Journal of Affective Disorders 156 (2014) 150–155

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research report

The impact of depression on musical ability

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ARTICLE INFO

Article history:
Received 13 February 2012
Received in revised form
2 December 2013
Accepted 2 December 2013
Available online 16 December 2013

Keywords:
Music
Depression
Musical ability

ABSTRACT

Background: While there is sustained effort to refine the models and to further decrypt the neuronal underpinnings of cerebral music perception, empirical investigations on the associations of music perception with diagnoses others than focal brain damage need to be amplified.
Methods: In the present study, a validated and standardized clinical test of musical ability was applied to a sample of severely depressed patients. Basic musical capacities of rhythm, melody and pitch perception, recognition of emotions, and musical memory were evaluated and compared to matched healthy controls and reassessed in a follow-up examination after clinical remission.
Results: We enroled 21 in-patients with major depression according to ICD-10 (F32 and F33). The score in the test of musical ability (maximum score 70) was 52.3 ± 7.8 for the patient group and 57.8 ± 4.3 for the control group ($p=0.010$). In particular, melody comparison, rhythm perception, and emotional categorising of music were impaired in patients. In the longitudinal study, patients improved from 53.6 ± 7.8 to 56.2 ± 6.7 ($p=0.038$); this improvement could be related to clinical improvement on the Hamilton Depression Scale.
Limitations: The sample size is small, in particular in the follow-up study.
Conclusions: The results clearly revealed a significant reduction of musical ability in patients with depression. A part of the patients could even be diagnosed with a clinically relevant amusia. Along with significant decrease of depressive symptoms, the patients significantly improved with respect to musical ability. These findings suggest a systematic impact of depression on musical ability, they are of importance for the application of music therapy in depressive patients and for the function of music to improve their quality of life.

1. Introduction

Music is an integral part of human history since our very early days as a species (Fitch, 2006). Particularly, neurosciences throughout their history appreciated the relevance of investigations on cerebral musical functions as one key to a better understanding of the human brain. Due to technical innovations and improved methodology, especially the last three decades have seen a rapid growth of knowledge in this field.

In this context, the pathology of the musical brain is one focus of research. Traditionally, patients with localised brain damage resulting from stroke or surgery predominantly served as subjects for case reports. These reports and their reviews have contributed greatly to the development of models and concepts of music perception and processing (e.g., Alossa and Castelli, 2009). Substantiation of the models and localisation of certain functions or deficits has been accomplished by imaging techniques (Peretz and Zatorre, 2005; Koelsch, 2011). Test batteries have been designed to further quantify the incidence and the degree of impairments in certain diagnoses (Peretz et al., 2003; Lorenz, 2000; Schuppert et al., 2000).

On the one hand, the efforts outlined helped to develop an increasingly concise model of the neuronal substrates of musical capacities. Music perception and processing is underpinned by a vast modular network involving regions in almost every part of the brain. This network is hierarchically organised and parallels language in its complexity. Some of its modules show (double) dissociations from each other and from other brain functions (Warren, 2008; Levitin and Tirovolas, 2009). Just alike other domains expertise and training lead to physiological and neuroanatomical changes reflecting the plasticity of the system (Gaser and Schlaug, 2003; Pantev et al., 2009).

On the other hand, it has been demonstrated that various pathological conditions handicap or completely disrupt musical abilities. Focal lesions in parts of the musical network either selectively impair single functions or beyond that interfere with subsequent stages of processing. Congenital forms of amusia have been identified (Peretz et al., 2003). Partial deterioration of musical memory seems to

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http://dx.doi.org/10.1016/j.jad.2013.12.010

occur in progressive degenerative brain diseases (Quoniam et al., 2003; Hsieh et al., 2011).

The influence of psychopathology has also been investigated. Steinberg and colleagues published a series of studies on receptive and productive musical capacities in musically trained psychiatric patients. They observed a decrease in tempo of instrumental performances by part of their depressive subjects probably reflecting psychomotor retardation (Steinberg and Raith, 1985). Depressive patients also showed impairments of their musical expression which was reversible with remission (Steinberg et al., 1985). This equally applied to music therapeutic utterances of musically untrained patients (Steinberg et al., 1991). The impairments were found to depend almost exclusively on reduction of expressive skills while performance features which depended mainly on education and actual training seemed to be robust even in severe conditions (Steinberg et al., 1992).

More evidence comes from several technically sophisticated studies on auditory processing of non-speech stimuli in patients with Major Depressive Disorder. Michael et al. (2004) reported abnormal auditory habituation patterns measured by functional magnetic resonance imaging (fMRI) after repeated tonal stimulation in a small group of depressed patients. These results were confirmed and further specified by Tollkötter et al. (2006) who observed a stronger disturbance of processing of tonal signals than of speech (vowels) by means of magnetic resonance spectroscopy and magnetoencephalography. They also reported evidence for a partial reversibility after successful antidepressive drug therapy. Conversely, Christ et al. (2008) found alterations in auditory processing of non-speech stimuli to persist after successful electroconvulsive therapy (ECT) and improvement of clinical symptoms. Thus, it remains to be clarified to what extent these phenomena are due to effects on sensory processing or to generalised cognitive and attention deficits known in Major Depression even after remission (Austin et al., 2001). The alterations of reward processing systems associated with depression also seem to influence music perception. By means of fMRI, Osuch et al. (2009) revealed differences in brain activation to music, rated as favourite versus neutral by the subjects beforehand, in depressive patients, and normal controls.

Hence, the literature available suggests a possible association of depressive disorders and disturbed basic musical capacities at several levels. We hypothesised that severe depression systematically and reversibly compromises these capacities. In order to empirically validate our hypothesis, we applied a clinical test of musical ability to a group of depressive patients. Comparison with matched data of healthy controls was made, and in a longitudinal approach the development of test results in the course of antidepressive drug therapy was assessed.

2. Methods

2.1. Subjects and procedure

We enroled 21 patients presenting with an acute episode of moderate or severe depression, either as current episode of a recurrent condition or as primary diagnosis. Diagnosis was ascertained according to the criteria of the ICD-10 by two experienced psychiatrists based on clinical impression and review of medical records, respectively.

Patients were hospitalised at the Department of Psychiatry of the University Hospital Münster or at the Westphalian Clinic for Psychiatry, Münster. Exclusion criteria were age below 18 or above 60 years, hearing impairment, history of stroke or other neurological disease (e.g., epilepsy, dementia), bipolar disorder, psychotic symptoms, alcohol or drug dependency, and ECT within 4 weeks prior to testing.

The experimental sessions were performed within an average of 20 days after admission to the ward and after the patients reached a certain extent of stability in their new environment. All patients were under psychopharmacological and psychotherapeutic treatment. Medication at the respective time of assessment was documented. Prior to testing, all patients underwent a complete neurological examination. For those 14 patients who participated in the longitudinal study, follow-up data were obtained when the responsible psychiatrist reported relevant improvement of depression severity, which occurred within an average of 30 ± 6 days after the first session.

All patients and control subjects were interviewed for general education, profession, musical training, and family history of depression. In the patient group general school education ranged from none to university degree. Musical training could be categorised in four degrees from completely inexperienced ($n=1$), musical education at school ($n=9$), amateur training for less ($n=10$), or more than 10 years to professional ($n=1$).

A group of 21 volunteers matched with regard to sex and age served as normal control subjects. They were healthy without any neurological or psychiatric disorders. The control subjects were recruited among hospital staff and among waiting relatives in a neurological outpatient department. Exclusion criteria were hearing impairment, psychotropic medication, and professional musical skills. In this group, all participants had only musical education at school ($n=11$) or amateur training for less than 10 years ($n=10$).

Informed consent was obtained from all participants and the study was approved by the Ethics Committee of The Faculty of Medicine, University of Münster, Germany, within a study programme on musical ability in neurological disorders.

2.2. Depression and anxiety/affect evaluation

In order to operationalise the severity of depression, several established psychometric instruments were applied. The responsible psychiatrist evaluated his/her patients' depression according to the Hamilton Depression Rating Scale (HAM-D) (Hamilton, 1960). Evaluation according to the HAM-D was carried out within 8 days to the administration of the music test.

Moreover, the patients answered standardized questionnaires of self-assessment shortly before the test, thus providing information about their affective state at the exact time of testing. These were the German versions of the Anxiety Sensitivity Index (ASI) (Reiss et al., 1986; German version by Alpers and Pauli, 2001), the State-Trait-Anxiety-Inventory (STAI) (Laux et al., 1981), and the Positive and Negative Affect Schedule (PANAS) (Krohne et al., 1996).

2.3. Testing musical ability

The clinical test of musical ability allowed us to assess basic musical capacities of the patients. This test battery, designed to address diverse components of music perception and processing, has proven to be sensitive in detecting impairments of musical brain functions and has been validated in a group of patients with mono- or multifocal stroke lesions and normal controls (Lorenz, 2000). The test is based on a set of audio samples in standardized sequence which were played to the subjects in a quiet surrounding, using a laptop and high quality headphones. The test results in a total score of 70 (the higher the score the higher the musical ability) with a high ceiling effect (i.e., the average score of healthy subjects is about 80%).

The clinical test of musical ability consists of the following five subtests:

(1) *Perception and reproduction of rhythm and metre.* Target patterns in the form of bongo drum rhythms were played to the