



Active music therapy improves cognition and behaviour in chronic vascular encephalopathy: A case report



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KEYWORDS

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Summary

Objectives: This study describes the effects of active music therapy (AMT) on cognition and behaviour in chronic vascular encephalopathy.

Design: A single case study investigated different cognitive and psycho-behavioural changes after AMT.

Setting: An adult patient with memory, attention, and verbal fluency deficits associated with Vascular Cognitive Impairment-No Dementia (VCI-ND) was treated.

Intervention: A four-months AMT course was based on creative and interactive music playing. Sixteen sessions were conducted simultaneously to the pharmacological therapy.

Main outcomes measures: Cognitive performances, mood, interpersonal interactions, and perceived abilities were assessed using standardized neuropsychological and psycho-behavioural measurements.

Results: At baseline, the patient reported a tendency to feel tense, nervous, and angry and difficulties in memory and visuospatial performances, frequently accompanied by attention drops. The social network was a habitual component of the patient's life, but not a source of sharing of personal experiences, safety or comfort. Neuropsychological tests showed deficits in object and figure naming, verbal fluency, short and long-term verbal memory, short-term spatial memory, selective attention, and visuomotor coordination. After AMT, the cognitive profile significantly improved in attention, visuomotor coordination, and verbal and spatial memory. Such positive changes were confirmed at the three-months follow-up. An increase of the interpersonal interactions and consistent reduction of anxiety were also observed.

Conclusions: In selected patients with VCI-ND, a well-structured AMT intervention added to standard therapy may contribute in determining a stable improvement of cognitive and psycho-behavioural aspects. Controlled studies are needed to confirm these promising results.

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Introduction

Different changes in the vascular system bear the risk of neurological disturbances as consequences of the vascular alterations or associated metabolic and haemodynamic abnormalities (e.g., diabetes, congestive heart failure, and obesity).¹ Primary or secondary vascular changes may cause oxidative stress, accelerate brain degeneration, provoke asymptomatic infarct or inflammation, and reduce cerebral blood flow and vascular density.^{2,3} In midlife, the proportion of dementia attributable to vascular causes may vary.⁴ Manipulation of the vascular risk yields up to a 50% reduction of the prevalence rate of dementia in people aged 65 years or older.^{5,6} Vascular cognitive impairment (VCI) refers to cognitive decline attributable to vascular disorders. Unlike mild cognitive impairment (MCI), which is a pre-clinical form of dementia, VCI encompasses any degree of cognitive decline associated with vascular lesions or risk factors. The severity of VCI ranges from mild difficulties to vascular dementia (VaD) or mixed VaD, where vascular and Alzheimer's disease (AD) pathologies co-occur. VCI not fulfilling the criteria for dementia is defined as VCI no dementia (VCI-ND). VCI-ND does not necessarily represent a pre-clinical stage of dementia, as the outcome across different VCI conditions may reveal improvement or stability of the cognitive patterns.^{7,8} In VCI, the neuropsychological profile is often represented by attention and executive deficits and psychomotor slowing, with spared language and memory abilities,⁷ although the deficits may vary in relation to the type and severity of the vascular disorder.^{8,9} In MCI, the coexistence of vascular lesions was associated with a decreased risk of cognitive decline or stable cognitive profile.^{10,11} Pharmacological and non-pharmacological treatment of the vascular disorders and their risk factors showed marginal effects on the prevalence of dementia in the general population.¹² However, as regards the primary prevention, physical activity proved to reduce the risk of VCI-ND.¹³

A large body of research supports the use of music therapy within many areas of physical, cognitive, and psychosocial rehabilitation.¹⁴ Different studies of the effect of music or music therapy on the behavioural and psychological symptoms of dementia (BPSD) were based on music listening or making (active music therapy, AMT).^{15–17} Sung et al.¹⁸ showed that older adults with dementia undergoing music activity were significantly less anxious than controls. In elderly patients with AD, Ziv et al.¹⁹ demonstrated significant reduction in disruptive behaviour and improvement in positive social behaviours, during the presence of music. Cooke et al.²⁰ analyzed the positive effect of live music on quality of life (QoL), depression, agitation, and anxiety. Two studies^{21,22} evaluated the effects of AMT on BPSD in patients with moderate to severe dementia. The first²¹ showed that AMT was more effective than educational and occupational activities, the second²² revealed a significant reduction of BPSD (delusions, agitation, anxiety, apathy, irritability, aberrant motor activity, sleep disorders) on the Neuropsychiatric Inventory. As for the influence of music therapy on cognition, two studies indicated a significant improvement of verbal memory and attention after listening to favourite music a hour a day²³ and an improvement in articulation, prosody,

verbal repetition, and comprehension after vocal, rhythmic, and melodic training,²⁴ respectively. Bruer et al.²⁵ showed cognitive improvement after the listening to familiar songs, while Ceccato et al.²⁶ reported a significant improvement in attention and prose memory.

This study adopted a standardized AMT method in a case of VCI-ND with the goal of analyzing its cognitive and psycho-behavioural effects. The patient showed high motivation and collaboration to AMT and repeated assessments, which made it especially representative of the type of intervention and measurement of the cognitive and psycho-behavioural changes. The AMT used in this study was characterized by an "inter-subjective approach"²⁷ based on relationship, "affect attunement" between therapist and patient, and empathetic listening, which bore the therapeutic character of the intervention. The non-verbal and sonorous-musical aspects in the patient/music therapist interaction may facilitate the organizational processes and emotional modulation.²⁸ The sonorous-musical elements may also stimulate the cognitive functions as a consequence of the activation of many brain areas.²⁸ AMT may secondarily help adapt to the disease and improve the interpersonal relations and QoL.^{27,29} This case represents a peculiar application of AMT in VCI-ND.

Methods

Participant

A 62 years-old woman, with 18 years of schooling, reported chronic difficulties in speech, memory, person and object naming, and recognition of the spatial position and orientation of objects, and short episodes of spatial disorientation. Past clinical history was characterized by arterial hypertension and high blood lipid levels. Two years after clinical onset, neurological examination showed impaired episodic memory, attention, and verbal initiative. Electrocardiogram provided normal results. Brain magnetic resonance revealed multiple small hypertense areas in the white matter of the left and right hemisphere, associated with very mild enlargement of the ventricles and cortical sulci. Carotid sonography showed small plaques in the absence of lumen alterations. The pharmacological treatment of the vascular risk factors (calcium antagonist, aspirin, dietary restriction) started 10 years before the onset of cognitive failures and remained unchanged during and after AMT. In this period, no anxiolytic or antidepressant drugs were added and the patient maintained her family, social, and leisure activities.

Neuropsychological assessment

Two neuropsychological evaluations were carried out before treatment at 7-months interval, after informed consent. Two evaluations were repeated soon after AMT and a 3-months interval, respectively (Table 1). Standardized neuropsychological tests assessed verbal and visuospatial short-term memory (Digit Span, Corsi Blocks Span), long-term memory (Short Story, Rey Complex Figure Recall), learning (Rey Auditory Verbal Learning Test), executive functions (Tower of London, Weigl Sorting Test), selective and divided attention

Table 1 Neuropsychological assessment.

	Before AMT				After AMT			
	1st evaluation		2nd evaluation		3rd evaluation		4th evaluation	
	RS	ES	RS	ES	RS	ES	RS	ES
Attentive Matrices	43	1	49	2	56	4	60	4
Trail Making Test B	145	2	133	3	111	4	94	4
Trail Making Test A	79	1	67	2	46	4	44	4
Boston Naming Test			43		34		44	
Raven Colored Progressive Matrices	28	2	31	3	28	2	30	3
Tower of London ^a	—	—	21	—	22	—	30	—
Weigl Sorting Test	10	2	10	2	9	1	13	3
Rey Complex Figure Copying	35	4	35	4	36	4	36	4
Word Fluency Test phonemic cues	25	1	33	3	34	3	40	4
Word Fluency Test semantic cues	22	0	38	3	28	1	35	2
Short Story	7	0	13	2	16	4	4,5	3
Digit Span	6	4	7	4	7	4	6	4
Corsi Blocks Span	4	1	3	0	4	1	6	4
Rey Auditory Verbal Learning Test immediate recall	43	3	43	3	35	2	45	4
Rey Auditory Verbal Learning Test delayed recall	9	3	10	4	8	4	9	4
Rey Complex Figure Recall	18.5	4	20.5	4	19	4	34	4

AMT, Active music therapy. RS, row scores. ES, equivalent scores.

^a RS were under cut-off values at the 2nd and 3rd examination, while they were normal at the 4th examination.

and visuomotor coordination (Attentive Matrices, Trail Making Test A and B), apraxia (Rey Complex Figure Copying), abstract reasoning (Raven Colored Progressive Matrices), and language (Word Fluency Test, Token Test, Boston Naming Test).³⁰ The changes after AMT were considered clinically significant if equal to or greater than one equivalent score (ES). Each ES identified a category of age- and education-adjusted scores in the healthy population; five ES were computed indicating deficit (zero), borderline performance (1), or normal performances (2, 3, and 4).

Psycho-behavioural assessment

The Multiple Ability Self-report Questionnaire (MASQ), Beck Depression Inventory (BDI), State Trait Anxiety Inventory (STAI1, STAI2), Lubben Social Network Scale (LSNS), and World Health Organization Quality of Life (WHOQoL 100) measured perceived cognitive abilities (language, verbal memory, visuospatial memory, attention and concentration, visuospatial abilities), depression, anxiety, social relationships, and QoL^{30,31} (Table 2). The higher the MASQ score, the worse the cognitive difficulties. The higher the BDI and STAI score, the worse depression and anxiety, respectively. The LSNS and WHOQoL 100 score are proportional to the level of social relationships and QoL. All of the questionnaires were administered three times (at the second pre-AMT neuropsychological assessment, at the two neuropsychological follow-ups).

Active music therapy

AMT^{20,21,27} lasted four months, with 16 two-weekly group sessions. After informed consent to the treatment, registration of the AMT sessions, treatment of personal data, and

publication for scientific purpose, the patient was included in a group with two other adult patients affected by cognitive decline of different origin; overall, 15 patients were treated in different groups. The intervention was conducted by a music therapist who had both a degree in conservatory (piano) and a licence in music therapy obtained after a four years specific training. Each session began with a song or activity designed to set emotions and to involve the participants. Participants were asked to play together and, alternatively, to listen to one another, assuming musical leadership or playing a supportive role. Apart from these cues, the production of music and sounds was not subjected to rules, restrictions or directions. Participants were free to produce rhythmic and melodic pieces using the instruments and their voice. The music therapist suggested, through non-verbal cues, to listen to particular sounds and musical outputs in order to foster interaction and emotional attunement.

Intra-setting evaluation

Intra-setting evaluation was carried out during each AMT session, analysing four areas: (a) attention, posture, and emotional participation, (b) interaction with musical and sound elements, (c) relationship with the therapist and (d) relationship with the other participants.

Results

Before AMT, the patient expected a pleasant and beneficial treatment. No adverse side effects were registered during AMT, although mild accidental trauma or negative emotions could not be excluded initially. Compared with previous

Table 2 Psycho-behavioural assessment.

	Before AMT 2nd evaluation	After AMT 3rd evaluation	After AMT 4th evaluation
Multiple Ability Self report Questionnaire			
Language	20/40	20/40	20/40
Verbal memory	26/40	25/40	24/40
Visuo-spatial memory	25/40	20/40	20/40
Attention	24/40	21/40	20/40
Visuo-spatial abilities	20/30	18/30	18/30
Beck Depression Inventory	7/39	6/39	4/39
State Trait Anxiety Inventory 1	42/80	36/80	34/80
State Trait Anxiety Inventory 2	48/80	49/80	43/80
Lubben Social Network Scale			
Relatives	9/30	12/30	15/30
Neighbours	6/30	8/30	6/30
Friends	5/30	6/30	5/30
World Health Organization Quality of Life 100	319	317	328

AMT, active music therapy.

months, during and after AMT, the patient reported improvement in topographic memory (she did not lose home objects and did not get lost in town anymore). Moreover, she did not report any spatial orientation or naming failures (she recalled more promptly the names of her friends and neighbours and famous people). She also felt more quiet and willing to initiate and to complete daily activities and new social relationships. At all of the sessions, she enjoyed music and AMT.

Neuropsychological results

Table 1 summarizes the test scores. Baseline assessment showed deficits in object naming, verbal fluency on semantic cues, short and long-term verbal memory, short-term visuospatial memory, selective attention, and visuomotor coordination. After treatment, clinically significant improvement (as expressed by the ES changes) was observed in verbal fluency, episodic memory, and attention. The episodic memory ES shifted from two to four, while the spatial memory ES shifted from zero to one soon after AMT and to four after three months. Minor improvement was observed in the elaboration and shifting of criteria.

Psycho-behavioural results

The scale scores are reported in **Table 2**. Before AMT, the MASQ showed difficulties with language, mainly in word-finding, oral expression speed, and the understanding of others' talks. The patient also reported difficulty to remember the arguments of a conversation, the location of home objects, and frequent attention drops. The STAI1 yielded a normal score (42; 66^o percentile), but revealed feelings of tension, nervousness, and agitation. These features also emerged from the STAI2, despite a total normal score (48; 67^o percentile). No relevant symptom of depression was reported on the BDI. On the LSNS, different psychosocial relationships represented a habitual component of everyday life, but they did not stimulate the sharing of personal experiences, safety, comfort or support. QoL, as expressed

by the WHOQoL 100 total score, was worse compared to that reported by healthy subjects (375.40 ± 38.41) and similar to that showed by patients with chronic vascular disorders (336.93 ± 52.94).³¹ After AMT, significant changes occurred in state anxiety: the patient reported an increased sense of calm, safety, and satisfaction (STAI1 score = 36; 18^o percentile at the end of AMT), although there was a mild tendency to sadness. The BDI showed an increase of positive feelings. On the LSNS, the social relationships resulted improved, in particular, those with family persons. All of the psycho-behavioural and cognitive improvements were confirmed at the three-months follow-up. At the three-months follow-up, positive changes were also reported in QoL, in particular in the psychological and social domains, although the WHOQoL 100 total score remained lower than normal scores.³¹

Intra-setting results

Intra-setting assessment highlighted the following aspects: (a) the patient was constantly curious and interested in AMT, showed careful and purposeful attitude, and was emotionally involved in making music. (b) She utilized all setting's musical instruments, responded to sound stimuli in an appropriate manner, and used the sonorous-musical element with dynamic, rhythmic, and ongoing changes. (c) She was interested in music therapist's actions and adhered to the setting with positive and relaxed behaviours. (d) The relationships with the other participants were positive and warm, with particular openness and support.

Discussion

This case study describes an adult patient with VCI-ND treated by AMT added to standard therapy. Different cognitive functions, anxiety, and interpersonal relationships improved after treatment, maintaining a stable profile.

Before treatment, the patient complained of severe episodic and visuospatial memory failures and suffered of scarce verbal fluency and attention. During and after

AMT, the course of the symptoms was characterized by improvement in topographic memory, spatial orientation, and naming, with secondary increase of initiative in carrying out daily activities and engaging interpersonal interactions. No adverse side effects were registered during AMT.

Soon after the completion of AMT, prominent neuropsychological changes were observed, achieving normal test scores. This improvement was confirmed at the three-months follow-up, suggesting that the beneficial effects of AMT may remain stable. Note that memory, attention, and verbal fluency also improved before AMT, in line with the effects of the standard pharmacological therapy. AMT may enhance such benefits. As showed by previous studies,^{18,19} group music activities (e.g., music-playing, listening to selected pieces, singing, creating) provide a real contribution in raising patients from distress caused by cognitive decline and in giving them the opportunity to focus on one's own resources and emotional well-being and to share activities and interests. Cognitive performances after music therapy using different methodologies were previously investigated, showing a significant improvement of verbal memory, verbal fluency, attention, and mood in dementia and stroke patients.^{23,24} Brain imaging revealed that listening to real polyphonic music calls for rule-based analysis and the combination of sound patterns from multiple auditory streams, which naturally recruits bilateral temporal, frontal, and parietal neural circuits underlying attention, working memory, semantic and syntactic processing, and imagery.^{32,33} Present study extends previous findings, underlining a positive role played by AMT in memory, attention, and verbal expression. Maintenance of normal neuropsychological performances after the end of the treatment may reflect clinical improvement and neural changes provoked by AMT (e.g., increase of brain connectivity).^{32,33} Also note that musical priming may enhance the activity of the inferior frontal cortex³⁴ and long-lasting music playing may induce volumetric changes in the frontal, temporal, and parietal cortex.³⁵ Normal neuropsychological scores at the three months-follow-up may be facilitated by a test-retest effect on memory, but such an effect does not explain the changes in verbal fluency and attention which pose on-line demands.

As for the psycho-behavioural aspects, this case highlights a positive influence for AMT on the interactions with the principal actors of daily life and family. Moreover, AMT was followed by clear-cut decrease of anxiety and enhancement of positive feelings. This is in line with previous findings in patients with degenerative cognitive decline.^{21,22} QoL only showed a slight trend to improvement, with low levels similar to those observed in patients with chronic vascular disorders,³¹ maybe reflecting long-lasting problems. The intra-setting evaluation across 16 sessions revealed that the patient was quiet, curious, careful, and interested in AMT; she actively participated to all of the sessions playing different musical instruments using appropriately the sonorous-musical stimuli and was also warm and open with other participants. It may be argued that the improvement of extra-setting emotional and relational aspects are facilitated by positive intra-setting behaviour and attitude towards AMT, even in the absence of experience in music playing.

Overall, these results suggest that, in patients with VCI-ND, AMT added to standard therapies may stimulate

the recovery of selective cognitive and psycho-behavioural aspects. Motivation to treatment and positive predisposition towards music may predict such an improvement. In this regard, the case represents a special model of AMT in VCI-ND.

Limitations

The limitation of this study may be the description of a single case. It is great interest to verify the effectiveness of AMT in patient groups with clinically homogeneous VCI-ND.

Conclusion

A well-structured AMT intervention may positively and stably influence cognition and behaviour. Controlled randomized studies are needed to confirm these promising results.

Conflict of interest statement

None declared.

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