessions may not be sufficient to detect improvements in cognitive function. Third, the results should be interpreted with regard to the eligibility criteria and the trial sample.

In conclusion, 6 months of once weekly music-based multitask training was associated with enhanced cognitive function and decreased anxiety in community-dwelling older adults at increased risk for falling, relative to non-exercising controls. To further delineate the training-induced changes in cognitive function, and the extent to which they mediate dual-task gait improvements and falls reduction, remains an exciting challenge.

Key points

- Music-based multitask training is a specific exercise regimen challenging both motor- and cognitive-related abilities.
- Six months of music-based multitask training improved executive function and benefited global cognitive function in older adults.
- The 6-month exercise program also reduced anxiety.

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Conflicts of interest

None declared.

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Supplementary data

Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

References

The very long list of references supporting this paper has meant that only the most important are listed here and are represented by bold type throughout the text. The full list of references is available in Supplementary data in *Age and Ageing online*, Appendix 1.

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Screening for depression in Parkinson's disease: the performance of two screening questions

Sarah Baillon[1], Michael Dennis[2], Nelson Lo[3], James Lindesay[1]

[1]Department of Health Sciences, University of Leicester, Leicester, Leics, UK
[2]College of Medicine, Swansea University, Swansea, Wales, UK
[3]Department of Geriatric Medicine, University Hospitals of Leicester NHS Trust, Leicester, Leics, UK

Address correspondence to: S. Baillon. Tel: (+44) 116 2588161; Fax: (+44) 116 2584078. Email: sfb5@leicester.ac.uk

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Abstract

Background: the study objective was to evaluate the validity of the two questions recommended by the UK. National Institute for Health and Clinical Excellence for depression screening in Parkinson's disease (PD).