

Music Structure and Emotional Response: Some Empirical Findings

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Eighty-three music listeners completed a questionnaire in which they provided information about the occurrence of a range of physical reactions while listening to music. Shivers down the spine, laughter, tears and lump in the throat were reported by over 80% of respondents. Respondents were asked to locate specific musical passages that reliably evoked such responses. Structural analysis of these passages showed that tears were most reliably evoked by passages containing sequences and appoggiaturas, while shivers were most reliably evoked by passages containing new or unexpected harmonies. The data generally support theoretical approaches to emotion based on confirmations and violations of expectancy.

Introduction

A common feature of musical experience for many people is the occurrence of "thrills" (Goldstein, 1980). One type of thrill is a pleasant physical sensation often experienced as a "shiver" or a "tingle" running from the nape of the neck down the spine. Such sensations are usually accompanied by heightened emotion. Thrills can be of various kinds. For instance, tears and other physical sensations associated with weeping are also widely reported (Frey, 1985). This paper presents some preliminary data on the occurrence of these various phenomena in a sample of music listeners.

One reason for the relative lack of well-founded psychological research on emotional aspects of music is undoubtedly the difficulty of measuring emotional responses. Meyer (1956) argued so convincingly and influentially against the possibility of meaningful behavioural measures that a whole generation of researchers followed his advice to concentrate directly on the analysis of musical structures, advice which has led to enormous gains in both musicology and psychology. Meyer's arguments against psychological measurement merit serious attention. For instance, he argued that physiological measures of emotional response are too undifferentiated to pinpoint particular emotions, whilst free verbal responses are too idiosyncratic and open to contamination from non-emotional factors to be really useful.

If "thrills" are, indeed, common concomitants of emotional responses to music, then they may allow us to escape some of the problems inherent in other measures. Although these physical manifestations are only part of a complex experience, they have the benefit of being stereotypical, memorable, clearly differentiated from one another, and easily identifiable. It is hard to be mistaken about whether one is or is not having one of these experiences, and it seems that they are experienced at one time or another by most people.

It is also likely that "thrills" are controlled by the same set of mechanisms that initiate or sustain emotion. This means that they directly reflect felt emotion rather than judged musical mood. It has long been known (Hevner, 1936) that members of a culture have broad agreement when asked to pick out adjectives from a larger set that describe the character of a specific passage of music. Kastner and Crowder (1990) have recently shown that reliable judgements of this sort can be elicited from children as young as three years of age, given appropriate means of response. But the ability to judge mood is logically and empirically separable from the ability to feel emotion in response to music. It is quite possible to judge a piece of music to represent extreme grief, yet be totally unmoved by it. Understanding the relationship between judgement and felt emotion is an important task for the future, but in advance of that understanding, the study of emotional response to music best proceeds from measures which relate as closely as possible to felt emotion.

One of Meyer's (1956) most significant objections to the psychological study of emotional response to music was his belief that people are, by and large, unable to pinpoint with any degree of accuracy the precise events in a musical passage which evoke significant emotional response. If true, this would, indeed, prove a serious setback to any systematic empirical study. Meyer did not, however, support his belief with evidence. One of the purposes of this study is to test the truth of this strong claim.

It is particularly important to test this claim when the whole thrust of contemporary thinking in musicology and psychology recognises that the psychological response to music is highly differentiated within a single piece. For instance, the nature and intensity of felt emotion can vary from moment to moment according to the precise nature of the musical events. In this respect music is like drama or fiction. There are moments of high emotional intensity (or "peaks") separated from one another by experiences of a different, less intense, kind. This research is concerned with such "peaks", their nature, their frequency of occurrence, and the precise musical events which evoke them.

Method

Eighty-three British adults participated in the study which entailed them completing a questionnaire in their own time. The questionnaire first asked them to consider a list of physical responses (see Table 1), and to rate the frequency with which each had been experienced to music within the last five years. Then, participants were asked to nominate up to three pieces of music in which they could remember experiencing one or more of these physical responses within the previous five years. For each piece, respondents were asked to identify the nature of the response, its consistency (*i.e.* did the same response occur at the same location), and the proportion of listenings on which the experience occurred. They were also asked to specify, as closely as possible, the precise musical event with which the response was associated (*e.g.* phrase, motive, chord, etc.), making reference to a musical score where possible.

Subjects completed the questionnaire in their own time and returned it to the investigator by post. The 83 respondents came from a pool of about 500 people who were given the questionnaire to complete. They comprised 34 professional musicians (including music teachers), 33 amateur performing musicians, and 16 people who listened to music but did not perform it. The age-range of the sample was 16 to 70. The low response rate reflects the difficulty of the task being asked of respondents, and raises some issues for discussion concerning the representativeness of the sample. A few non-respondents voiced a strong reluctance or inability to analyse and communicate their private responses in this way, and others claimed to be unable to remember the occasions of the responses in anything like the detail requested. Yet others lacked the musical resources to be able to identify "peak" moments in musical compositions with any precision. Most of the 83 respondents entered into the task with immense commitment, often taking trouble to find musical scores and give precise bar numbers, and providing detailed commentary on their answers. It clearly was a meaningful task for many respondents.

Results

Overall Response Frequency. Respondents were asked to rate the frequency of occurrence of a set of physical responses to music on a 1 to 5 scale, where 1 = never, 2 = rarely, 3 = occasionally, 4 = quite often, and 5 = very often. Table I gives the mean score for each physical response, together with the percentage of respondents who experienced that response at all in the preceding five years (categories 2-5).

TABLE I
Frequency of occurrence of physical responses to music.

	Mean score (max = 5)	% experiencing in previous five years
Shivers down the spine	3.08	90
Laughter	2.80	88
Lump in the throat	2.68	80
Tears	2.65	85
Goose pimples	2.40	62
Racing heart	2.31	67
Yawning	2.15	58
Pit of stomach sensations	2.11	58
Sexual arousal	1.56	38
Trembling	1.51	31
Flushing/blushing	1.46	28
Sweating	1.44	28

The most common responses to music, shared by a large majority of respondents were shivers, laughter, lump in the throat and tears. Of these, women experienced tears significantly more than men, and people in their thirties laughed significantly more than at other ages.

Works Nominated. Respondents were asked to nominate up to three pieces which had elicited one or more of the above reactions. 83% of respondents were able to name at least one piece. There were 165 nominations in all, 65 classical vocal (e.g. oratorio, opera), 28 popular vocal (e.g. ballads, rock), 67 classical instrumental (e.g. symphony, concerto), and six popular instrumental (e.g. jazz). The imbalance in favour of classical music probably reflected the sample, which was biased towards serious music activities. It is of note that instrumental music is almost as well represented as vocal music. 52 of the nominations were duplicated by two or more respondents. The five most commonly nominated works were: 1. J. S. Bach *Matthew Passion* (6 nominations); 2. W. A. Mozart *Requiem* (4 nominations); 3. S. Rachmaninov *Piano Concerto 2* (4 nominations); 4. J. S. Bach *B Minor Mass* (3 nominations); 5. P. I. Tchaikovsky *Overture Romeo and Juliet* (3 nominations).

Reliability of Response. Respondents were asked to say, for each piece nominated, how many times they had listened to the piece in question during the last five years, and on how many of those occasions had the physical reactions occurred. Table II shows the relationship between these two variables. Except for those cases where there had been fewer than ten listenings, responses were reported as being rather reliable, with the majority of subjects reporting the same reactions for all or most hearings. It is particularly interesting that this is so even for those respondents who had listened to the piece in question more than 50 times. Clearly, listening to a piece of music very many times does not always entail a diminishing of strong emotional response to it.

TABLE II
Frequency of physical responses to music as a function of number of hearings in previous five years.

	Number of hearings			
	1-10	10-20	20-50	over 50
<i>Rated proportion of hearings on which reaction occurred</i>				
All or most	10	19	32	25
Around half	1	5	6	8
Rarely	12	3	2	1
Total	23	28	39	34

Specificity of Response. Respondents were asked to locate the precise musical event associated with each response, if possible. Table III shows the level of success with which people were able to do this.

In 57 out of 165 cases, respondents were able to identify the precipitating event within a theme or smaller unit. Notwithstanding Meyer's (1956) assertion, this study shows that a significant minority of respondents do have the necessary precision of response. It is, however, of note that almost all the respondents in this category were performers (12 professionals and 13 amateurs). Only two respondents were non-performers.

TABLE III
Specificity of location of physical response.

	Number of citations
Unspecified or unable to comply	10
Whole piece or movement	46
Section of piece or movement	52
Theme	10
Phrase	16
Motif or bar	24
Chord or moment	7

Musical Analysis of Emotion-provoking Segments. The 57 specific nominations identified in the previous paragraph were considered as candidates for structural analysis. It was decided to reject some nominations if (a) a respondent had not reported experiencing the specified reaction on at least 20 occasions, and (b) if no published score of the work was available for inspection. The former restriction ensured that only highly reliable reactions were included, and the latter eliminated most of the popular music examples. This left 38 individual musical passages or events. Of these 19 were from purely instrumental works, and 17 were from vocal works. These 38 passages are listed in Table V:

TABLE IV
Music-structural features associated with physical responses.

Feature	Response:			χ -square	P
	Tears	Shivers	Heart		
Total No. of passages provoking each response:	20	13	5		
	Number of passages containing each feature				
1. Harmony descending cycle of fifths to tonic	6	0	0	8.96	<0.02
2. Melodic appoggiaturas	18	9	0	17.36	<0.001
3. Melodic or harmonic sequence	12	4	1	8.06	<0.02
4. Enharmonic change	4	6	0	2.00	NS
5. Harmonic or melodic acceleration to cadence	4	1	2	3.19	NS
6. Delay of final cadence	3	1	0	1.88	NS
7. New or unprepared harmony	3	12	1	8.56	<0.02
8. Sudden dynamic or textural change	5	12	3	4.92	NS
9. Repeated syncopation	1	1	3	13.97	<0.001
10. Prominent event earlier than prepared for	1	4	3	8.83	<0.02

Each nominated score segment was analysed in isolation from all but its immediate context. Issues of large-scale structure were generally ignored. Special attention was paid to the harmonic and melodic structure, the metrical and phrase structure, and to textural and dynamic considerations. It was discovered that the major structural features associated with these passages could be classified into ten broad groups. These groups are listed on

the left side of Table IV. On the right side are the number of passages containing each feature. There are three columns, which split the works according to the physical reaction experienced. Tears = tears or lump in the throat (18 passages), Shivers = shivers or goose pimples (19 passages), and Heart = racing heart or stomach sensations (5 passages). Eight passages evoked both tears and shivers simultaneously, and so appear in the figures for two columns (asterisked in Table V). On the extreme right of the table are the results of χ -square tests for non-random relationship of each of these features to the physical reaction experienced.

These tests show a clear differentiation between musical structures on the basis of the physical reaction they provoke. Tears are most reliably provoked by melodic appoggiaturas, and to a lesser extent by sequences and harmonic movements through the cycle of fifths to the tonic. Shivers are most reliably provoked by relatively sudden changes in harmony. The number of passages provoking racing heart is small (confirming the relatively infrequent incidence of this response to music), but the data suggest acceleration and syncopation as major concomitants. The low observed frequencies in this latter case make the χ -square results unreliable.

Table V gives full details of the location of the selected musical passages and the structural features associated with them. The columns on the right represent the ten numbered structural features listed in Table IV, and a Y in the relevant row indicates that this feature was judged by the author to be present in that passage. Eight of the passages (marked by asterisks) were judged by listeners to provoke both Tears and Shivers. The frequency counts for these eight passages have been subsumed into both the Tears and the Shivers totals as indicated by the row of numbers in parentheses.



FIG. 1

Principal lines of the opening bars from Rachmaninov *Second Symphony*: 3rd movement. The second system is a reduction showing the underlying appoggiaturas.

A prototypical example of a "tears" passage is the opening six bars of the 3rd movement of Rachmaninov's *Second Symphony*, which contains features 1, 2 and 3 from Table III (see Figure 1). An equally clear example of a

TABLE V
Musical passages eliciting specific reactions.

			Structural features									
			1	2	3	4	5	6	7	8	9	10
1. Tears or lump in throat												
ALBINONI	<i>Adagio</i>	Opening 8 bars	y	y	y							
BACH	<i>Matthew Passion</i>	Opening chorus bars 1-8	y	y	y	y	y					
	<i>B minor Mass</i>	Dona nobis pacem bars 40-42	y	y	y							
BEETHOVEN	<i>Piano concerto 4</i>	M2 bar 31-35	y	y	y	y						
	<i>Fidelio</i>	*Act 1 No. 3 bars 14-22	y									
		*Act 2 No. 11 bars 81-87 (poco allegro)		y	y					y	y	
		*Act 2 Finale bars 173-7 (sost. assai)	y	y	y							y
		*	y									
		M2 2nd piano entry	y	y	y	y	y					
BRAHMS	<i>Piano concerto 1</i>	M2 bar 2 beat 2				y						
MENDELSSOHN	<i>Violin concerto</i>	*Act 2 No. 25 bars 51-54	y									y
MOZART	<i>Così fan tutte</i>	*Act 2 No. 29 bars 11-19	y	y								
PUCCHINI	<i>La Bohème</i>	Act 2 No. 21 bars 1-7 (Musetta's song)	y	y	y							
		Act 2 No. 26 bars 1-5 (Donde lieta)	y									
		Act 3 conclusion No. 31 bars 1-6 (Mimi)	y	y								y
RACHMANINOV	<i>Symphony 2</i>	M3 bars 1-4	y	y	y							
SIBELIUS	<i>Symphony 7</i>	1st solo trombone entry	y	y		y						
STRAUSS	<i>Rosenkavalier</i>	*Finale trio: M's entry (No. 285)	y				y					y
		*Finale trio: Sophie's entry	y	y	y					y		
TCHAIKOVSKY	<i>Romeo and Juliet</i>	Love theme (three citations)	y	y	y							y
			6	18	12	4	4	3	3	5	1	1

2. Shivers down the spine or goose pimples

BACH	<i>Matthew Passion</i>	Part 2 No. 54 (Barrabas!)										
BEETHOVEN	<i>Piano concerto 4</i>	M1 bar 105		y								
		M1 bar 170		y								
		M1 bars 257-8										
		M2 bars 68-71										
		M3 bar 360										
BRUCKNER	<i>Ave Maria</i>	Bar 16-21 (Jesus)										
CALDARA	<i>Laborare in gemitu</i>	Bar 3	y									
GIBBONS	<i>The Silver Swan</i>	Bars 11-13 (thus sung)				y						
MAHLER	<i>Symphony 3</i>	M1 bar of No. 74										
MENDELSSOHN	<i>Lauda Sion</i>	M1 bars 17-25	y			y						
SCHOENBERG	<i>Verklarte Nacht</i>	Bar 229		y								
Tr (art Wilcox)	<i>Hark the Herald</i>	V3 bar 17	y									
			0	2	1	3	1	1	9	9	1	3
			*(0	0	7	3	3	0	1	3	3	0 1)
			0	9	4	6	1	1	12	12	1	4

3. Racing heart or stomach sensations

BEETHOVEN	<i>Piano concerto 4</i>	M3 bar 191										
		M3 bar 392								y	y	
		M3 bar 439								y	y	
PROKOFIEV	<i>Symphony 5</i>	M4 No. 107										
RACHMANINOV	<i>Piano concerto 2</i>	M2 No. 17 (flute entry)	y									
			0	0	1	0	2	0	1	3	3	3

"shivers" passage is the chord in bar 228 of Schoenberg's *Verklarte Nacht*, which contains features 4, 7 and 8 (see Figure 2). A clear example of a "heart" passage is bar 191 of the last movement of Beethoven's Fourth Piano Concerto, which contains features 8 and 10 (see Figure 3).



FIG. 2

Piano realisation of bars 224-229 from Schoenberg *Verklarte Nacht*.



FIG. 3

Principal lines of bars 184-192 from Beethoven *Fourth Piano concerto: 3rd movement*. Square brackets indicate phrase boundaries. Incomplete brackets show point where prominent event precedes its "expected" point of entry.

These features are shared by vocal and instrumental items. It is not the case that emotionally charged words or situations replace appropriate musical devices, although they are often consistent with them. For instance, in Act II of Puccini's *La Boheme*, at the moment when Mimi declares that she is leaving Rodolfo ("Donde lieta usci") we find the use of features 2 and 3 in the orchestra (see Figure 4). Tears are obviously the appropriate response for the dramatic situation. For a more detailed discussion of some of the musical examples the reader is referred to Sloboda (1991).



FIG. 4

Principal orchestral lines of No. 26 from Puccini *La Boheme: Act II* ("Donde lieta usci").

Discussion

This study shows that some people can reliably recall "peak" emotional experiences in classical music which are accompanied by physical reactions. The respondents capable of this are mainly regular music performers. They are able to locate the precise musical event which gave rise to the reactions, and it appears that distinct reactions are provoked by rather different types of musical structure.

Do these data allow us to conclude that these specific responses are widespread in the population? The physical responses described are part of the innate autonomic response system of all human beings. They do not have to be learned. However, it is clear that the ability to experience these responses in connection with specific music structures is learned. This is because (a) the responses are not shared by young children and people from different musical cultures; (b) the structures mediating these responses are often only perceptible in terms of a musical syntax; for instance there is no way of perceiving a cycle of fifths harmonic progression unless one has internalised the system of tonal relationships and hierarchy inherent in traditional Western music; and (c) the emotional response to a piece of music can grow during repeated exposure to the same piece, as one discovers more of the subtle structural features (a point made by several respondents in this study). This process may be assisted to some extent by the descriptive discourse that surrounds music. Programme notes, record sleeves, and the informal sharing of experiences amongst musicians may direct listeners to particular passages and suggest a "received" emotional interpretation. For these reasons, the present results can lead to no strong claims about the extent to which the pattern of response reported here will be replicated in less experienced musicians.

The high sample attrition rate is another feature of this investigation that urges some caution in the interpretation of the data. It may be that the questions asked were too difficult and time-consuming for many potential respondents. However, it is at least a possibility that non-respondents just did not experience any of the listed physical responses to music, and so did not consider it worth their while to co-operate with the research.

It should also be noted that there is no absolute guarantee that the "thrills" reported by the subjects in these studies corresponded to actual physiological events. It is possible that the accounts are figurative descriptions which exist at the same cognitive level as the perceived musical events. There are, however, various commonly observed phenomena that make it rather unlikely that all these events are without a real physiological basis. In yet to be reported *in-vivo* studies of music listeners, visual and auditory records of actual crying behaviour are not uncommon. It is also a commonplace observation among amateur choral singers that experienced emotion can cause such a "lump in the throat" as to disrupt normal singing mechanisms. None the less, without direct measurement of such phenomena as pilo-erection and lachrymation, it will never be possible to be absolutely certain that a particular experience is not "figural". The significance of this research is to show that these responses, whatever their physiological basis, are shared by a

significant number of people, and are linked to particular structural features (occurring in widely differing musical idioms) in a non-intuitively obvious way.

Although further confirmatory work is required to verify and extend these findings, the most interesting question raised by this research is why these specific musical structures come to be associated with these specific psychophysiological effects. Some of the respondents claimed that music allowed a level of intensity of emotional response rarely experienced in everyday life, with beneficial psychological consequences for motivation and self-image. The hypothesis is being pursued that certain musical structures represent significant emotion-provoking events at a rather abstract level (see Sloboda, 1989). For instance, tears may relate to emotions provoked by endings (whether of loss or of relief), and the precipitating musical structures may be those which encourage the listener to anticipate an impending ending or release of tension. Musical structures can then provide the kind of cathartic outlet sometimes offered through stories or drama, but without their specific semantic content.

If this thinking is correct then it follows that the structures of conventional tonal music are only one of a number of possible ways of representing these emotion-bearing events. It should be possible to find confirmatory evidence in the emotional responses of experienced listeners to music of other cultures. Although the precise musical structures will be different, their functions (in the rather abstract sense suggested above) should be the same.

These data also provide some partial confirmation for the analytical conclusions of Meyer (1956; see also Meyer, 1973; Narmour, 1977). This approach links emotional response to various classes of creation and violation of expectancy or implication within musical structures. Most of the ten significant structural features are clearly linked to such violations. The data offer no support for alternative theories (such as that of Cooke, 1959) which link emotion to particular melodic patterns within a key.

The primary purpose of this paper is not, however, to comment on the considerable literature of unverified theoretical speculations, but to show that the empirical investigation of emotion-linked responses yields data of a sufficiently reliable and fine-grained nature to impinge directly upon the analytic concerns of both musicologists and psychologists. There is still much work to be done in this respect.

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