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REVIEW

Effects of music and music therapy on mood in neurological patients

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Abstract

Mood disorder and depressive syndromes represent a common comorbid condition in neurological disorders with a prevalence rate that ranges between 20% and 50% of patients with stroke, epilepsy, multiple sclerosis, and Parkinson's disease. Notwithstanding, these conditions are often under-diagnosed and under-treated in the clinical practice and negatively affect the functional recovery, the adherence to treatment, the quality of life, and even the mortality risk. In addition, a bidirectional association between depression and neurological disorders may be possible being that depressive syndromes may be considered as a risk factor for certain neurological diseases. Despite the large amount of evidence regarding the effects of music therapy (MT) and other musical interventions on different aspects of neurological disorders, no updated article reviewing outcomes such as mood, emotions, depression, activity of daily living and so on is actually available; for this reason, little is known about the effectiveness of music and MT on these important outcomes in neurological patients. The aim of this article is to provide a narrative review of the current literature on musical interventions and their effects on mood and depression in patients with neurological disorders. Searching on PubMed and PsycInfo databases, 25 studies corresponding to the inclusion criteria have been selected; 11 of them assess the effects of music or MT in Dementia, 9 explore the efficacy on patients with Stroke, and 5 regard other neurological diseases like Multiple Sclerosis, Amyotrophic Lateral Sclerosis/motor neuron disease, Chronic quadriplegia, Parkinson's Disease, and Acquired Brain dysfunctions. Selected studies are based on relational and rehabilitative music therapy approaches or concern music listening interventions. Most of the studies support the efficacy of MT and other musical interventions on mood, depressive syndromes, and quality of life on neurological patients.

Key words: Music; Listening; Music therapy; Epilepsy; Narrative review; Stroke; Mood; Amyotrophic lateral sclerosis; Depression; Parkinson; Dementia; Multiple sclerosis; Neurological disease; Neurological disorders; Acquired brain injury

Core tip: We conducted a search on PubMed and PsychInfo databases identifying 25 Randomized Controlled Trials or Clinical Controlled Trials regarding the effects of Music Therapy and other musical interventions on mood disorders in neurological patients. Although the Jadad score evaluation revealed a generally poor methodological quality of the research protocols, we found that almost all studies supported the effectiveness of musical interventions in improving mood, depression, quality of life, functional recovery, and neuromotor performances. Therefore Music Therapy and other musical approaches seem to be effective, inexpensive and non-invasive, being that no adverse side-effects were observed.

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INTRODUCTION

Neurology and psychiatry

Neurological diseases are often associated with several behavioral and psychological symptoms that are usually overlooked by neurologists because require diagnostic methods that differ from those used for classical somatic symptoms and are more suitable to the field of psychiatry. On the other hand, psychiatrists do not seem to give an adequate attention to these symptoms considering them as a consequence of a cerebral damage and more pertinent to neurologists. This clinical attitude is historically based on the obsolete and reductive distinction between "organic" and "functional" behavioral disorders introduced by the phrenologist George Combe in 19th century. According to Combe, cerebral diseases were respectively classified depending on the presence or the absence of cerebral lesions and from that time on this terminology has been used to indicate that some behavioral disorders are linked to a neurological damage while others are not. However, the reductionism of Combe's distinction clearly emerges from the clinical observation given that a wide range of nervous system's illnesses with different etiology shows both neurological and psychiatric symptoms. Emotional and behavioral disturbances with a polymorphic symptomatology are often connected to neurological disorders such as Multiple Sclerosis (MS)[1-3], Parkinson's Disease (PD)[4], stroke[5], dementia[6], traumatic brain injury[7], epilepsy[8,9], Amyotrophic Lateral Sclerosis (ALS) and others Motor Neuron Diseases (MND)[10,11], pain syndromes (like headaches) and can be observed even with or without "organic" neurological diseases, thus miming in some cases an idiopathic psychiatric disorder.

Most common psychiatric disorders in neurology are depression, anxiety, maniacal states, and thought and perception disorders. Other psychiatric syndromes that can be seen in persons with neurological disorders are alexithymia, worry, and locus of control[12]. For example, mood disorders are often associated with acute or chronic cerebrovascular pathologies where the most common complications is certainly depression, usually defined post-stroke depression (PSD). The frequency of this syndrome is variable accordingly to different studies with a mean of 40% of the cases[13] and data obtained by numerous studies seem to indicate the presence of multiple etiological factors, both structural-endogenous and environmental-external, that may change depending on the early or late onset of the depressive disorder. In addition, a bidirectional association between depression and neurological disorder may be possible being that depressive syndromes may be considered as a risk factor for certain neurological disorders. As sustained by two recent meta-analysis, depressive syndromes, particularly major depressive disorder (MDD), are associated with a significantly increased risk of stroke[14,15]. On the other hand, lower rates of depression in equally impaired orthopedic patients suggest that PSD may even result from a stroke-specific neurobiological change and not only from a consequence of the psychological distress or the related impairments[16-18].

The second most common neurodegenerative disorder is represented by PD, with a prevalence of 1% of the elderly worldwide population. About 30% of PD patients show clinically significant depressive syndromes and, again, it appears to be also an increased risk for depressed patients to develop PD[19-23].

As far as regard MS, depressive syndromes are psychiatric most common disorders associated to the illness. Among individuals with MS, relative to the general population, lifetime prevalence rates are elevated for MDD (36%-54%), bipolar disorder (13%), anxiety disorders (35.7%), adjustment disorders (22%), and psychotic disorders (2%-3%). Suicide may be at least twice as common[1].

Many reports of depression and its correlation with numerous variables in clinical samples of people with MS have been published. The few population-based studies have reported a high prevalence of depression, despite using different methods of data collection. The lifetime risk of major depression in people with MS has been estimated to be as high as 50% compared to 10% to 15% in the general population[24,25].

In a recent cross-sectional, population-based study conducted in Stockholm county, the authors reported a prevalence rate of depression of 19% [Beck Depression Inventory (BDI) > 13] among patients suffering of MS. It's interesting to note how depressive symptoms were associated with worse self-reported functioning, with poor memory function and with weak sense of coherence (SOC) (referring to "general resistance resources" - capacities that facilitate coping

with stressors). Moreover, the authors suggested to incorporate depressive symptoms or mental health as a standard parameter for assessment and follow-up in clinical MS management[26].

Data from the United Kingdom MS Register, those obtained directly from MS patients, confirmed a high rate of anxiety and depression: over half of the respondents (54.1%) reported anxiety and 46.9% reported a variable level of depression[27]. From this registry data were recently examined about the positive relationships between physical disability, anxiety and depression[28].

Other reports confirmed the need to recognize and treat, having widely effective treatments, several emotional disorders which may worsen functioning and quality of life, decrease treatment adherence, and increase risk of suicide[1].

The prevalence of depressive disorders is higher in MS patients than patients with other chronic disease, suggesting a possible direct effect of the illness on the pathogenesis of the depressive syndromes in addition to the reactive disorder. Some evidences suggested that depression in MS is largely biologically mediated by some of the same processes involved in the immunopathogenesis of this neurologic disease. In particular, the increase in proinflammatory cytokines, the activation of the hypothalamic-pituitary-adrenal axis, and the reduction in neurotrophic factors. Notwithstanding, depression and mood disorders still remain under-diagnosed and under-treated in neurological patients claiming for a bio-psychosocial model be used[29-32].

Music therapy

In last decades, a growing body of evidence in the use of musical intervention in clinical setting have been seen, concerning singing, music listening, musical improvisation, and other musical activities, as long as more structured music therapy (MT) treatments. Given that music engages a variety of brain areas involved in emotion, motivation, cognition, and motor functions, musical interventions have been used to increase socialization and cognitive, emotional, and neuromotor functioning[33-38]. Although the debate on what the boundaries of MT is still going on, different approaches of musical intervention are actually available referring to three principal domains: relational approaches, rehabilitative approaches and music listening.

Relational approaches refer to psychological models and involve both active and receptive techniques[39,40]. The former consist of different musical activities such as free or structured musical improvisation by means of simple musical instruments, singing, songwriting *etc*. that allow patient and therapist to directly interact building a musical relationship[41]. In receptive approaches music imagery and music listening are used to induce psychological beneficial effects and even to evoke and process emotions and thoughts[40].

Rehabilitative approaches, such as Neurologic Music Therapy (NMT)[42] refer to neuroscientific models and use primarily the potential of musical stimuli to activate perception and production areas in the human brain, providing a series of therapeutic applications to sensory, cognitive, and motor dysfunctions resulting from neurological disorders. Using directive approach based on a series of exercises, NMT may be used, for example, to improve gait and movements in post-stroke and PD patients[43-47] and language in persons with aphasia[48,49].

On the other hand, simple music listening interventions don't require neither a specifically trained therapist nor a direct therapeutic relationship with the patient being that beneficial effects are induced by the content of the musical stimuli and by the activity of listening itself. For these reasons, this practice is sometimes defined with the term "Music Medicine" rather than "MT"[41,50,51]. Notwithstanding, listening interventions seem to be quite common in clinical literature, usually based on self-selected or other-selected music proposed individually[52,53] or in group, as in the case of background music[54,55].

As far as regard neurological disorders, MT may promote functional recovery and also improve social and psychological outcomes such as socialization, motivation, mood, and depression[56]. Literature in this field shows that most of the musical interventions are currently used in clinical practice, being that the majority of the interventions are based on a combination of rehabilitative and relational techniques. Also music listening seems to be a common practice in neurological rehabilitation. Due to the possible side effects of pharmacological treatment of depressive syndromes following neurological disease, music and MT may represent a valid support in reducing depressive symptoms, improving mood and adherence to treatment while contributing to the functional recovery at the same time.

RESEARCH

PubMed and PsychInfo databases were considered for articles to include in the current narrative review. The research has been conducted by three independent reviewers using the following search terms: ("Music" OR "MT") AND (name of pathology) AND ("Mood" OR "Depression"). Names of pathologies where used alone or in combination with "OR" Boolean operator and included: "Stroke", "Parkinson", "Dementia", "Epilepsy", "ALS", "MS", "Cerebral palsy", "Neurological disease", and "Acquired brain injury".

We included only Randomized Controlled Trials (RCTs) or Clinical Controlled Trials (CCTs) studies in English language published in peer-reviewed journals between 1st January 1997 and 31st May 2014. Importantly, we considered only trials including outcomes concerning mood or depression where experimental conditions were clearly stated and consisted only or primarily of musical activities.

Assessments of methodological quality of selected studies have been provided using Jadad score[57]. Jadad scale is based on 7 items that evaluate three main characteristics of a clinical trial: the random assignment, the double-blinding of assessments, and the flow of participants. Scoring ranges from a minimum of 0 to a maximum of 5 points where a score of 3 indicates a good quality study. Being that 2 points on 5 are scored for double-blinding and none of the included studies had double-blinding assessment, the maximum possible score was 3. Even if it doesn't take into account allocation concealment and has been criticized for placing too much emphasis on blinding[58], Jadad scale represents a simple, easy and common way to evaluate the methodological quality of a clinical trial with good validity and reliability[59]. Due to the heterogeneity of the outcomes, no meta-analysis was carried out.

DESCRIPTION OF SELECTED STUDIES

A total of 464 records resulted from the search of which 301 from PubMed and 163 from PsychInfo. Twenty-five articles that met the inclusion criteria have been found and were included in the current review. Most of the selected studies are related to dementia (44%) and stroke (36%) while others regard MS, ALS/motor neuron disease, PD, Chronic quadriplegia, and acquired brain dysfunctions (20%). Fourteen studies (56%) employed a relational approach including both active and receptive techniques, six studies (24%) adopted a rehabilitative approach, and five (20%) concerned music listening interventions. Activities were conducted by trained music therapists in the most part of the experimental interventions. As far as regard the methodological quality of included studies, our analysis showed that only nine on twenty-five (36%) of the included studies received a Jadad score of 3 and thus can be considered of good quality. Five studies (20%) had a Jadad score of 2, three studies (12%) a score 1, and eight studies (32%) were evaluated with a score of 0. Results of the methodological assessment pointed out a general poor rigor in research protocols.

In the following subsections, results are presented through a subdivision of the selected studies by pathology (Tables 1-3).

Effects on dementia

Eleven studies assessed the effects of music and MT on dementia[60-70]. Eight studies employed a relational approach[60-61,63-65,68-70] based either on active or receptive techniques or a combination of both of them. Two studies concerned music listening interventions[62,67] and one study adopted a rehabilitative approach[66]. In most cases the results show a positive effect on mood, depression, and anxiety. Two studies revealed no significant effect of musical intervention[64,66] while in three studies both experimental and control group improved emotional and behavioral functioning in the same way[65,67,69]. Characteristics of the studies and main results have been summarized in Table 1.

Effects on stroke

Nine studies assessed the effects of music or MT on post-stroke patients[71-79]. Four of them were based on a relational approach[71,72,76,77], three regarded music listening interventions[74,75,78], and two used a rehabilitative approach[73,79]. All studies show a positive effect of music or MT on mood in patients with Stroke. For a synthesis of studies and results please see Table 2.

Effects on other neurological disorder

Five studies concerning other neurological disorders such as MS, ALS/motor neuron disease, PD, Chronic quadriplegia, and Acquired Brain dysfunctions, have been found[80-84]. Three studies concerned a rehabilitative approach[80,82,84] and two studies adopted a relational approach using an active technique[81] or both active and receptive techniques depending on what the therapist deemed appropriate in consultation with the patient[83]. All studies but one[83] reported positive effects of music and MT on outcomes as mood, depression, anxiety, and quality of life. Characteristics of the studies and main results have been summarized in Table 3.

DISCUSSION

In the last few decades, the development of neuroscience demonstrated that the brain isn't a static structure only influenced by genetic determinants but it is a plastic organ that continuously reorganizes synaptic connections under the influence of inner and outer factors such as genetic programs, environmental stimulation, learning and expertise[85-87].

Neurological illnesses that provoke behavioral disturbances might originate from both endogenous and external causal factors thus determining, depending on the circumstances, a more "structural" or a more "environmental" etiology. The mutual interaction between these factors occurs in the brain and gives rise to a variety of psychiatric disorders that can be distributed upon a continuum, on one end of which are behavioral disturbances clearly linked to neuroanatomic and neurochemical alterations while on the opposite those more associated to the environment.

Synaptic functions and neuroanatomic structures are proper "organic" factors that determine those alterations that are usually treated by neuropsychiatry and biological psychiatry. Behavioral disorders resulting from these factors include psychiatric syndromes that are linked to alterations of the neural transmission caused by receptor's abnormalities and by modifications of the synaptic concentrations of one or more neurotransmitters. Given that neurotransmitters regulate the neural impulse transmission processes into neurotransmitter systems, with a widespread projection in the

Table 1 Characteristics of the included studies concerning effects on dementia

Ref.	Design/ (Jadad)	Subjects	Diagnosis	Intervention	Professionals	Frequency	Outcome measures	Results
Ashida[60]	CCT (0)	20	Dementia	Playing percussion instruments and listening to live songs performed by the therapist	Music therapist	Five daily session of about 40 min each in a single week	CSDD	Significant reduction of depressive symptoms ($P < 0.05$)
Choi *et al*[61]	CCT (1)	20	Dementia	Singing songs, analysis of libretto, making musical instruments, playing instruments, song drawing, and song writing	Music therapist	50 min, 3 times 1 wk for 5 wk (15 sessions)	MMSE, GDS, GQoL, NPI-Q	Positive trends for GDS and GQoL in music group. Improvements in BPDS ($P = 0.004$) and caregiver distress ($P = 0.003$)
Guètin *et al*[62]	RCT (3)	30	Dementia (Alzheimer's type)	Weekly sessions of individual, self selected music listening. Control group underwent reading sessions	Not specified therapist	Once 1 wk for 18 mo for 20 min	HRSD, GDS	Significant improvements in anxiety and depression ($P < 0.01$) in the music therapy group
Raglio *et al*[63]	RCT (3)	20	Dementia	Active-intersubjective approach, based on sonorous-musical improvisation. Control group took part in educational and occupational activities without music	Music therapist	2 times a week for 15 wk for 30 min	ECG Holter, MMSE, ADAS-Cog test, NPI, ADL, IADL	Significant improvement of depression symptoms ($P = 0.02$) and increase of HRV ($P = 0.013$)
Cooke *et al*[64]	RCT (3)	47	Dementia	Musician-led familiar song singing and music listening. Control group participated in reading sessions	Musicians	3 mornings 1 wk for 8 wk for 40 min	DQOL, GDS, MMSE	Not significant effects on GDS and QOL. Positive trends in music group at sub-analysis
Fischer-Terworth *et al*[65]	CCT (0)	49	Dementia	Singing in group with the therapist, playing elementary musical instruments and listening to biographically relevant music. Control group participated in a nonspecific occupational therapy	Not specified	Once 1 wk for 6 mo for 45 min	NPI, ICEA-D, MMST, GDS	Depression decreased in both groups ($P < 0.05$). Improvements of NPI and ICEA-D ($P < 0.01$) in favor of music group No effects on mood. Improvements ($P < 0.05$) for MPI, MPD, attentional matrices
Ceccato *et al*[66]	RCT (3)	50	Dementia	Cognitive and sensorial exercises associated with musical stimuli	Music therapist	2 times 1 wk for 12 wk for 45 min	NPI, MPD, ADL, SVAM, GMP, MMSE, CMAI, GDS	No effects on mood. Improvements ($P < 0.05$) for MPI, MPD, attentional matrices, ADL, SVAM, and GMP
Janata[67]	RCT (3)	38	Dementia	Preferred music listening. Control group was incidentally exposed to the music programming in the course of daily life	Music therapist	Every day for 12 wk from 21 to 65 min	NPI, CMAI, CSDD, MMSE	Reduction of CSDD, NPI, and CMAI score in both groups ($P < 0.0001$)
Clément *et al*[68]	RCT (2)	14	Dementia (Alzheimer's type)	Listening to music and playing hand-drums over recorded music. Control group underwent cooking activities. Both groups alternated receptive and productive phases	Psychologist with no musical experience	2 times 1 wk for 4 wk for 1 h	BEHAVE-AD, PSMS, SIB. EFE, Discourse contents and STAI-A	Short time effects of emotional indices ($P < 0.05$) and longer term effects of mood ($P < 0.05$) up to 4 wk after the end of the treatment
Narme *et al*[69]	RCT (2)	48	Dementia	Listening to music, singing and playing percussion instruments. Control group took part in cooking activities. Both groups alternated receptive and productive phases	Psychologist with no musical experience	2 times 1 wk for 4 wk for 1 h	SIB, NPI, CMAI, MMST, EFE, Discourse contents and STAI-A	Both group improved in emotional state, NPI score, and professional caregiver distress at different evaluation periods ($P < 0.05$)
Chu *et al*[70]	RCT (3)	104	Dementia	Song choice, music-prompted reminiscence, singing, music listening, and instrument playing	Music therapist	Two sessions per week for 6 wk for 30 min	C-CSDD, salivary cortisol, MMSE	Short time effects on depression ($P < 0.001$) and long time effects on cognition at 1 mo follow-up ($P = 0.039$)

ADAS-Cog: Alzheimer's Disease Assessment Scale-Cognitive Subscale; ADL: Activities of daily living; BEHAVE-AD: Behavioral Pathology in Alzheimer's Disease Scale; CCT: Controlled Clinical Trial; CMAI: Cohen-Mansfield Agitation Inventory; CSDD: Cornell Scale for Depression in Dementia; C-CSDD: Chinese Cornell Scale for Depression in Dementia; DQOL: Dementia Quality of Life; ECG Holter: Electrocardiography Holter; GDS: Geriatric Depression Scale; GMP: Good Manufacturing Practice; GQoL: Geriatric Quality of Life; HRSD: Hamilton Rating Scale for Depression; IADL: Instrumental Activities of Dailiy Living; ICEA-D: Inventory to Asses Communication, Emotional Expression and Activity in Dementia; MMSE: Mini-Mental State Examination; NPI: Neuropsychiatric Inventory; NPI-Q: Neuropsychiatric Inventory Questionnaire; RCT: Randomized Controlled Trial; SVAM: Metacognition Assessment Scale.

Table 2 Characteristics of the included studies concerning effects on stroke

Ref.	Design/ (Jadad)	Subjects (*n*)	Diagnosis	Intervention	Professionals	Frequency	Outcomes measures	Results
Purdie *et al*[71]	RCT[1] (0)	40	Stroke	Playing familiar or improvised music with the therapist by means of percussion instruments, synthesizers, or voice	Music therapist	Once a week for 12 sessions lasting 30-40 min each	FAST, HADS, MBRS, NRS	Positive trends in communication skills, behavior and psychological state in treatment group (not significant result)
Nayak *et al*[72]	RCT[2] (0)	18	Stroke or TBI	Singing, playing instruments, composing, improvising, listening	Music therapist	2 or 3 sessions a week during the hospitalization up to a maximum of 10 sessions	Face Scale, VAS, SIP, questionnaire	Positive trends in mood and significant improvements in social interaction ($P < 0.02$) and involvement in therapy ($P < 0.01$) in experimental group
Jeong *et al*[73]	RCT (2)	33	Stroke	Rhythmic motor activity with music based on Rhythmic Auditory Stimulation (RAS) theory (Neurologic Music Therapy)	Instructors	One weekly session of 2 h for 8 wk	ROM, POMS, SS-QOL, exit interview	Improvement in mood states and interpersonal relationship, flexibility, and range of joint motion ($P < 0.05$)
Särkämö *et al*[74]	RCT (3)	60	Stroke	Treatment group underwent preferred-music listening.A second group received self-selected audio book listening while a third control group had no listening material	Music therapists	Every day for 2 mo for 1 h (at minimum)	RBMT, WMS-R, BDAE, CERAD, Token test, BVRT, MBEA, FAB, POMS, SAQUOL-39	Improvements in depression ($P = 0.024$) and positive trends in confused mood with cognitive recovery (verbal memory and focused attention) in music listening group
Forsblom *et al*[75]	RCT(3)	39	Stroke	Preferred music listening. Control group underwent audio-book listening	Music therapist	Every day for 2 mo for 1 h (at minimum)	Analysis of patient's interviews	Improved mood, better relaxation, increased motor activity in music listening group ($P < 0.0001$)
Kim *et al*[76]	CCT (0)	18	Stroke	Hello song and sharing of events in their lives (5 m), planned musical activities (30 m) and sharing feelings and goodbye song (5 m)	Not specified therapist	Twice a week for 4 wk for 40 min	BAI, BDI, questionnaire of satisfaction	Improvement in depression ($P = 0.048$) and positive trends for anxiety
Jun *et al*[77]	RCT (2)	40	Stroke	Stretching exercises while listening to music, singing and/or playing songs on percussion instruments, and final verbalization	Researchers and music therapist	Three times per week for 8 wk for 60 min	ROM, K-MBI, K-POMS-B, CES-D	Improvements in mood states ($P = 0.04$) and increase in the degree of shoulder ($P = 0.03$) and elbow ($P = 0.04$) joint flexion
Chen *et al*[78]	CCT (0)	19	Stroke	Self-selected individual listening in two different conditions: pleasant music and unpleasant music. A white noise condition acted as control	Not specified	1 session for each condition, separated by no more than 1 wk[3]	VAS, HR, GSR, SCT, LBT, PST, visual task	Improvement of mood ($P = 0.03$) and arousal ($P < 0.001$) under pleasant music condition
Van Vugt *et al*[79]	RCT[4] (1)	28	Stroke	Play fingers exercises and children's song on the piano	Music therapist	10 therapy sessions for 3/4 times a week for 30 min	9HPT, Finger tapping measurements, POMS	Reduction of depression ($P = 0.002$) and fatigue ($P = 0.02$) and improvement in the synchronization tapping ($P < 0.05$)

[1]Subjects expressing a clear preference for treatment (25% of total) were allocated to music therapy while all others were randomly assigned to either treatment or control group; [2]The goal of random assignment was not fully achieved because of the need to have 2-3 subject available at the same time to held group session in the treatment condition; [3]Subjects heard 1 min of music or noise and after were given all assessments while they were continuously exposed to the sound up to the end of the evaluation; [4]Patients were quasi-randomly assigned to groups making sure that the two groups were as close as possible in terms of numerosity and clinical characteristics of participants. 9HPT: Nine-Hole Pegboard Test; FAST: Frenchay Aphasia Screening Test; HADS: Hospital Anxiety and Depression Scale; MBRS: Musical Behaviour Rating Scale; NRS: Neurobehavioural Rating Scale; VAS: Visual Analogue Scale; SIP: Sickness Impact Profile; ROM: Range of Motion; POMS: Profile of Mood State; SS-QOL: Stroke Specific Quality of Life Scale; RBMT: Rivermead Behavioural Memory Test; WMS-R: Wechsler Memory Scale-Revised; BDAE: Boston diagnostic aphasia examination; CERAD: Consortium to Establish a Registry for Alzheimer Disease; BVRT: Benton Visual Retention Test; MBEA: Montreal Battery of Evaluation of Amusia; FAB: Frontal Assessment Battery; POMS: Profile of Mood State; SAQUOL-39: Stroke and Aphasia Quality of Life Scale-39; BAI: Beck anxiety inventory; BDI: Beck Depression Inventory; ROM: Range of Motion; K-MBI: Korean-Modified Barthel Index; K-POMS-B: Korea-Modified Profile of Mood States-Brief; CES-D: Center for Epidemiologic Studies Depression Scale; HR: Heart Rate; GSR: Galvanic Skin Response; SCT: Star Cancellation Test; LBT: Line Bisection Test; PST: Picture Scanning Test; POMS: Profile of Mood State.

brain, the whole emotional, motivational, and affective state of the person will be altered[88,89].

Table 3 Characteristics of the included studies concerning effects on other neurological disorders

Ref.	Design/ (Jadad)	Subjects (*n*)	Diagnosis	Intervention	Professionals	Frequency	Outcomes measures	Results
Pacchetti *et al*[80]	RCT (2)	32	Parkinson's Disease	Relaxing music, choral singing, breathing/voice exercises, rhythmic movements, collective improvisation, body expression to music. Control group underwent specific motor exercises	Music therapist	Once a week for 3 mo for 2 h,	HM, MS, PDQL, UPDRS	Improvement in emotional ($P < 0.0001$) and motor ($P < 0.034$) functions, activities of daily living, and quality of life ($P < 0.0001$)
Schmid *et al*[81]	RCT (0)	20	Multiple Sclerosis	Active role of both patient and music therapist on playing instruments or singing (Nordoff-Robbins approach)	Music therapist	3 blocks of individual sessions (8 to 10 sessions per block) over the course of 1 yr	BDI, HADS, SESA, HAQUAMS, MSFC	Not significant differences between groups but medium effect size on depression ($d = 0.63$), self esteem ($d = 0.54$), and anxiety ($d = 0.63$)
Thaut *et al*[82]	CCT (0)	54	Acquired brain dysfunctions	Group improvisation, singing, synchronization, attention, and memory exercises with music (Neurologic Music Therapy). Control group spent an equal amount of time resting	Music therapist	4 group sessions on different days for 30 min each	WAIS-III, AVLT, TMT-B, BSI-18, MAACL, SEQ	Improvements on depression ($P = 0.02$), anxiety ($P = 0.04$), sensation seeking ($P < 0.01$), and executive functions (mental flexibility) ($P < 0.01$)
Horne-Thompson *et al*[83]	CCT	21	ALS/Motor neuron disease	Music relaxation, playing/ singing familiar songs, and music and imagery. A second group received a listening intervention of self-selected music while a third control group underwent activities such as reading or watching TV	Music therapist	3 d per week for 30 min each condition	HADS, ESAS, HR, oxygen saturation levels	No effect was found on depression, anxiety, heart rate, and oxygenation levels between groups
Tamplin *et al*[84]	RCT (3)	24	Chronic Quadriplegia	Oral motor and respiratory exercises and therapeutic singing (Neurologic Music Therapy). Control group received group music appreciation and relaxation	Not specified	3 times weekly for 12 wk for 1 h	Standard respiratory function testing, EMG, PVP, POMS, AQoL	Both groups improved in mood ($P = 0.002$). The singing group showed positive effects on arousal ($P = 0.006$), speech intensity ($P = 0.028$), and maximum phonation length ($P = 0.007$)

HM: Happiness Measure; MS; Motor Subscale; PDQL: Parkinson's Disease Quality of Life Questionnaire; UPDRS: Unified Parkinson's Disease Rating Scale; BDI: Beck Depression Inventory; HADS: Hospital Anxiety and Depression Scale; SESA: Self-Acceptance Scale; HAQUAMS: Hamburg Quality of Life Questionnaire in Multiple Sclerosis; MSFC: Multiple Sclerosis Functional Composite; WAIS-III: Wechsler Adult Intelligence Scale-III; AVLT: Auditory Verbal Learning Test; TMT-B: Trial Making Test Part B; BSI-18: Brief Symptoms Inventory-18; MAACL: Multiple Affect Adjective Check List; SEQ: Self Efficacy Questionnaire; HADS: Hospital Anxiety and Depression Scale; ESAS: Edmonton Symptom Assessment System; HR: Heart Rate; EMG: Electromyogram; PVP: Perceptual Voice Profile; POMS: Profile of Mood State; AQoL: Assessment of Quality of Life.

External causal factors related to the environment may promote and characterize those behavioral disorders that are commonly counted accordingly to a bio-psychosocial model and interfere with the cognitive and emotional state of the person thus inducing an important change in the quality of the inter-individual relationships. These disorders may be considered as a reaction to the physical disability and the psycho-social difficulties produced by the disease but also as an adjustment disorder if we consider the impact of the diagnosis on patient's life, or the weight of a chronic illness and all the other factors that may affect patient's quality of life[90-92].

Depressive syndromes in chronic neurological illness are common and disabling. Their etiology is complex and may be multifactorial. Good history taking and detailed examination of physical and mental state (including cognitive function) will usually reveal the diagnosis and the formulation.

Providing a correct diagnosis of an emotional disorder and starting an appropriate treatment may help physicians to increases in function and quality of life of their neurological patients[93].

The current review showed how MT and musical interventions can improve mood and psychological well-being in neurological patients. These clinical results are in accordance with the literature that highlights the effects that music listening and music making have on brain structures of emotion regulation[36], on various neurochemical systems[38], and on neural plasticity[94,95]. However, the strength of this review's findings is limited due to a generally poor methodological quality of the studies and the restricted size of samples. Moreover, the heterogeneity of the outcomes prevented any meta-

analysis. Notwithstanding, the analysis of the 25 RCTs or CCTs included in this work points out a positive effect of interventions with music on psychosocial outcomes such as mood, depression, and quality of life when compared to standard care or other treatments.

CONCLUSION

Music-based activities can represent a valid and without side effects intervention for reducing psychological and behavioral disturbances related to neurological disorders and also for promoting the functional recovery. Specifically, the most significant results of the music interventions on the psychological side can be identified in the aspects more closely related to mood, especially in the reduction of the depressive and anxiety's component, and in the improvement of the emotional expression, communication and interpersonal skills, self esteem and quality of life. As revealed in advance, the efficacy of music and MT interventions could be explained by different points of view. From the neurochemistry point of view we know that music can activate limbic and paralimbic structures, such as the amygdala, the hippocampus, the nucleus accumbens, etc. that function abnormally in patients with a high depressive component. At the psychological level music can engage several social functions, can increase communication and social cohesion and can promote empathetic relationships, especially in the active MT approaches. Finally, from the rehabilitative point of view, making music can involve and influence motor areas functioning and regulation. This effect appears to be connected to the pleasure and thereby can positively affect the mood and consequently the rehabilitative process[36-38].

In conclusion, a more methodological rigor and a clearer definition of music approaches are needed to improve the quality of MT research and to focus on the specific role of music-based interventions in psychological symptoms in the field of neurology.

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