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Musical anhedonia: Selective loss of emotional experience in listening to music

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Recent case studies have suggested that emotion perception and emotional experience of music have independent cognitive processing. We report a patient who showed selective impairment of emotional experience only in listening to music, that is musical anhedonia. A 71-year-old right-handed man developed an infarction in the right parietal lobe. He found himself unable to experience emotion in listening to music, even to which he had listened pleasantly before the illness. In neuropsychological assessments, his intellectual, memory, and constructional abilities were normal. Speech audiometry and recognition of environmental sounds were within normal limits. Neuromusical assessments revealed no abnormality in the perception of elementary components of music, expression and emotion perception of music. Brain MRI identified the infarct lesion in the right inferior parietal lobule. These findings suggest that emotional experience of music could be selectively impaired without any disturbance of other musical, neuropsychological abilities. The right parietal lobe might participate in emotional experience in listening to music.

Keywords: Music; Musical anhedonia; Emotional experience; Infarction; Parietal lobe.

Some authors in the field of visual recognition have reported cases of selective loss of emotional experiences to visual stimuli, despite the preservation of the capacity of visual perception (Bauer, 1982; Habib, 1986). Such ‘visual hypoemotionality’ was hypothesized to be caused by visual-limbic disconnection (Bauer, 1982) due to isolation of the temporal lobe (Habib, 1986). Emotional processing of music might also have two domains: emotion perception and emotional experience (Juslin & Västfjäll, 2008). Emotion perception means the recognition of expressed emotions in music without necessarily feeling an emotion (Juslin & Västfjäll, 2008). Emotional experience is the subjective experience of emotion (Juslin & Västfjäll, 2008). These two domains can be independent from each other. We can, for instance, judge music as beautiful, but not be moved emotionally by it (Brattico & Jacobsen, 2009). The selective loss of emotional experiences to music, namely a similar disturbance with ‘visual hypoemotionality’, has been reported in two cases (Griffiths, Warren, Dean, & Howard, 2004; Mazzoni, Moretti, Pardossi, Vista, & Muratorio, 1993). The causative lesion was situated in the right tempo-parietal (Mazzoni et al., 1993) and left insular extending into the frontal lobe and the amygdala (Griffiths et al., 2004).

We treated a patient with right parietal lobe infarction who showed a selective disturbance of emotional experience only in listening to music;
other cognitive functions, including the perception, expression, and emotion perception of music, were preserved. This is the third case which showed such an impairment, and some aspects of mental processing in the emotional experience of music are discussed.

**CASE REPORT**

On the morning of April 7, 2005, during a trip with his wife, a 71-year-old right-handed retired teacher treated for hypertension developed dizziness as a sole problem. Because the dizziness persisted over several hours, he presented at a local hospital. Brain CT showed a slight low-density area in the right parietal lobe, and he was admitted. Examination revealed a mild disturbance of constructional ability, but there was no evidence of weakness, sensory disturbance, unilateral neglect, aphasia, apraxia, dyscalculia, or visual discrimination difficulties. Dizziness and constructional disturbance disappeared after a few weeks, and he returned home 18 days after symptom onset. Following discharge, he found himself unable to have an emotional experience at any time when listening to music; he could not elicit interest in any music, even his favorite music or artists. He described the music as dull and lacking freshness. He thought that this symptom might be caused by listening to recorded music by the stereo and would disappear if he listened to music at a live concert. At a concert of his favorite singer, he felt that, as was expected, the quality of sound was much superior to the recorded one. But he could not experience any emotional response. He could recognize familiar music and types of instruments. No hearing deficit was found in two consultations at otolaryngology clinics. He enjoyed pictures in the art museum, movies in the theater, watching comic dialogues on television, playing with his grandchildren, and eating delicious foods, as he did before the incident. He had been an excellent amateur go player; go is a Japanese traditional game using white and black pieces on a board. He had belonged to a go club in his city for more than 30 years, and had even attended the national competition as the representative of his prefecture several times. When he returned to his home, he felt that his ability to play go was somewhat decreased. But, a month later, that recovered to the same level as before his illness. He received a normal score on the Hamilton Depression Scale (Hamilton, 1967), and consultation with a psychiatric specialist ruled out any psychogenic diseases. In November, he was referred to us for assessment of his impairment in music appreciation. He had never taken music lessons but had previously enjoyed recorded music every day and live concerts once every two months. From his youth, he had been an enthusiastic lover of classical music. He collected many compact discs of his favorite artists and composers, and, when the artists came to his town, he always went to their concerts. He met criteria for Grison’s third level of musical culture (Grison, 1972).

Duvernoy’s atlas (Duvernoy, 1991) was used to estimate the location of the lesion. MRI scans performed on November 16, 2005 (Figure 1) revealed that the infarct lesion was situated in the cortical and subcortical regions of the right inferior parietal lobule and included both the angular and supramarginal gyrus. Scans also showed areas of altered signal in right-hemispheric white matter that was interpreted as an asymptomatic old infarct. MR angiography revealed severe stenosis of the right internal carotid artery (ICA). The right middle cerebral artery (MCA) was fed by the right posterior cerebral artery via the posterior communicating artery. N-isopropyl-[123]Ijodoamphetamine ([123]I-IMP) single photon emission computed tomography (SPECT) imaging obtained four months earlier on July 29, 2005 showed absent regional cerebral blood flow (rCBF) in the infarcted area and decreased rCBF in the area of the right hemisphere fed by the right ICA (Figure 2).

Neuropsychological assessments included a full score on the Mini-Mental State Examination (30/30) and normal scores on a Japanese version of Raven’s Colored Progressive Matrices (33/36) (Raven, 1995). As for memory function, we performed the Meaningful and Meaningless Syllables Memory Test (MMSMT) (Ikeda, 1990). In administering the MMSMT, 5 meaningful and 5 meaningless words were read to the patient in 5 trials, and the patient was required to recall all these words. Our patient showed normal score in the MMSMT (meaningful 25/25, normal 17–23; meaningless 15/25, normal 8–12). We also preformed the Japanese version of the Rivermead behavioral memory test (RBMT). The RBMT yielded a normal score: a standard profile score of 21 (mean±SD; 19.73±2.93) and a screening score of 11 (9.15±1.78). He clearly remembered daily and social events. Therefore, we can reasonably conclude that our patient had normally functioning
short- and long-term memory. He could correctly copy the figure of a cube and tetrahedron, and his clock drawing was accurate. The patient verbally named as many different animals as he could in 1 minute. The lower limit of normal was set between 8 and 10 (Satoh, Takeda, & Kuzuhara, 2009), and the patient replied 15 words. Considering into the fact that his ability to play go recovered to the same level as before cerebral infarction, we may say that his executive function and working memory was also preserved. Speech audiometry revealed a full score on single sounds (80/80) and numbers (36/36). Recognition of environmental sounds was assessed by a test used previously (Satoh et al., 2005; Satoh, Takeda, & Kuzuhara, 2007). Twenty-four familiar environmental sounds were presented, and the patient correctly stated what each sound meant (24/24). Assessment of responses to other sounds showed that he felt comfortable when he listened to recorded natural sounds. Unpleasant stimuli such as disgusting smells, the sound of scratching a blackboard, pictures of wars and disasters, and...
physical pain caused him to feel uncomfortable. For

For the assessment of evaluation of emotion experience, we used the International Affective Picture System (IAPS) which is a set of normative emotional stimuli for experimental investigations of emotion and attention (Center for the Study of Emotion and Attention, 1999). Two primary dimensions were one of affective valance (ranging from pleasant to unpleasant) and one of arousal (ranging from calm to excited). To assess these dimensions, the Self-Assessment Manikin (SAM) which is an affective rating system was used. According to Meagher’s report (Meagher, Arnau, & Rhudy, 2001), we used 50 IAPS slides (fear 10, disgust 10, erotic 10, nurturant 10, neutral 10) and compared our patient’s result with the mean value of the literature (Meagher et al., 2001). Our patient’s replies were within normal limits: fear valence 3.2 (mean 3.13), arousal 6.7 (mean 6.71); disgust valence 1.9 (mean 1.75), arousal 7.1 (mean 6.82); erotic valence 6.7 (mean 6.86), arousal 6.3 (mean 6.36); nurturant valence 8.4 (mean 8.15), arousal 4.5 (mean 4.75); neutral valence 5.1 (mean 4.93), arousal 2.8 (mean 2.61). Thus, he could normally experience emotion to visual stimuli, and the preservation of pleasure against a variety of other stimuli suggesting that loss of pleasure was restricted to listening to music.

His perception and expression of music were investigated by the tests used in our previous studies of amusic patients (Satoh et al., 2005, 2007) and by ‘The Montreal Battery of Evaluation of Amusia (MBEA)’ (Peretz, Champod, & Hyde, 2003). As for the former tests (Satoh et al., 2005, 2007), we performed the following tasks regarding perception of music: pitch discrimination, discrimination and recognition of familiar songs, discrimination of unfamiliar phrases, rhythm discrimination, meter discrimination, discrimination of isolated chords, and timbre discrimination. Pitch discrimination involved measurement of the range in which two pure tones sounded in the same pitch (standard tone, 440 Hz). For discrimination and recognition of familiar music, 30 familiar nursery songs were chosen, with part of the melody locally altered in 20 songs. Two different response modes were used: (a) song decision and (b) ‘familiar–unfamiliar’ decision. In the song decision task, the patient was required correct–wrong decision for each song. In the familiar–unfamiliar task, the patient replied whether he was familiar with that song or not. For discrimination of unfamiliar phrases and rhythm discrimination, the tonal memory and rhythm tests from Seashore’s measures of musical talents (Seashore, Lewis, & Saetveit, 1960) were used, respectively. Meter discrimination and discrimination of isolated chords was performed using items from the meter and harmony section of a test for assessment of musical capacity in school children (Mashino, Hamano, & Motegi,
In order to evaluate emotion perception capacities of music, we performed the emotion categorization test by Gosselin, Peretz, Johnsen, and Adolphs (2007). This test contains 56 novel musical excerpts which intended to express fear, peacefulness, happiness, or sadness (14 excerpts per intention). The happy and sad excerpts were in the major and minor mode at relatively fast (92–196 beats per minutes, bpm) and slow tempo (40–60 bpm), respectively. Peaceful music was in the major mode at an intermediate tempo (54–100 bpm), and scary music at a relatively fast tempo (44–172 bpm) with minor chords. For each stimulus, the patient was asked to judge to what extent it expressed each of four emotions by indicating their rating on a 10-point scale (where 0 corresponded to ‘absent’ and 9 ‘present’). When the maximal rating corresponded to the label that matched the intended emotion, a score of 1 was given. In other cases, the score was 0. As the normal data, those in Gosselin et al.’s (2007) paper were used.

In order to evaluate perception capacities of musical characteristics, we performed the ‘Musical sensitivity: Part I–Phrasing’ test of the ‘Musical Aptitude Profile’ (Gordon, 1995). The test was designed to evaluate the musical aptitudes of elementary, junior, and senior high school students, and consisted of 30 pairs of identical musical phrases which were played by a violin and a cello. In each pair, one performance sounded more musically accomplished compared to another one. The differences between two performances were the timbre, legato or staccato, crescendo or decrescendo, accelerando or ritardando, playing carefully or crudely, the way of finishing the phrase, and the ‘agogic’ which was the term for a type of accent based on duration (the lingering on a note in order to stress it) (Sadie, 1994). The difference of timbre was revealed in 5 pairs. The subjects were required to judge the structural property between two performances, and to answer which of two renditions of the same musical phrase made better ‘musical sense’. This test can reveal a more subtle and complex capacity of perception of the characteristics of music which produce emotional experiences compared with the judgment of emotional categorization of mode and tempo of music. As a normative data, we used those from senior high school students, which were the highest among elementary, junior, and senior high school students. If the result was within normal limits, we could say that the patient could perceive the characteristics of music, and that our patient’s disturbance was
exactly situated only in the emotional experience of music.

The patient’s abilities regarding perception and expression of music were normal. He discriminated pitch differences as well as controls. His score for in ‘song decision’ task in discrimination and recognition of familiar songs was 27 (controls, 27.7; range 26–30). The patient replied that he was familiar with all of the 30 songs. Scores were normal for discrimination of unfamiliar phrases (22/30; controls, 21.8; range 17–27), rhythm discrimination (26/30; controls, 24.8; range 20–29), meter discrimination (4/4; controls, 3.8/4; range 3–4), and discrimination of isolated chords (12/14; controls, 12.6; range 11–14). In the discrimination of isolated chords, he could correctly discriminate consonance or dissonance against each chord. He could completely discriminate the timbre of the instruments from the synthesizer. As for the expression, three volunteers judged that he sang correctly familiar songs, and reproduced a single sound, two-note phrases, and simple rhythm, without any fault or effort. The results of the MBEA were also within normal limits: scale 27 (mean±SD, 27±2.3), and contour 26 (27±2.2).

As for the emotional perception of music, our patient’s scores were within normal limits as follows: fear 13/14=92.9% (normal control 87±4.5%); peaceful 11/14=78.6% (70±8.5); happy 14/14=100% (97±1.8); sad 13/14=92.9% (80±4.6). We can reasonably conclude that the capacities to perceive and to recognize musical emotions were preserved in our patient. The result of the ‘Musical sensitivity: Part I–Phrasing’ test of ‘Musical aptitude profile’ (Gordon, 1995) was normal (22) compared to that of senior high school students (23.0±3.79). All of the pairs with the difference of timbre were correctly answered (5/5).

In summary, our patient had loss of emotional experience only in listening to music, with retention of normal ability regarding perception, expression, and emotion perception of music. His infarction was in the right parietal lobe, with no other neuropsychological deficits.

**DISCUSSION**

Defective perception of music due to altered capacity to discriminate elementary components of musical stimuli (rhythm, pitch, timbre) and emotion perception produces an alteration in emotional experience in music (Mazzoni et al., 1993). However, the present case and others (Griffiths et al., 2004; Mazzoni et al., 1993) show that emotional experience in listening to music can be selectively impaired. We call this musical anhedonia, normal perception of elementary musical components and emotion perception coexisting with impaired capacity to respond emotionally to music. Two prior cases described a patient with impaired perception of elementary musical components and emotion perception despite preserved emotional experience of music (Matthews, Chang, May, Engstrom, & Miller, 2009; Peretz & Gagnon, 1999), showing the possibility of a double dissociation between emotion perception of and emotional experience of music. We conclude that these two cognitive domains have an at least partially independent neural network in the brain.

Our patient showed the selective loss of emotional experience only in listening to music due to right parietal infarction. The neural substrates of emotional experience have been difficult to pin down (Johnsen, Tranel, Lutgendorf, & Adolph, 2009). Regions of right parietal cortex have long been thought to play a role in emotion (Borod, 1992). Johnson et al. (2009) reported that patients with damage to the right somatosensory cortex were impaired in their self-rated feelings in response to music. The lesion site for musical anhedonia is unknown. There is some literature which investigated the brain regions activated while listening to pleasant/unpleasant or positive/negative music (Blood, Zatorre, Bermudez, & Evans, 1999; Blood & Zatorre, 2001; Brown, Martinez, & Parsons, 2004; Koelsch, Fritz, Cramon, Müller, & Friederici, 2006; Mitterschiffthaler, Fu, Dalton, Andrew, & Williams, 2007), but, among them, only one article reported the participation of the parietal lobe. A positron emission tomography (PET) study showed activation of the left inferior parietal lobule during listening to unfamiliar, pleasant music, in addition to temporal and limbic cortices (Brown et al., 2004). Based on the literature (which suggested the participation of the right hemisphere in emotional experience), the present case and Mazzoni’s patient with music imperception (Mazzoni et al., 1993), and on the PET activation study by Brown et al. (2004), we suppose that the right parietal lobe might participate in emotional experience in listening to music, and could be responsible for musical anhedonia.

We are aware of one relevant report other than Mazzoni’s: it described a case of musical anhedonia due to left-hemispheric damage (Griffiths et al., 2004). Griffiths’ patient had an insular lesion...
extending into the frontal lobe and the amygdala. A large body of literature now exists implicating the insula in emotional experience (Singer et al., 2004). The right insula might be a key substrate for the conscious awareness of feeling emotions (Craig, 2002). And, it is known that the amygdala has the relationship with emotion processing of music, especially of negative types such as scary and sad music (Gosselin et al., 2006, 2007), dissonant chords (Pallesen et al., 2005), and music-syntactically irregular chord functions (Koelsch, Fritz, & Schlaug, 2008). The lesions of the present and Griffiths’ case were quite different, so it remains unclear how and to what extent the right and left hemisphere participate in emotion experience of music. Additional research will be necessary to determine the responsible brain regions for musical anhedonia.

REFERENCES


