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Cognitive and behavioural effects of music-based exercises in patients with dementia

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Objective: To evaluate the effect of a musical exercise programme on mood state and cognitive function in women with dementia.
Design: Randomized controlled trial.
Setting: Public Psychiatric Hospital Rekem, Belgium.
Patients: Twenty-five patients with dementia.
Interventions: Fifteen patients attended exercise training for three months, which consisted of daily physical exercises supported by music for 30 min/session. They were compared with a group of 10 control patients, who received an equal amount of attention through daily conversation.
Main measures: The effect on cognition was measured by the Mini-Mental State Examination (MMSE) and the Amsterdam Dementia Screening Test 6 (ADS 6). Behaviour was evaluated with the abbreviated Stockton Geriatric Rating Scale (BOP scale). The assessments were made before, after six weeks of intervention and immediately after the three-month experimental period.
Results: The exercise group showed a significant improvement in cognition. This was documented by an increased MMSE mean score of 12.87–15.53, and by a higher median score, rising from 10 to 14 points, on the subset 'fluency' (ADS 6 test). The control group showed no significant improvement, either on the MMSE (mean score of 10.80–11.00) or on the fluency subtest of the ADS 6 (median scores were 6.5–7 points). The effects on behavioural changes were not significant.
Conclusion: The present study suggests a beneficial effect of cognition using a music-based exercise programme in a group of patients with moderate to severe dementia. Further studies are needed to confirm these findings.

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Introduction

> Music and rhythm find their way into the secret places of the soul.
>
> Plato

Dementia is a neurological syndrome, characterized by a gradual deterioration of multiple cognitive functions, emotional control and social behaviour.[1] In a later stage of dementia, deficits in skilled motor performance become increasingly apparent.[2] Eventually, patients exhibit severely compromised motor ability, such as gait disorders, an increasing risk of falls, limb rigidity and flexed posture.[3]

Several studies have demonstrated a positive impact of exercise on strength, balance, flexibility and quality of life in patients with Alzheimer's disease.[4,5]

Many caregivers and family members recount anecdotal evidence noting the therapeutic effect of individualized or group-based music sessions in patients with Alzheimer's disease.[6–8] Beneficial effects have been reported in the areas of behaviour, speech, motor integration and rhythmic movement.[9–13]

Few studies have investigated effects on cognition of either listening to music or exercising to music in patients with Alzheimer's disease. Johnson's case study[14] on a set of twins showed considerable improvement on a spatial-temporal task after a 'Mozart listening' session. However, replication of the intervention in other study groups has shown inconsistent results.[15] A study on 30 patients with Alzheimer's, 30 patients with memory disorders and 30 healthy persons suggests that patients with Alzheimer's perform better in visuoconstructional tasks while listening to music.[16]

Apparently, so far only one study has used exercised to music specifically as an intervention for measuring its effect on cognition.[17] Even with only 15 patients, the study indicated a significant improvement on several aspects of cognition. However, no control group was implemented.

The purpose of this study is to evaluate the effect of three months of daily music-based seated dance sessions on cognition and behaviour in women with dementia.

Methods

Participants

The controlled trial was carried out in the Public Psychiatric Hospital at Rekem (Limburg, Belgium), where 100 patients with dementia reside permanently. Subjects who were diagnosed with multiple infarct dementia or who met the NINCDS-ARDRA criteria for probable or possible Alzheimer's disease[18] were eligible for the study. The severity of dementia was defined in terms of scores on the Mini Mental State Examination (MMSE).[19]

To be included in the study, patients had to display a MMSE score lower than 24/30; they had to be able to respond to verbal or visual commands; to be able to mimic the movements of the therapist; and to hear the music. Patients who were apathetic or unable to remain in a sitting position for 30 minutes were excluded. Medication regimes remained unchanged throughout the experiment. Consent from patients and their family were obtained. Physicians gave medical clearance for participation in the study.

Intervention

Through flipping a coin, 15 patients were randomly assigned to an exercise group and 10 to a control group.

Both treatments were carried out over a period of three months. To standardize the patient–therapist relation, the same therapist was in charge of both the music-based dance therapy and the conversational session. Both sessions were organized daily for 30 minutes per session.

Control patients were sitting in the day room and the therapist had a daily one-to-one conversation with each of them separately, taking care that this conversation did not concern issues addressed by the MMSE. No music was played and patients were not asked to perform any movements.

Patients in the exercise group attended a group-based exercise programme in a separate room. The residents sat in a circle, facing the therapist, so they could follow the exercises through constantly mimicking the movements of the instructor. The therapist used specific one-step verbal instructions, combined with continuous visual demonstration. To enhance interest and participation, the music was chosen with consideration of their age. There-

fore, folkloric accordion songs, such as polka, folk, country and western music was chosen. The exercises focused on upper and lower body strengthening, as well as balance, trunk movements and flexibility training.

Evaluation

The MMSE and the Amsterdam Dementia Screening Test 6 (ADS 6)[20] were used to measure cognition. The MMSE has proved to be a valid and reliable screening instrument assessing and monitoring changes in cognitive impairment.[21] Because memory items tend to 'bottom out' early,[22] the ADS 6 was added in order to cover a broader range of cognitive decline. The ADS 6 test contains six subsets and aims at visual short-term memory; orientation in time and space; visuoconstructional problems; category fluency; copying figures; and free recall of eight words. In a category fluency test, patients are required to say words that belong to a same semantic category (for example 'animals'). This skill requires temporal lobe-mediated semantic knowledge and is more impaired in patients with Alzheimer's disease, who are predominantly affected in medial temporal and posterior cortical regions.[23] The BOP scale (Beoordelingsschaal voor Oudere Patiënten/Evaluation Scale for Elderly Patients)[24] was used to investigate behaviour. This scale is a Dutch adaptation of the Stockton Geriatric Rating Scale and is a reliable and valid instrument in geriatric patients.[25,26] The scale contains 35 items pertaining to six aspects of the patient's daily behaviour on the ward: helplessness; aggressive behaviour; physical disability; depressive behaviour; mental disability (disorientation and communicational disturbances); and inactivity. Each behavioural aspect is scored separately, with zero indicating normal behaviour, and higher scores for progressively worse behavioural symptoms.

Patients were tested three times: at the beginning of the experimental period, after six weeks and after three months. The physiotherapist who was conducting both treatments evaluated the patients on cognition. However, the nurses who scored the patients on behaviour were all blind to the group assignment. The latter scoring was performed after a week of observation each time. One patient in the control group was hospitalized for a hip fracture during the last test time. Therefore, the last MMSE and ADS 6 test could not be administered.

Statistical analysis

Depending on the type of scale, several statistical procedures were used to examine differences over time between the two groups. A two-way ANOVA repeated measures was used for the MMSE. To evaluate the effect size on the MMSE, Cohen's *d* was calculated as the difference in improvement (the last test score is subtracted from the first score) between the experimental group and the control group, divided by the pooled standard deviation.[27] The effect sizes of 0.2–0.4 are considered as small, 0.5–0.7 as medium, and 0.8–2.0 as large.

The ADS 6 test and the BOP scale are ordinal scales and were examined with nonparametrical analysis. First, a Friedman two-way analysis of variance by ranks test was employed to evaluate differences over time for each test group. If the Friedman test revealed significant differences, Wilcoxon's signed rank tests were applied. Additionally, Wilcoxon's rank sum tests compared the difference in scores between the first and the last test session of both groups. For all statistical evaluations, the significant threshold was set at $\alpha = 0.05$. Statistical procedures were performed with the SAS System Release 6.12.

Results

Figure 1 shows patients' progress throughout the trial. Twenty-five women fulfilled the inclusion criteria. Twenty-two participants were diagnosed with Alzheimer's disease and three persons with multiple infarct dementia. Most patients used a wheelchair or required assistance with transfers, due to impaired balance, immobility, contractures or muscle atrophy. However, all could move their limbs voluntarily and demonstrated at least a minimal range of motion.

The two patient groups were similar with respect to age (mean 81.33±4.24 years and 81.90±4.18 years), and length of hospitalization (mean 21.8 months±24.66 and 22±15.94 months), for the exercise group and the control group respectively. Severity of cognitive decline, as measured by the

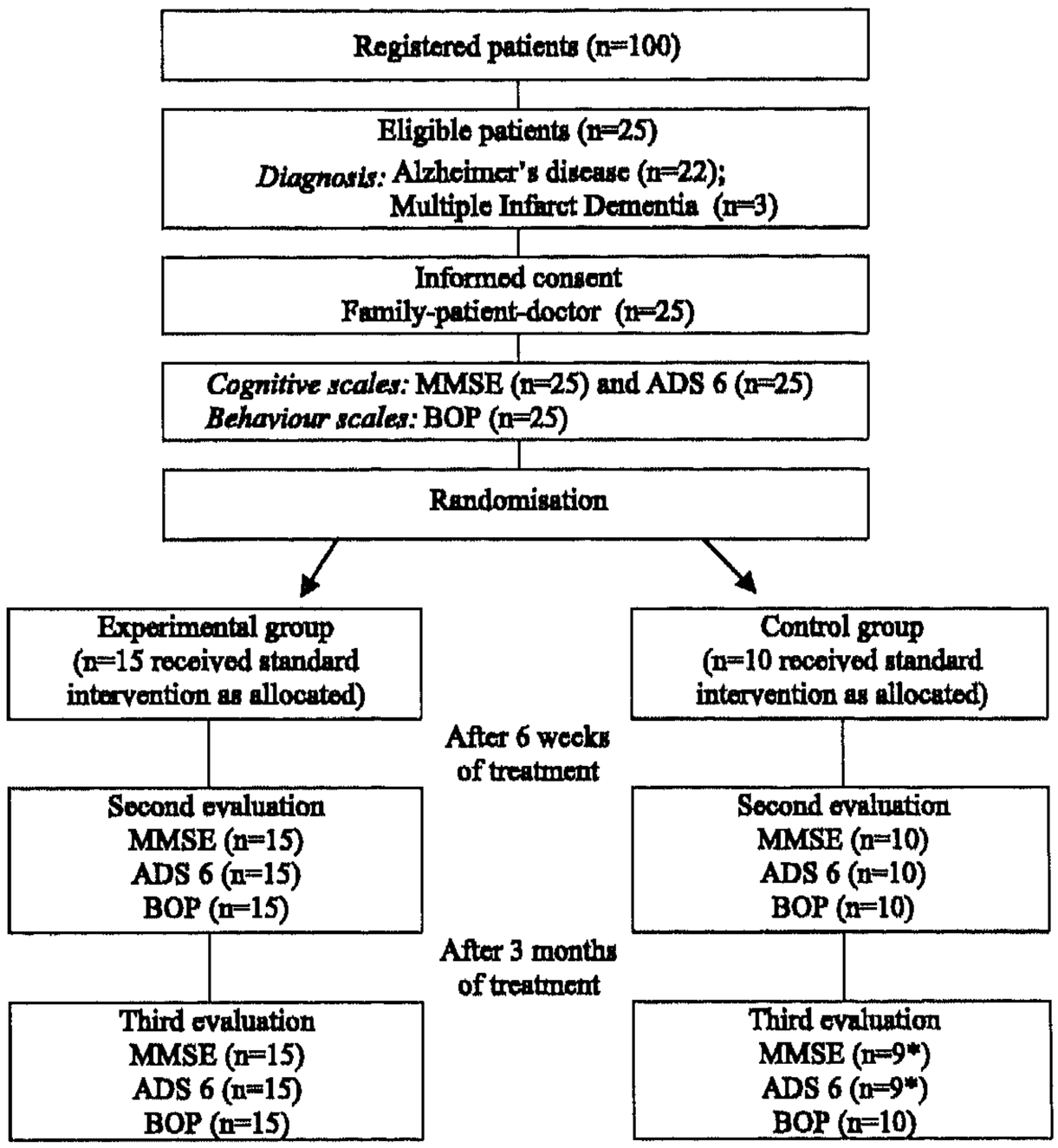

Figure 1 Flow chart describing patients' progress throughout the trial. *One patient was hospitalized for hip fracture. MMSE, Mini-Mental State Examination; ADS 6, Amsterdam Dementia Screening Test 6; BOP, Beoordelingsschaal voor Oudere patienten (Evaluation Scale for Elderly Patients).

MMSE, revealed no significant difference between the two groups at the beginning of the study (mean 12.87 ± 5.01 and 10.80 ± 5.01) for exercise group and control group respectively.

Table 1 presents the mean MMSE scores and standard deviations, and median ADS 6 and BOP scores (with lower and upper quartile values) of both exercise and control group over the three test sessions. The mean improvement on the MMSE was 2.67 ± 1.88 for the experimental group and 0.2 ± 2.87 for the control group. The effect size was 0.5. The repeated measures ANOVA revealed a significant 'group × time' interaction, indicating a significantly different pattern of scores over test sessions in the two groups ($F(2,44) = 4.41$, $p = 0.02$). Further analysis showed that the mean MMSE scores for the control group displayed no significant differences over time ($F(2,16) = 0.22$, $p = 0.8$), while the exercise group improved significantly on the MMSE scores ($F(2,28) = 9.86$, $p = 0.001$). Post-hoc contrasts in the exercise group demonstrated both significant improvements after six weeks ($F(1,14) = 4.50$, $p = 0.05$), and 12 weeks of therapy ($F(1,14) = 30.27$, $p = 0.0001$).

The Friedman analysis on the ADS 6 test revealed a significant improvement over time for the subset 'fluency' in the experimental group ($\xi^2 = 6.63$, $p < 0.05$). The medians in this group represent the number of words that patients can enumerate with regard to a given category. Post-hoc analyses with Wilcoxon signed rank test revealed significant differences between 0–6 weeks (signed rank $= -31.5$, $p = 0.0254$) and 0–12 weeks (signed rank $= -35$, $p = 0.0034$).

Additionally, Wilcoxon rank sum test compares the differences in test scores between the first and

the last test time between exercise and control group. The test confirms that the improvement was significantly larger for the experimental group than for the control group for the subset 'fluency' ($z = -2.44$, $p = 0.01$). Medians are 10–14 for the first and last test time of the exercise group, and 6.5–7

Table 1 Mean with standard deviations (MMSE) and Medians with lower and upper quartile values (ADS 6/BOP) at three time points for each group on cognition and behaviour.

Test subset	Prior to treatment	Midway	Post treatment
	Mean (standard deviation)		
MMSE (range 0–24)			
Exercise	12.87 (5.01)	14.40 (4.40)*	15.53 (4.44)**
Control	10.80 (5.01)	11.50 (5.21)	11.00 (4.30)
	Median (lower and upper quartile values)		
ADS 6			
Picture recognition (0– >3)			
Exercise	3 (1.5–3)	0 (0–3)	1 (0.5–1.5)
Control	0 (0–0)	0 (0–0)	0 (0–0)
Orientation in time/space (0–4)			
Exercise	0 (0–1)	1 (0–1.5)	1 (1–1)
Control	0 (0–0)	0 (0–0.75)	1 (0–1)
Draw alternating sequences (0–4)			
Exercise	0 (0–2.5)	1 (0–2)	2 (1–4)
Control	0 (0–1.5)	0 (0–1.75)	0 (0–1)
Category fluency (0– > 25)			
Exercise	10 (4.5–13.5)	13 (9.5–16)*	14 (11.5–19.5)**
Control	6.5 (4.25–9.25)	7 (3.25–8.75)	7 (4–9)
Copying figures (0–13)			
Exercise	10 (8–11)	9 (6.5–11)	9 (8–10)
Control	6 (5–7)	6.5 (5.25–9.5)	5 (5–9)
Free recall (0– > 24)			
Exercise	12 (7.5–16)	12 (7–15.5)	13 (7.5–18)
Control	8.5 (6–10.5)	8.5 (3.5–10.5)	12 (6–14)
BOP			
Need for help (46–0)			
Exercise	17 (12–25.5)	17 (11–21.5)	19 (12.5–23.5)
Control	23 (16.5–26.75)	17.5 (13–26)*	21 (16.25–27.5)*
Aggressiveness (10–0)			
Exercise	2 (0–4)	2 (0–3.5)	2 (0–4)
Control	1.5 (1–2.75)	0.5 (0–2.5)	1.5 (0–2.75)
Physical invalidity (6–0)			
Exercise	1 (1–2)	2 (0.5–2)	1 (0.5–2)
Control	2 (2–5.5)	2.5 (1.25–5.75)	3.5 (2–5.5)
Depressed behaviour (6–0)			
Exercise	2 (1–3)	2 (0.5–3.5)	2 (1–3)
Control	1.5 (1–2)	1 (0.25–1.75)	1.5 (1–2)
Mental invalidity (8–0)			
Exercise	4 (2.5–5)	4 (3–5)	4 (4–5)
Control	4 (3–4)	3.5 (3–4)	4.5 (4–5)
Inactivity (14–0)			
Exercise	9 (7–10.5)	8 (6–9.5)	8 (6.5–10)
Control	9 (8.25–10)	8.5 (8–9.75)	8 (7.25–9.75)

*Significant at $p < 0.05$; **significant at $p < 0.01$.
MMSE, Mini Mental State Examination; ADS 6, Amsterdam Dementia Screening Test 6; BOP, Beoordelingsschaalvoor Oudere patienten (Evaluation Scale for Elderly Patients).

for the for the first and last test time of the control group.

No items in the BOP scale showed significant differences over time in the experimental group. In the control group, however, a significant change was found for the subset 'need of help' ($\xi^2 = 6.45$, $p < 0.05$). Post-hoc analyses disclosed that patients improved significantly on this subset in the first period (signed rank = 22, $p = 0.03$), but a significant reversed trend was observed between six weeks and three months (signed rank = -14, $p = 0.02$).

Discussion

This study showed that daily music-based dance sessions for three months led to significantly higher scores on the total MMSE score in patients with dementia. The mean difference in improvement between the experimental group and the control group was 2.67 on the MMSE, representing a medium effect size of 0.5. The effect of the music-based intervention can therefore be considered as clinically relevant.

The mechanisms involved in the improvement of cognition from exercise are not well understood. One possibility is that the effects are mediated through an increase in processing speed. This suggestion is consistent with findings of improvement on speeded tasks.[28] As memory and attention deficits are among the first clinical manifestations to develop in Alzheimer's disease,[29] it is possible that physical exercise stimulation may increase temporary arousal, stimulating cognitive activity.

The exercise group also improved significantly on the 'category fluency' test after 6 and 12 weeks, when compared with the control group. Both findings are consistent with the results in Palleschi's study,[17] where music-based exercise was investigated on cognition in 15 male patients with Alzheimer's. He demonstrated a significant improvement on the MMSE, but also on a test of attention and a verbal span test.

Huff *et al.* have observed that patients with Alzheimer's have difficulties in producing names of objects and in distinguishing among objects within a category.[30] He concludes that the anomia deficit is characterized by a loss of information about specific objects and their names rather than by a simple difficulty in retrieving information. Consequently, the effects found on the category fluency test in this study could also be explained as an increase in processing information, and thus, making the latent information more available to the patient.

On the other hand, Kovach and Henschel pointed out that lyric recall in patients with dementia was excellent in the music sessions versus remembering a short story or event in history during the cognitive activities.[31]

The key component in the treatment described in this study was combining music to exercise. However, from this type of intervention, the mechanisms underlying the improved outcome of cognition cannot be identified. We hypothesize that music enhances arousal, and combined with exercise, motivates to patient to be even more active and alert to the present. This could help the patient to perform better on cognitive tasks, such as category verbal fluency (ADS 6); questions in regard to orientation in time and space; and other cognitive tasks as raised by the MMSE.

According to the results on the BOP scale, no significant behavioural effects have been found.

A number of limitations to the current study are worth noting. The sample size was small. The study did not evaluate the long-term effect of the cognitive improvement in a follow-up. Also the randomization and evaluation procedures were not ideal. However, this is the first controlled study suggesting that music-based exercise training may improve cognition in patients with dementia. The intervention is also feasible for staff to deliver with minimal training, and does not require costly exercise equipment.

Verbal and visual cueing were offered continuously during exercise sessions. Mimicking the movement appeared to be the most important cue. When repetitive verbal cueing was given

Clinical messages

- Music-based exercise training over three months may improve cognition in patients with moderate to severe dementia.
- The exercise training yielded no significant behavioural changes.

without visual aid, the patients continued with the last shown movement. Ghilardi *et al*. confirmed this finding.[32] They found that in the absence of visual feedback, movement accuracy in patients with Alzheimer's disease was severely impaired. While scarcely using feed forward commands, patients with Alzheimer's disease relied on continuous on-line external cues.

In conclusion, the present study suggests the efficacy of a music-based exercise programme in a group of patients with moderate to severe dementia. It could represent a worthwhile approach to slow down the progression of disability. The mechanisms by which music-based exercises exert their effects, however, remain unclear. Hopefully this study will encourage more researchers to elaborate and evaluate group interventions to music in a larger sample of participants with dementia.

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Note

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