

Music and emotion : the brain neglected side

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Abstract

The detailed study of a brain-damaged patient suffering from bilateral damage to the auditory cortex will be presented. As a consequence of the brain insult, the patient is no longer able to discriminate and recognize music. In contrast, she is perfectly able to process musical excerpts emotionally. The origin and nature of this neuropsychological dissociation between emotional and non-emotional processing of music has been the focus of detailed experimental investigation and will be discussed in the light of current models of brain and emotion in other domains.

Music is often characterized as the language of emotions. Ironically, most recent empirical efforts have been devoted to the study of musical structure, as a nonverbal language, rarely as an emotional language. Part of this situation can be attributed to the widely held notion that emotional interpretation of music is a highly personal and variable experience, hence escaping scientific examination. A fortiori, emotional interpretation of music is not conceived as the product of a neuro-anatomical arrangement that can be shared by most members of a given musical culture. The present study shows that this view is misleading.

We present the case of a woman -I.R.- who suffers from a severe loss of musical recognition and expressive abilities and yet retains the capacity to appreciate music to a normal level. I.R. is a right-handed 40-years old woman with ten years of formal education. She sustained, 10 years prior to the present study, successive brain surgeries for the clipping of mirror aneurysms on each middle cerebral artery. As a result, sequelar lesions were found in both temporal lobes, extending bilaterally to frontal areas. At the time of testing, I.R.'s intellectual and memory abilities corresponded to a normal level for her average level of education and age. Speech comprehension and expression were also normal except for some mild articulatory deficiency (she, however, scored perfectly on all standard language diagnostic tests). Contrasting with normal level of mental functioning, I.R. experiences persistent difficulties with music. I.R. can no longer recognize melodies that were once highly familiar to her ; she is unable to discriminate musical sequences. I.R. can no longer sing more than a single pitch or play the piano, while she used to do so before her brain accident since she was raised in a musically educated environment (her brother is a professional conductor). Her musical abilities were thus found to be severely impaired while her speech and intellectual functions were spared. This pattern corresponds to a clear-cut case of amusia without aphasia in neuropsychological terms [1].

Despite her clear deficit for music, of which I.R. was fully aware, she claimed that she still enjoyed music.

This is a nontrivial claim. How can someone derive a proper emotional interpretation of music without an adequate structural analysis of it ? This is the question experimentally addressed in the present study. To our knowledge, no prior study has assessed emotional processing of music in brain-damaged populations. A fortiori, no dissociation between emotional and structural judgments has ever been envisaged. The present study thus constitutes a first exploration of this vast domain of emotion and cognition in the musical domain.

The first step into that exploration was to objectively demonstrate that I.R. is indeed capable to judge the emotional character of music. To this aim, I.R. as well as four neurologically intact women who were matched in age and education were presented with 32 selections of pre-existing instrumental music (written by Albinoni, Mozart, Beethoven, Ravel, etc.), which had to be judged on a 10-point scale as being « happy » or « sad ». Both I.R. and her controls performed this classification with ease whether the musical selections were performed by humans or by a synthesizer. Even when all instrumental versions were set to a unique instrument (piano), the emotional judgments remained quite distinct for the happy and sad music. These results indicate that a) emotional interpretation can reach a high level of consensus, and hence is amenable to scientific study and b) I.R. displays normal functioning at that level.

The next step consisted in identifying the structural cues on which these emotional judgments were based. Two structural features that are known to convey important information with regard to the happy-sad dimension in music[e.g. 2]. were thus manipulated. The first cue concerns timing or tempo : slow tempi tend to evoke sad moods whereas fast tempi evoke happy ones. The other major cue in the Western musical system is related to the subset of pitches selected in a given musical segment : the minor mode is associated to a sad tone whereas the major mode to an happy one. The original version of the musical stimuli used here obeyed these general principles : the selections that were judged to be sad had a slow tempo (from 20 to 100) and were written

in the minor mode while the reverse applied to the happy selections which had a fast tempo (from 80 to 255) and were played in a major mode. To measure the influence of tempo on the emotional judgments, all tempi were set to the same value (84) in one condition. To measure the influence of mode, the modes were interchanged (from minor to major, and vice versa) in another condition. Both manipulations impaired performance, particularly when the presented musical excerpts incorporated both tempo and mode modifications. I.R.'s responses were strikingly similar to those of normal subjects, hence showing spared ability to employ tempo and mode as cues for emotional interpretation. Thus, the results show that a) emotional appraisal is to a large extent perceptually determined and b) I.R.'s emotional judgments reveal normal structural analysis of the musical input, hence leading to opposite conclusions from the ones derived from the previous non-emotional tests that were used with her [1].

To verify that indeed I.R. is poor in non-emotional judgments while using the same stimuli as those used here in the « happy-sad » judgment task, we devised an error detection task. In the latter, an obvious error (created by randomization of pitch or of tone onset time) was applied to a whole measure of the leading voice in half the excerpts. These errors were readily picked up by normal controls. In contrast, I.R. performed poorly on this error detection task, thereby confirming her deficit in (non-emotional) perceptual organization of music.

This dissociation found after brain damage between (spared) emotional and (impaired) non-emotional evaluation of music raises a number of questions. Does this dissociation imply that emotional appreciation recruits distinct processing mechanisms from those governing structural (or cognitive) analysis of the musical input? This view is currently advocated by several scientists [e.g. 3] in other domains than music. The alternate view is to consider that emotional and non-emotional judgments differently tap the perceptual system, by relying on the computation of different structural features. For instance, tempo is a musical parameter which is most pertinent for emotional evaluation and of little relevance for the building of a structural representation of the musical excerpts. By this account, brain damage can spare the musical computations (i.e. tempo) that are necessary for appropriate evaluation of emotional content and interfere with the abstraction of the musical parameters that are most relevant for cognitive evaluation.

Although this account expressed in terms of different perceptual demands on the music processing system is, in our view, the most plausible explanation, it does not fully account for I.R.'s dissociation. The intriguing aspect of the dissociation between I.R.'s spared ability to assess emotional expression and impaired ability to assess musical structure of the same musical excerpts concerns the pitch dimension. I.R. is able to normally

pick up abstract pitch information, such as that defining mode, when required to emotionally treat the stimuli, whereas she is poor at detecting basic (nontonal) changes on the pitch dimension when required to monitor the same musical selections for the occurrence of an error.

In order to better understand this dissociation, we ran a series of other experiments aiming at a) assessing the importance of redundancy in the signal and b) contrasting the emotional and non-emotional judgments in the same time window. We can safely conclude from the present study that extensive brain damage can leave emotional appreciation of music intact. The precise origin and mechanisms underlying this spared and isolated area of music functioning remain, however, to be elucidated.

Acknowledgments

This research was supported by a research grant from the Natural Sciences and Engineering Research Council of Canada to the first author and by a doctoral fellowship from the « Fonds de la Recherche en Santé du Québec » to the second author.

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