A case of musical agraphia

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Damage to the left upper parietal lobule causes pure agraphia. However, we experienced a patient who exhibited musical agraphia following such a lesion after the agraphia improved. The patient was a 53-year-old female piano teacher. After surgery, she exhibited agraphia and musical agraphia. There was no expressive amusia, receptive amusia, aphasia, agnosia or apraxia. Fifteen months post-surgery, when her agraphia had resolved, her abilities to read, write, and copy music were evaluated. She could read and write single notes and musical signs, but her ability to write a melody was seriously impaired. Furthermore, the salient impairment was in writing rhythm rather than pitch. She could copy music, but only slowly. We consider her a case of pure musical agraphia. *NeuroReport* 11:3053–3057 © 2000 Lippincott Williams & Wilkins.

Key words: Amusia; Left upper parietal lobule; Musical agraphia; Short-term memory

INTRODUCTION

Music impairment due to brain damage is known as amusia. Amusia can be classified in the same way as aphasia, and broken down into expressive amusia, receptive amusia, musical alexia and musical agraphia [1]. Because few people have the ability to read and write music, neuropsychological studies of the disruption of music ability have focused mainly on expressive and receptive abilities, rather than on these skills; only 12 cases of musical agraphia have been reported in the literature [2]. In addition, musical agraphia without aphasia is rare, and has been reported only by Dejerine [3], Charcot [4] and Dorgeuille [5].

We present the case of a piano teacher who suffered from musical agraphia without musical alexia following a left upper parietal lobule lesion. Her ability to read and write music was examined in detail, and the intracerebral mechanism of reading and writing music was considered.

SUBJECT, METHODS AND RESULTS

Case report: The patient was a 53-year-old right-handed female [6]. She began piano lessons in junior high school. In the second grade of high school she began taking vocal and solfège (fundamental training in reading and writing music) lessons, as she wished to study in a college of music. She passed the college entrance examination directly on graduation, and completed college in the normal 4 years. After graduation, she established her own private piano school, and began teaching vocal and piano lessons. At the age of 30, she developed a laryngeal polyp and could no longer sing well, so she devoted herself to teaching piano. She was a good teacher of piano and voice, and several of her pupils passed the entrance examination for the vocal course at music colleges.

In August 1996, she developed a venous aneurysm of a lower extremity. At the same time, a meningioma of her left lateral ventricle was discovered on cranial CT. The neoplasm was enucleated using a high parietal approach in September of the same year. In January 1997 she was transferred to the Department of Neurology of Showa University for further treatment.

On initial examination, right homonymous hemianopsia, right lower extremity sensory disturbance, right hand reaching impairment, verbal memory disorder, acalculia, agraphia and musical agraphia were found, but aphasia, visual agnosia, and apraxia were not recognized. T1-weighted MR images 6 months after surgery showed a tumor scar in the cortical and subcortical white matter of the left upper parietal lobule (Fig. 1).

Neuropsychological evaluation: A neuropsychological evaluation was conducted 6 months after her operation (Table 1). Her intelligence was evaluated using the Japanese version of the WAIS-R. Her verbal IQ was 88 and her performance IQ was 94. A decline in her IQ resulted from acalculia and right hand reaching impairment. The standardized Japanese version of WAB did not detect an impaired ability to read and write letters, but impairment was recognized in her daily activities, such as writing in her diary, for about 6 months postoperatively [7].

Although standardized tests indicated a memory disorder, she remembered daily events very well. The Japanese version of WMS-R showed a verbal memory disorder. Her verbal memory was 68, and her visual memory was 112. There was a marked decline in her scores for digit span and logical memory on the WMS-R. Moreover, there were declines in the first and second trials of the Rey Auditory Verbal Learning Test (AVLT). In view of these points, she

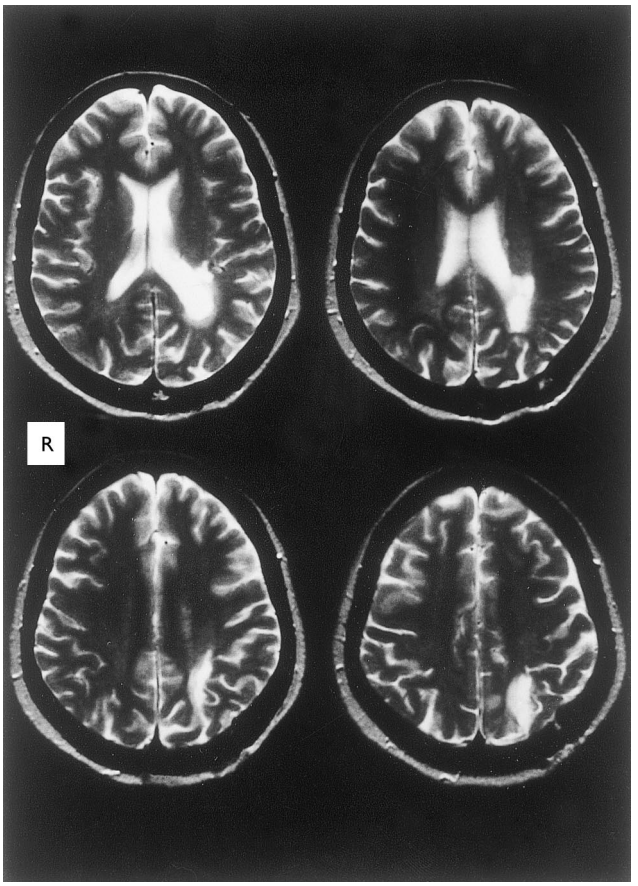

Fig. 1. MRI scan 6 months after surgery showing tumor scar in the cortical and subcortical white matter of the left upper parietal lobule.

was considered to have verbal short-term memory impairment. Constructional apraxia was not apparent. She had an IQ of 80 on Koh's cube examination, and scored 36/36 points in the Rey Complex Figure Test.

Fundamental music ability: Since she did not have absolute pitch, she sang in a movable key. After surgery, she did not go to concerts or listen to recordings actively, but her ability to listen to music was unchanged. She could discriminate between the pitch of two tones, such as a minor second. When she listened to a well-known tune or song, sometimes she could not remember the name of the tune, but she could sing along with it and knew that it was a well-known tune.

We asked her to listen to tunes and count the cadence, in simple triple, quadruple, and sextuple time, for example. She could not count the cadence when she counted silently, but when she counted aloud, such as '1, 2, 3, 1, 2, 3' for triple time music, she answered correctly. The rhythm test of Révész [8] (cited in Umemoto [9]) showed that it was difficult for her to reproduce complicated rhythms. At the time agraphia was evident, and she had clear impairment of her ability to write music signatures, such as a quarter rest. When given a cue, such as the name of a famous song or the piano tune, she could sing the song without mistakes, with the correct rhythm and pitch.

Table 1. The results of a neuropsychological examination conducted 6 months after the operation

WAIS-R	
Verbal IQ	88
Performance IQ	94
Full scale IQ	90
WAB (Western Aphasia Battery)	
Fluency	20/20
Auditory comprehension	9.95/10
Repetition	10/10
Naming	9.7/10
Reading	9.6/10
Writing	9.55/10
WMS-R	
Verbal memory	68
Visual memory	112
General memory	80
Attention and concentration	80
Delayed recall	80
Benton Visual Retention Test	
Correct score	7/10
Error score	5
Auditory Verbal Learning Test	
1st recall	2/15
2nd recall	4/15
3rd recall	6/15
4th recall	8/15
5th recall	10/15
Kohs Block Design Test	
IQ	81
Rey's Complex Figure Test	
Copy	36/36

Although she seldom played the piano after her operation, she could still play, but not as well as before surgery because she had a right hand reaching impairment. Her right hand played the wrong notes and its movement was delayed in comparison with the left hand.

Methods and Results: The patient's ability to read and write music was examined 15 months after surgery, when it was obvious that her agraphia had resolved, both in tests and in daily life. At this time, her right hand reaching impairment and verbal memory disorder were also improved. Agraphia of music, right homonymous hemianopsia, and sensory disturbance of the right lower extremity were the only cardinal symptoms.

Her ability to read single notes, music signs, and unknown melodies was tested. For single notes, various quarter notes were presented individually (Fig. 2a), and she was instructed to name the aural sound. She scored 100% (24/24) correct and her responses were quick. She was then shown individual music signs (Figure 2b) and instructed to name them. Her score was 88% (21/24) correct. When she could not recall the name of the sign, she could give its meaning, such as 'repeat' for 'D.C.' (*da capo*).

To test tonality, she was shown a stave with several flats or sharps (Fig. 2c) and instructed to identify the key. She scored 100% (8/8) correct, and responded quickly.

She was shown four measures of an unknown tune used in the entrance examination of a music high school [10]. We instructed her to sing it 3 min after she was given a tuning sound. Her pitch and rhythm were good. Further-

Fig. 2. Examples of the music reading tasks. (**a**) Single note: Different quarter notes were presented individually, and the patient was instructed to reply with the name of the note in German. Correct answer is 'Fis' (F#). (**b**) Musical signs: Music signs were presented individually, and the patient was instructed to name them. Correct answer is G (treble) clef. (**c**) Tonality: Several flats or sharps were presented in a stave, and the patient was instructed to identify the key. Correct answer is G major or E minor.

more, four people with music experience (three people who played instruments as amateurs for more than 10 years and one college vocal music course instructor) watched a recording of her singing and all judged the patient's singing ability as good. Eight measures of a melody from the entrance examination of the music high school were also presented. She was instructed to write the name under each note and did so perfectly.

From these results, it was clear that there was essentially no impairment in reading single notes, music signs, and melodies.

The patient's ability to write music was examined using single notes, music signs, unknown melodies, and well-known melodies. For single notes, the patient was told the name of a note orally, and was instructed to write it on a staff. She scored 100% (24/24) correct and her responses were quick. She was then told the name of a music sign, and instructed to write it on a staff. She scored 100% (24/24) correct. The mistakes that she made soon after her surgery were not noted this time.

She was played four measures of a melody from the entrance examination of music high school [10] four times, and was instructed to write out the tune. The result is shown in Fig. 3a. Her result is on the bottom, and the correct answer is on the top. Wrong notes are enclosed in boxes. The first measure, consisting of quarter notes was written correctly, the second measure contains the third measure's notes, notes that were not in the tune were added, and a rest was omitted in the second measure.

In a second test before writing down an unknown tune, she learned four measures of the melody until she could play it from memory. The result is shown in Fig. 3b. Although the simple first and second measures were written correctly, the third and fourth measures were incorrect. Each measure was written in four-four time, which was different from the actual rhythm.

She was then instructed to write down a well-known Japanese nursery song 'The Fire' (lyrics by S. Tatsumi, melody by S. Watanabe) from memory. She knew the tune well and could sing it from memory. This melody has a simple rhythm. There are 16 measures of quarter notes, with occasional half notes and dotted half notes. She wrote the pitch and rhythm correctly, but took a long time to complete the task.

She was also instructed to write down a well-known piano melody 'Sonata K. 545' (W. A. Mozart), which she sang from memory. Although she wrote the pitch correctly, the rhythm was notably wrong (Fig. 3c). She knew that this tune was in four-four time, and put her writing in four-four time. Nevertheless, she wrote two measures more than in the actual melody and substituted a dotted half note for a dotted quarter note and a full note for a quarter note.

As a test of her ability to copy music, the subject was instructed to copy a tune used in the entrance examination of the music high school. The tune was in the key of G major and consisted of eight measures. She completed the task perfectly (Fig. 3d), but took a long time.

Summarizing the patient's results, she could read music almost normally. Although she could write single notes and musical signs, she could not write unknown or well-known melodies. She made rhythm errors, rather than pitch errors in writing music. Although she copied music perfectly, she took a long time to complete the task.

DISCUSSION

Only 12 cases of musical agraphia have been reported in the literature [2]. Almost all of these cases exhibited musical agraphia with aphasia. Cases of musical agraphia without aphasia, like our case, are rare; only three cases have been reported [3–5]. Furthermore, the cases reported by Dejerine and Dorgeuille had musical agraphia with musical alexia (Table 2). Therefore, ours is only the second reported case of pure musical agraphia or musical agraphia without musical alexia.

It is known that damage to the left upper parietal lobule, as in the present case, causes pure agraphia [11–13]. Initially, our patient showed both letter agraphia and agraphia for musical signs, which suggests that writing music and writing letters depend on the same proximal nervous background. Moreover, in this case, the inability to write music was more severe than that of just copying, and it took the patient a long time to copy music. These features are recognized in pure alexia. Thus, pure musical alexia and pure alexia have similar symptoms. In the course of improvement, however, only the agraphia for musical score remained. This suggests that writing music has the same mechanism as writing letters, but writing melody has a different mechanism.

Henson [14] identified two types of musical agraphia: the inability to copy music and the inability to write down the tune. Our patient could copy music well, but dictation of melody was disordered. There was a time lag between when the patient listened to the melody and when she wrote it down. Since she was unable to remember the melody, this might imply musical agraphia. Therefore, to examine only her writing ability, we used a tune that she could sing or play from memory. This showed that she could write down neither well-known nor unknown melodies correctly. It is clear that her inability to write down the melody was not the result of a memory disorder.

The patient's ability to read was preserved, and the disorder in writing music affected writing rhythm more severely than writing pitch. Brust [15] reported a disorder of writing pitch, and it is recognized in cases of musical alexia [2,3]. This type of musical agraphia is thought to result from an impaired visual feedback mechanism [2]. A

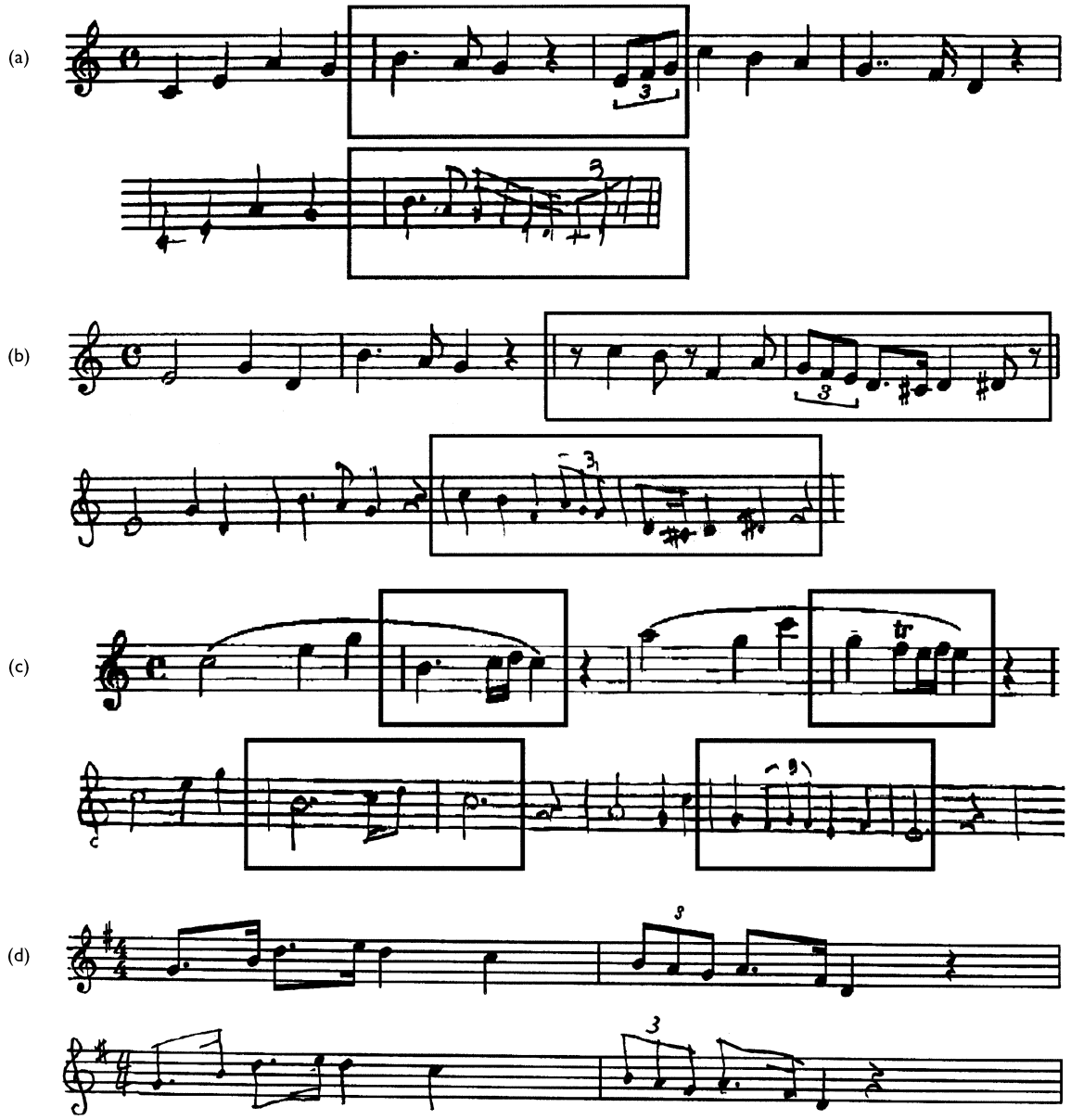

Fig. 3. (**a**) The result of writing unknown melody I: Four measures of a melody used for the entrance examination of a music high school were played on the piano four times, and the patient was instructed to write out the tune. The result is on the bottom, and the correct answer is on the top. Errors are enclosed in boxes. The first measure consisting only of quarter notes was written correctly, but the second measure contains the third measure's notes, there are notes that do not actually exist in the melody, and a rest is omitted in the second measure. (**b**) The result of writing unknown melody II: Before writing down a tune, the patient was asked to learn a melody consisting of four measures until she could play it from memory. Although the simple first and second measures were written correctly, the third and fourth measures were incorrect. Each measure was in four-four time, while the written rhythm differed from the actual rhythm. (**c**) The result of writing a well-known melody: The patient was instructed to write down a well-known piano melody, Sonata K. 545 by W. A. Mozart, which she sang from memory. Although the pitch was written correctly, the derangement of rhythm was remarkable. Since she knew this tune was in four-four time, her writing was in four-four time. Nevertheless, she wrote two measures more than there are in the actual melody and substituted a dotted half note for a dotted quarter note and a full note for a quarter note. (**d**) The result of copying music: The subject was instructed to copy the tune used for the entrance examination of the music high school. The sample was a tune in G major that consisted of 8 measures. She completed the task perfectly, but took a long time to complete it.

different mechanism may well produce the disorder in rhythm writing that was observed in our case.

In this case, both musical agraphia and verbal short-term memory disorder were recognized. It is known that cases of short-term memory disorder following parietal lesions, such as our case, have an impaired short-term memory rehearsal process [6,16,17]. In our case, short-term memory impairment was obvious in her fundamental musical

Table 2. Cases of musical agraphia without aphasia

						Reading		Writing	
Author	Background	Lesion	Aetiology	Aphasia	Amusia	Language	Music	Language	Music
Charcot, 1886 case 2	Trombonist		Syphilis	−	+	−	−	−	++
Dejerine, 1892	Singer, businessman	LOS	Stroke	−	+	++	++	−	+
Dorgeuille, 1966 case 22	Keyboards, singer, violin	LT	Glioblastoma	−	−	+	+	++	++
Present case, 2000	Piano teacher	LP	Tumor, surgery	−	−	−	−	−	++

L, left; O, occipital lobe; P, parietal lobe; T, temporal lobe, AG, angular gyrus; S, splenium.
++, severely impaired;+, mildly impaired; −, unimpaired.

ability. She couldn't count the cadence of a tune silently, but could count it aloud immediately. This inability was thought to arise from an impaired short-term memory rehearsal process.

The relationship between the rehearsal process and rhythm ability has been shown in experimental psychology studies. Saito [18] reported that interference with the rehearsal process could cause deterioration in performing a rhythm from memory. Considering these points, the rehearsal process of short-term memory plays a crucial role in writing down a melody, especially the rhythm element. It follows that pure musical agraphia results from a disorder of the rehearsal process of short-term memory.

CONCLUSION

We present the case of a female piano teacher who suffered from musical agraphia without musical alexia following a left upper parietal lobule lesion. Fifteen months post surgery when her agraphia was resolved, she exhibited musical agraphia and short-term memory disorder without expressive amusia, receptive amusia, aphasia, agraphia, visual agnosia or apraxia. On examination of her musical ability, she could read and write single notes and musical signs, but her ability to write a melody was seriously impaired, and this was not only for unknown melodies, but also for ones she knew very well. Furthermore, the salient impairment was in writing rhythm rather than pitch. In addition to her inability to write a melody, impairment of short-term memory rehearsal process was suggested. From these results, we concluded that she was a pure musical agraphia resulting from a disorder of the rehearsal process of short-term memory.

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