They sang these words most musically, and as I longed to hear them further I made by frowning to my men that they should set me free; but they quickened their stroke, and Eurylochus and Perimedes bound me with still stronger bonds till we had got out of hearing of the Sirens’ voices. Then my men took the wax from their ears and unbound me.

Homer’s *Odyssey*, written some 2,800 years ago, contains one of the earliest accounts in Western literature of the emotional power of music. According to the well-known episode, such was the power of the Sirens’ singing – capable of luring sailors to shipwreck on the rocks – that Ulysses could resist it only by being tied to the mast and having his men’s ears plugged with beeswax. Unencumbered by pre-existing literature on music and emotion, Homer was perhaps freer than are we to seize upon the obvious: music’s power to seduce, spellbind, dazzle, amaze and hook its listeners. Homer, miraculously transported into the early twenty-first century, would be surprised that these effects play only a marginal role in current views of music-induced emotions.

One reason for this neglect is that such effects do not fit readily into established theories and criteria of emotion. Music theorists and philosophers of music often argue that, since emotions require an intentional object and music does not provide such objects, specific emotions cannot be felt in response to music. Psychologists and neuroscientists, while readier to accept that music does arouse emotion, nevertheless have relied on theories which made this difficult to show: chiefly basic emotion theory, or the circumplex model of affect. Basic emotion theory posits that all emotions can be derived from a limited set of universal and innate basic emotions, which typically include fear, anger, surprise, disgust, sadness and happiness, and possibly also shame, embarrassment, contempt and guilt. Each basic emotion category may be explained functionally in terms of goal-relevant events which have been shaped by evolution. Disgust, for example, is seen as an adaptation that warns humans to stay away from places where germs and other pathogens may be lurking.

The main alternative to categorical models is a dimensional approach, most notably the circumplex model. This model proposes that emotions represent a mixture of two core dimensions: valence and arousal. Thus, any emotion state can be mapped in an affective space that is defined by axes, respectively, of pleasure–displeasure and activation–deactivation. Dimensional models, then, do not attempt to characterise emotional experiences; if anything, their strength lies in...
removing specificity from experienced emotion. Thus, if feelings of gratitude, compassion, tenderness and contentment were to occupy the same location in the circumplex, they would be treated as affectively equivalent. Hence, little can be learned about the nature of music-evoked emotions from the circumplex model.

This notwithstanding, well over 80 per cent of all music and emotion studies to date have relied on categorical or dimensional approaches. Since theorists have typically worked from established emotion models towards music, rather than letting music shape a model suited to its emotions, many obvious questions have been left neglected. What do discerning listeners feel when attending to their music of choice? Does music elicit specific emotions? If so, do these emotions conform to the emotion categories posited by basic emotion theory? If not, what is the range and organization of emotions evoked by music? Such questions compelled me, in association with various colleagues and co-workers, to conduct a series of field and laboratory studies aimed at addressing them.

I will begin, in Part I, by summarising this earlier project, which resulted in a model comprising nine broad categories of musically inducible emotions. These are the primary musical emotions referred to in the title, of which Homer had described the single most quintessential. In Part II, I will address the conditions required for an emotion to be successfully elicited by music. In Part III, I consider how a music-induced emotion can be measured. Part IV contextualises these empirical findings within current psychological and philosophical views of music and emotion.

I. Particularizing Music-Evoked Emotions: the GEMS Model

Our work takes as a point of departure the fact that all affect states, including emotions, moods and feelings, have become encoded in the human language. Thus, we began our work with a fairly comprehensive compilation of 515 affect terms. This compilation was derived from three sources: (1) a collection of affect terms used in five major languages, (2) terms derived from the affective lexicon and (3) an extensive review of emotion terms used in the literature on music and emotion. We did not consider it necessary that these terms refer to emotions as they are defined in philosophy or psychology textbooks. Rather, we felt it more important that the terms be generally understood and judged to reflect emotive states that could be felt, rather than reflecting cognitive or propositional states of mind. Many terms were removed because they did not meet this criterion.

In the subsequent study, a sample of 252 listeners was presented with the affect labels retained from Study 1. The listeners were asked to rate the frequency with which they felt any of the affect states in response to their music of choice, which included classical, jazz, rock/pop, Latin American and techno genres. The participants were also asked to rate the frequency with which they thought the music could express or represent these emotions. We then retained only those labels rated as being at least occasionally aroused or expressed by any of the genres. Some of the labels that did not meet this criterion included guilt, shame,
jealousy, disgust, contempt and embarrassment. This process, which is described in detail in the original article, left us with 66 terms relating to emotions which are commonly felt in response to music. To help ensure that no important emotion was missing from this compilation, in subsequent studies listeners were instructed to add any terms for an emotion which they had felt, but which was missing from the list. The terms that recurred the most frequently were added to the final list.

We conducted a further study to ensure that the selected terms would be relevant in a naturalistic setting. Study 3 thus measured the relative frequency of occurrence of these emotive states during a music festival that takes place in Geneva every June, the Fête de la Musique. Examining emotional responses to music in this context has several advantages: the festival visitors typically come from different age groups and socioeconomic strata, the sheer profusion of visitors makes it easy to recruit a large sample and the performances of the festival cover a relatively broad spectrum of musical genres. We trained a team of ten research assistants to deal with this range of genres (classical, jazz, rock and world music). They approached festival visitors by asking them to fill out the rating list containing the 66 emotional adjectives either during or right after the performances.

Of the 801 questionnaires which were returned, 72 per cent related to classical, 11 per cent to rock, 10 per cent to world music and 7 per cent to jazz. Table 1 shows the percentage of listeners who reported having felt one or more of our listed emotions ‘somewhat’ or ‘a lot’. Percentages were calculated for the entire sample as well as for each particular genre. Strikingly, the results of our study closely matched those of Patrik Juslin and Petri Laukka’s comparable survey of adults and the elderly in Sweden,9 which also looks at the relative frequency of occurrence of reported emotion states. In particular, we found that the most frequently reported emotions included ‘feeling moved’, ‘nostalgic’, ‘relaxed’, ‘enchanted’ and ‘tender’. ‘Admiring’, a term featuring strongly in the Swedish study, was the most frequently added term in the free-response spaces of our own study. The congruence between the Swiss and Swedish studies is noteworthy, as it suggests that our findings may generalise to different listener populations, listening contexts and music excerpts.

Our second aim was to examine the structure underlying ratings of musical affect. To this end, we used a series of statistical data reduction techniques that make it possible to group the emotion terms into superordinate categories of relatively homogeneous items. The procedures ensure that terms in a given category are similar to each other yet dissimilar to terms in other clusters. These statistical techniques revealed that a model with nine primary emotion clusters and three higher-order factors best fit the data.10 These clusters (or categories) of music-evoked emotions are reproduced in Fig. 1, together with their respective emotion terms. In a subsequent study (Study 4), we also demonstrated that this model provides a much better approximation to what listeners feel in response to music than do basic emotion or circumplex models.11
We refer to this model as the GEMS model, which is named after the Geneva Emotional Music Scale.

The first component to emerge from this analysis we chose to call ‘wonder’, after the French term émerveillé, which is typically rendered in English as ‘amazed’, but is more accurately translated as ‘filled with wonder’. The ‘wonder’ family includes those feelings which are perhaps the most potent and rewarding emotive states generated by music – the ones which hook people on music. Music’s almost drug-like effect has been noted elsewhere. The psychologist Abraham Maslow, for example, saw music as one of the most reliable means (along with sex) of inducing a so-called peak experience (Maslow, 1976).

Table 1 Percentage of listeners who reported having felt each affect state somewhat or ‘a lot’

<table>
<thead>
<tr>
<th>Affective state</th>
<th>Weighted totals</th>
<th>Affective state</th>
<th>Weighted totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxed</td>
<td>44.6</td>
<td>Spiritual feeling</td>
<td>15.3</td>
</tr>
<tr>
<td>Happy</td>
<td>41.5</td>
<td>Affectionate</td>
<td>13.8</td>
</tr>
<tr>
<td>Joyful</td>
<td>39.0</td>
<td>Exciting</td>
<td>13.7</td>
</tr>
<tr>
<td>Dreamy</td>
<td>37.1</td>
<td>Feeling of transcendence</td>
<td>13.7</td>
</tr>
<tr>
<td>Stimulated</td>
<td>35.4</td>
<td>Mellowed</td>
<td>12.4</td>
</tr>
<tr>
<td>Dancing (bouncy)</td>
<td>33.5</td>
<td>Disinhibited</td>
<td>12.3</td>
</tr>
<tr>
<td>Enchanted</td>
<td>32.8</td>
<td>Caressing</td>
<td>12.0</td>
</tr>
<tr>
<td>Nostalgic</td>
<td>32.1</td>
<td>Shivers (thrills)</td>
<td>11.2</td>
</tr>
<tr>
<td>Allured</td>
<td>31.0</td>
<td>Electrified</td>
<td>11.2</td>
</tr>
<tr>
<td>Touched</td>
<td>30.9</td>
<td>Agitated</td>
<td>10.6</td>
</tr>
<tr>
<td>Free</td>
<td>30.7</td>
<td>Fiery</td>
<td>10.4</td>
</tr>
<tr>
<td>Calm</td>
<td>28.0</td>
<td>Sad</td>
<td>10.2</td>
</tr>
<tr>
<td>Sentimental</td>
<td>27.5</td>
<td>Triumphant</td>
<td>10.1</td>
</tr>
<tr>
<td>Energetic</td>
<td>27.4</td>
<td>Voluptuous</td>
<td>9.6</td>
</tr>
<tr>
<td>Filled with wonder</td>
<td>26.5</td>
<td>Goose bumps</td>
<td>9.1</td>
</tr>
<tr>
<td>Amused</td>
<td>23.6</td>
<td>Solemn</td>
<td>8.3</td>
</tr>
<tr>
<td>Passionate</td>
<td>23.4</td>
<td>Languorous</td>
<td>7.8</td>
</tr>
<tr>
<td>Animated</td>
<td>22.6</td>
<td>Heroic</td>
<td>7.2</td>
</tr>
<tr>
<td>Melancholic</td>
<td>22.5</td>
<td>Impatient</td>
<td>6.8</td>
</tr>
<tr>
<td>Light</td>
<td>22.5</td>
<td>Serious</td>
<td>6.6</td>
</tr>
<tr>
<td>Moved</td>
<td>21.9</td>
<td>Irritated</td>
<td>6.6</td>
</tr>
<tr>
<td>Inspired</td>
<td>21.6</td>
<td>Proud</td>
<td>6.4</td>
</tr>
<tr>
<td>Dazzled</td>
<td>21.3</td>
<td>Revolted</td>
<td>6.3</td>
</tr>
<tr>
<td>Serene</td>
<td>21.3</td>
<td>Annoyed</td>
<td>6.2</td>
</tr>
<tr>
<td>Tender</td>
<td>19.8</td>
<td>Nervous</td>
<td>5.5</td>
</tr>
<tr>
<td>Euphoric</td>
<td>19.7</td>
<td>Tense</td>
<td>5.2</td>
</tr>
<tr>
<td>Meditative</td>
<td>18.4</td>
<td>Bittersweet</td>
<td>4.7</td>
</tr>
<tr>
<td>Floating</td>
<td>18.3</td>
<td>Indifferent</td>
<td>4.6</td>
</tr>
<tr>
<td>Sweet</td>
<td>18.2</td>
<td>Aggressive</td>
<td>4.2</td>
</tr>
<tr>
<td>Soothed</td>
<td>17.8</td>
<td>Anxious</td>
<td>3.4</td>
</tr>
<tr>
<td>In love</td>
<td>17.8</td>
<td>Sorrowful</td>
<td>3.4</td>
</tr>
<tr>
<td>Sensual</td>
<td>17.5</td>
<td>Depressed</td>
<td>2.7</td>
</tr>
<tr>
<td>Strong</td>
<td>15.3</td>
<td>Angry</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Adapted from Zentner, Grandjean and Scherer 2008.
Moreover, ‘the emotional reaction in the peak experience has a special flavor of wonder, of awe, of reverence, of humility and surrender before the experience of something great’ (Maslow 1968, pp. 87–8). Alf Gabrielsson, in his large-scale study of individuals’ autobiographical memories of strong experiences with music, noted many similar responses. Here is one typical report: ‘suddenly I experienced a tremendously strong feeling that was felt in my body and in my head. It was ... like a strong intoxication. It made me ecstatic, inconceivably exhilarated, everything concentrated to a single now ... . The intoxication lasted the whole piece, and I staggered out afterwards. What a fantastic happy experience!’ (Gabrielsson 2001, p. 437). Marcel Proust, like many novelists a better psychologist than many psychologists themselves, was typically alive to the wonder of music, as in his celebrated account of Vinteuil’s ‘little phrase’:

But then at a certain moment, without being able to distinguish any clear outline, or to give a name to what was pleasing him, suddenly enraptured, he had tried to grasp the phrase or harmony – he did not know which – that had just been played.

From Zentner, Grandjean and Scherer (2008).

Fig. 1 Illustration of the GEMS model

An empirically derived classification of music-evoked emotion. Left are the selected feeling terms, in the middle their groupings into nine clusters based on a statistical data-reduction method (CFA), and right are the higher order groupings of the clusters.

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and that had opened and expanded his soul, as the fragrance of certain roses, wafted upon the moist air of evening, has the power of dilating one’s nostrils. (Proust 2005, p. 250)

Proust cleaves to the archetype established by Homer, as does, ironically, Charles Darwin in *The Descent of Man* (1871). By emphasising the elusive and seductive nature of music’s effects – whose functions seem to be limited to calling, charming and exciting the opposite sex – the precursor of the basic emotion model draws attention to emotions other than the basic ones.

The next component, ‘transcendence’, is related to wonder, but with a stronger aspect of spirituality or ‘otherworldliness’. Our concurrent work on English emotion terms found that ‘awe’ is also a strong marker of transcendence. Nevertheless, although ‘awe’ has long been noted in music and the arts, we excluded it from our survey for the linguistic reason that the term simply doesn’t exist in French. Emotion and music studies have virtually ignored wonder and transcendence, with the signal exception of Vladimir Konečni (2005 and 2008), in whose work ‘awe’ takes its place alongside ‘being moved’ and ‘thrills’ as part of the ‘holy trinity’ of quintessentially musical emotions. Our own taxonomy identifies these responses are part of a broader nomological network than Konečni’s. ‘Being moved’ is a marker term of the ‘wonder’ family and as such relates to feeling allured, amazed or dazzled. ‘Thrills’, a reaction that is often studied in isolation, is a member of the transcendence family. Immaterial or otherworldly as these emotions may seem, they have been seen to co-occur with strong activation patterns in reward-related emotive regions of the brain.

‘Tenderness’ has been noted as a musical emotion, but usually as an expressed emotion, not as an aroused state. Yet our work suggests that ‘tender affect’ is one of the prime emotive states generated by music. The French language has an apt word for this effect, *attendrir*, meaning ‘to make tender’, or ‘to cause to melt’, as in, ‘She radiates a charm that would make every man’s heart melt’. German has the term *dahinschmelzen* (‘to melt away’), much used to describe the effects of music. The Italian *dolce*, a common expression marking, is also comparable.

The emergence of ‘nostalgia’ as an emotion component in its own right was unexpected. It is relevant, however, that one of the most frequently mentioned functions of music in everyday life is as a reminder of a valued past event. These findings not only suggest a link between music-related emotion and music’s functions; they also point to the mediating role of memory and imagery in the induction of musical emotion. Recent brain imaging confirms that the subjective experience of nostalgia is related to increased activation in the hippocampus and the visual cortex. Finally, the prominence of nostalgia within music-induced emotions is also consistent with the venerable historical tradition of Sehnsucht – a state invoked not only in the Austro-German canon but also in pop, rock and folk songs. For instance, *saudade*, which denotes a form of nostalgia in Portuguese, is an emotive state inextricably linked with an entire music genre, the *fado*. 
Less surprising were ‘peacefulness’ and ‘relaxation’. The calming effects of music on emotional as well as physiological arousal have been put to use since ancient times. Thus, the Pythagoreans claimed to have developed a science of musical psychotherapy capable of clearing people’s minds of the scares of the day and preparing them for a restful sleep.21 In one of the first psychiatric asylums, built in eighth-century Fez, Morocco, music therapy figured prominently among the various treatments.22 Today, there is growing research evidence for the usefulness of music as a relaxant in medical settings.23

‘Joy’ is an interesting case because of the subtle difference between its music-induced and basic emotion varieties. In the first respect, we found that musically induced joy implies an action tendency to dance. This is consistent with my discovery, with Tuomas Eerola, that infants’ rhythmic coordination with music, which is driven by the metrically regular beat, is positively related to displays of positive affect such as smiling.24 Thus, insofar as music-evoked joy is coupled with rhythmic entrainment from a very early age, it is distinct from joy in everyday life. There is no beat in the head of the department’s announcement of a professional promotion: the joy felt in response to this extramusical event lacks the movement or entrainment component which is an integral part of musically induced joy. We therefore chose to call this class of feelings ‘joyful activation’ rather than ‘joy’ pure and simple.

Joyful activation is compounded with ‘power’ to form a dimension at the next level, one we call ‘vitality’. We prefer ‘power’ to a term such as ‘energy’ so as to capture the flavour of ‘large’, ‘heroic’ or ‘triumphant’. When a passage is performed maestoso, it makes us feel maestoso: large and powerful.

The factor ‘tension’ lends itself to two possible interpretations. Our first finding qualifies Leonard B. Meyer’s theory (1956) that surprise (that is, when expectations are subverted) plays a central role in musical experience.25 In fact, our results indicate that surprise is not a significant musical emotion. One explanation for this is that surprise works beneath conscious awareness; another is that it plays a greater role among expert listeners than among lay audiences, since trained listeners utilise more conscious and sophisticated kinds of rule-based expectations. Hence, what elicits surprise in the expert (say, a sudden shift in key) may induce amazement in the lay listener.

Tension can also be heard as irritation or anger. Although admittedly rare, these properties are arguably inherent particularly in music which contains a number of successive unresolved dissonances. Pace Schoenberg (1984), who held dissonance aversion to be a product of acculturation, it has been observed in young infants,26 and it is probably universal. More typically, however, irritation and anger arise when people are exposed to music they dislike, fail to understand or even abhor. The standard case in point is heavy metal music, which is generally thought of as a prototype of aggression-inducing music. And yet heavy metal does not evoke anger in people who identify with it – only in those who do not.27

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The emotion of fear is conspicuously absent from our spectrum of emotion clusters. When people think of ‘fearful’ music, what they usually have in mind is the soundtracks of thrillers and horror films (see Biancorossi, this issue). Fearful reactions in such films are prevalently caused by learned associations, not by the nature of the sounds themselves. Because music and narrative are so interwoven, it is difficult to tell whether the music acts as producer, amplifier or neither. Thus, although these emotions are occasionally elicited by the music in itself, it is far more common for them to arise from conditioning (fear) or a violation of taste or attitude (anger), as in ‘I really hate this kind of music’.

Like joy, sadness is another component which ostensibly fits with basic emotion theory. Nevertheless, as with joy, it is far from clear whether everyday sadness is the same as musically induced sadness. Like fear, sadness tends to be experienced as an aversive state – one most people wish they could avoid. In contrast, people do not usually turn off the radio when a sad song hits the air. Nor do they periodically purge their collections of sadness-evoking musical scores or recordings. The fact that people are drawn to sad music indicates that it must involve a denatured kind of sadness. It is thus perfectly understandable why most listeners in our studies preferred the term mélancolique (‘melancholy’) to describe music-induced sadness. On average, ‘melancholy’ was reported more than twice as often as the term ‘sad’ and more than five times as frequently as ‘depressed’.

Having distinguished the specific characters of the GEMS emotions, I should emphasise that they are not mutually exclusive. Indeed, music-evoked emotions tend mostly to occur in combination with one another. A tender response to a Mendelssohn andante may co-occur with wonder and nostalgia. By the same token, the feeling of power induced by a Bruckner symphony might be tinged with feelings from the ‘joyful’ or ‘transcendence’ clusters. In other words, a musical passage will tend to elicit an emotion pattern, rather than any discrete emotion. It would thus make more sense to characterise and compare the emotions evoked by musical works in terms of blends and configurations of emotions, rather than individual emotions.

In summary, our work discerned nine primary musical emotions, that is, emotions that appear to be the most salient ones induced by music. These music emotions differ markedly from those defined by basic emotion theory. Anger, fear and disgust are so rarely induced by music as to warrant being defined as atypical. This verdict applies even more strongly to shame, guilt, embarrassment and jealousy. Sadness evoked by music is seldom aversive, making it difficult to equate this feeling with real-life sadness. Happiness refers to such a vast range of emotions that it is an uninformative descriptor. Music usually elicits ‘happiness’ or ‘positive affect’, and the challenge or merit lies not in stating the obvious, but in specifying musical happiness in all of its multiple forms. Our classification system thus constitutes an attempt to map out the terrain of the predominantly positive emotional experiences provided by music. Whether these experiences should be characterised as emotions at all is a point I will turn to later.
II. How Are Musical Emotions Induced? The Induction Rule Model (IRM)

The frequent pairing of emotion with music in both research and fiction suggests that emotions are triggered by music easily if not almost inevitably. However, the induction of emotion by music is a complex and still poorly understood process. The aim of this section is to particularise this process based on some of our and other researchers’ work. When we analysed the responses from the previously mentioned festival study, we were surprised to find that even the most commonly reported emotions were experienced by fewer than half of the attendants. Even more striking, fewer than a quarter of the festival attendants reported having felt any significant degree of emotion (see again Table 1). This is a remarkable outcome given that most listeners probably picked concerts which they expected to be engaging. This finding suggests that the induction of emotion by music is a fragile process that depends on multiple interacting factors which not only influence whether or not an emotion is being elicited, but may also determine the kind and the intensity of the emotional experience.

A decade ago, we introduced a model which classifies the multiple factors involved in the induction of musical emotion into four broad categories: structural features, performance features, listener features and contextual features. Our study also explored emotion-induction mechanisms such as empathy, entrainment, conditioning and memory. The distinction between mechanisms and factors is similar to that between moderators and mediators in the social sciences. Moderators specify the conditions under which a certain effect may be observed, whereas mediators specify the process by which the effect comes about. Thus a fast tempo is a moderator because it may increase the likelihood that agitation can be experienced. In contrast, heart-rate acceleration would be a mediator, or a process which translates a fast tempo into an agitated feeling. We referred to this model as the ‘production rule model’, because it aims at identifying the rules necessary to produce an emotion. Here, I will use the term ‘induction rule model’ or IRM instead.

Structural features posited by the induction rule model are features of the music itself, which may include timbre, meter, tempo, harmonic progression, and so on. Our model was not intended to make minute predictions about the emotion-inducing effects of these musical elements and their combinations. Rather, it broadly classifies them into what we term ‘segmental’ and ‘suprasegmental’ units. The emotion-inducing effects of segmental features are expected to be relatively stable and universal, with the exception of random error, over all types of listeners and performance conditions. Such effects are generally mediated by evolutionarily developed, iconic signalling characteristics, based on physiological changes in affect vocalization which are relatively independent of individual or cultural differences. An example would be a musical sound that resembles the scream of fear. Suprasegmental features, by contrast, consist of systematic configurational patterns in sound sequences, such as intonation and
amplitude contours in speech. These correspond to formal musical features involving melody, harmony, rhythm and tempo. While iconic coding also plays an important role (e.g. with respect to tempo and rising or falling contours), suprasegmental features seem to carry emotional information primarily through symbolic coding by means of historically evolved, sociocultural conventionalization. Thus, the minor mode came to symbolize a sad mood during the seventeenth century. Performance features comprise the ways a piece is played. Emotion induction may be strongly influenced by the established identity of the performer (physical appearance, expression and/or reputation) and his or her ability (technical and interpretative skills), as well as by transient performance-related variables we designate as performance state (interpretation, concentration, motivation, mood, stage presence, audience contact, and so on).

Listener features are based on the individual and sociocultural identity of the listener and on the symbolic coding conventions prevalent in a particular culture or subculture. They can consist of interpretation rules (for instance, musical systems) which are shared in a group or culture, or of inference dispositions based on personality, prior experiences, musical talent and music preferences. For example, a mismatch between listeners’ musical preferences and the music played for them will tend to mute or even vitiate their emotional response.\(^{32}\)

These various factors can be organised into the two basic categories of musical expertise (including culturally constructed understandings of musical meaning) and stable dispositions (such as personality traits). For example, we found that two personality traits in particular make individuals emotively responsive to music: ‘absorption’ and ‘openness to experience’. Absorption relates to the propensity for imaginative and self-involving experiences. Individuals who score high for absorption are described as emotionally responsive to engaging sights and sounds; they are readily captivated by entrancing stimuli, and they think in images. In contrast, low scorers are not easily caught up in sensory or imaginative experiences and do not readily relinquish a realistic frame of reference.\(^{33}\) Openness to experience involves active imagination, aesthetic sensitivity, attentiveness to inner feelings, a preference for variety and intellectual curiosity. Ideally, however, one would want to have not only an inferred index of emotive responsiveness to music, but a direct index. Such an index was developed at our laboratory and includes items such as ‘I have a constant yearning for music’, ‘Without music, my life would be meaningless’ or ‘Music touches me unlike anything else’.\(^{34}\) Scores along this scale are distributed in a bell curve, with most people expressing moderate endorsement of these statements and fewer tending towards the extremes. Thus, we were able to isolate some of the factors that make individuals more or less emotionally responsive to music.

We also found that emotion was influenced by transient states such as listeners’ motivation, concentration and mood. Memory also plays a part, through learned associations and evaluative conditioning. We called this process ‘associative coding’ (operating side by side with iconic and symbolic coding). Contextual features refer to certain aspects of the performance and/or listening situation.
Thus, a location may be a concert hall, church, open-air site, car or recording studio. The dominant material surrounding the listener or performer may be wood, glass, stone, metal or cement, all materials which affect acoustical features such as reverberation. The music may be transmitted through loudspeakers or headphones, or without any technical support at all. The music may be heard without interruption or may be disturbed by an ambulance siren or audience coughing. And the music may be performed at a specific event, such as a wedding, funeral, ball or celebration of an outstanding achievement. All these features bear upon the acoustics, the ambience of the location or the behaviour of the audience, and these in turn affect listeners’ emotional experience.

The induction rule model (see Table 2) predicts that listener emotion is determined by a multiplicative function between these classes of elicitors. The model postulates a multiplicative, rather than additive, function for two reasons. First, it is unlikely that any one of the constituent factors can reliably elicit a marked emotional effect in and of itself, and in the absence of the other factors. Second, even if every elicitor worked, a single break in the chain would nullify the whole process. Imagine an extremely moving passage, perfectly performed in an atmospherically and acoustically evocative surrounding. In an additive model, these features would make it highly likely that emotion would be induced, irrespective of the listener’s subjective state. By contrast, our model predicts that the probability of emotion induction is low if any one of these factors breaks down – say, if the listener is distracted or is in a flat mood, or if performance and contextual conditions are less than optimal.

The induction rule model makes a provision for quantitative predictions, as can be illustrated with a simplified example (a formal test would require analyses of regressions that are beyond the scope of this article). Assume that musical, performer and contextual features are almost maximally effective, say 90 per cent, and assume further that the receptiveness of the listener is slightly below average, say 40 per cent. In the additive model, the probability of successful emotion induction would remain high, around 70 per cent. In our multiplicative model, the probability drops to 29 per cent. We should underline that even

Table 2 A multiplicative model of musical emotion induction factors: the induction rule model (IRM)

<table>
<thead>
<tr>
<th>Experienced emotion = structural features × performance features × listener features × context features</th>
</tr>
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<tbody>
<tr>
<td>Structural features = ( \beta_1 ) (segmental features) ( \times ) ( \beta_2 ) (suprasegmental features)</td>
</tr>
<tr>
<td>Performance features = ( \beta_3 ) (performer skills) ( \times ) ( \beta_4 ) (performer state)</td>
</tr>
<tr>
<td>Listener features = ( \beta_5 ) (musical expertise) ( \times ) ( \beta_6 ) (stable dispositions) ( \times ) ( \beta_7 ) (mood state)</td>
</tr>
<tr>
<td>Context features = ( \beta_8 ) (location) ( \times ) ( \beta_9 ) (sound acoustics) ( \times \beta_{10} ) (event)</td>
</tr>
</tbody>
</table>

Adapted from Scherer and Zentner (2001). \( \beta \) represents a variable.
when conditions across all four categories of elicitors are close to optimal
\((0.9 \times 0.9 \times 0.9 \times 0.9)\), our model indicates that probability of emotion induction is
still only 66 per cent. This estimate is consistent with findings from the festival
study, which showed a relatively modest success rate of emotional induction,
even in the presence of highly conducive circumstances.

Clearly, much work is required to test and refine the model’s predictive acuity.
It may be, for instance, that the model’s constituent factors need to be weighted
differently to reflect their relative importance. Nevertheless, we hold that, by
distinguishing the factors enabling the induction of musical emotion, our model
can serve as an organizing principle for future research in the field. In principle,
each trait in Table 3 defines an area for possible research, and a fuller picture of
what it takes to successfully induce a musical emotion may begin to emerge only
once the individual factors are understood both separately and through their
relationships with one another.\(^{35}\)

In what follows, I will present an example of how such work might proceed in
the case of suprasegmental features. It is clear that melodic, harmonic and
rhythmic patterns tend to evoke different emotional responses even within the
same work. And yet empirical evidence for this is largely confined to perceived,
rather than induced, emotion.\(^{36}\) In a recent study, Martin Guhn, Alfons Hamm
and I (2007) sought to identify musical correlatives for felt emotions. Specifi-
cally, we analyzed musical events that tend to evoke the phenomenon called
‘chills’. Chills are strong emotional reactions that are accompanied by physi-
ological symptoms such as goose bumps and shivers down the spine – reactions
that the GEMS model classifies as ‘transcendence’ and ‘wonder’.

In our experiment, twenty-seven participants listened to the slow movements
of Chopin’s Piano Concerto No. 1, Mozart’s Piano Concerto No. 23 and Max
Bruch’s Kol Nidrei. Listeners were asked to press a button whenever they expe-
rienced a chill, allowing us to record it in real time. These subjective chill
sensations were correlated with heightened physiological arousal (heart rate and
galvanic skin response). Importantly, we found that instances of chills were not

<table>
<thead>
<tr>
<th>Characteristics of chill-inducing passages</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion in register</td>
<td>Melody goes one octave higher</td>
</tr>
<tr>
<td>Suspension notes</td>
<td>Upper melody ‘arrives’ at phrase end, while lower voices lag behind</td>
</tr>
<tr>
<td>Chromaticism</td>
<td>Vast possibilities for modulation</td>
</tr>
<tr>
<td>Instrumental dialogue</td>
<td>A motive played by violins is taken over by the flutes; alternations</td>
</tr>
<tr>
<td>Melodic, rhythmic and timbric properties</td>
<td>Rising melody, syncopated rhythms, unusually expressive cello</td>
</tr>
<tr>
<td>Slow tempo</td>
<td>Facilitates ‘emotion sedimentation’</td>
</tr>
</tbody>
</table>

Table 3 Musical characterisation of chill-inducing passages

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the case of suprasegmental features. It is clear that melodic, harmonic and
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\(\)
spread randomly across the music, but tended to occur during certain specific passages. Analysis of these passages revealed technical (rhythmic, melodic and harmonic) features which were consistently associated with this effect. The most salient of these features are summarised in Table 3.

A key section (bars 21–24) of Bruch’s Kol Nidrei (see Fig. 2) illustrates some of these elements working together to create reported chills: slow tempo, a sudden registral leap and tonal and dynamic shifts. Thus the solo cello melody leaps an octave (or a tenth from the F cadential note of the previous phrase), the music swells in volume from piano to forte and it modulates to a new key, confirming the modal shift at the end of bar 20 to F major. Also, the number of reported chills per phrase increases from a maximum of three in earlier material to eight in the current passage, underscored by a spike in the physiological sensors (particularly skin conductance, which is widely used as an indicator of emotional arousal).

III. Emotional Response Modes to Music (Subjective Experience, Motor Expression and Neurobiology)

One of the fundamental problems facing empirical research in music and emotion is how to measure listener responses. The problem is particularly acute because music, by its nature, is such a transient phenomenon. After a two-hour concert, most listeners have difficulty recalling and describing the flow of affective feelings they may have experienced during the performance. Many people also find it hard to categorise and label their emotions precisely, because most emotional episodes are a blend of different emotion qualities. Hard-pressed to come up with a particular label to characterise their affective experiences, listeners often resort to general descriptions such as ‘I found it most interesting’, ‘I greatly enjoyed it’ or ‘I thought it was beautiful’. Individual listeners also differ greatly in their ability to label their experiences, as well as in their preference for certain types of descriptors.

However, if presented with an emotion vocabulary suited to musical experiences, listeners should find it less difficult to characterize their emotional experience. This has been our experience with the Geneva Emotional Musical Scale (GEMS), which was designed to capture nuances in the experience of complex musical emotions. Thus, we found that listeners tended to show relatively strong agreement with respect to the emotions triggered by a given piece of music on the level of the broader GEMS categories (e.g. power, nostalgia, wonder, etc.). For obvious reasons, the same extent of agreement cannot be expected for the specific emotion terms (see again Fig. 1). For example, some listeners may report having felt ‘melancholy’, others ‘dreamy’ and still others ‘sentimental’ to, say, Eva Cassidy’s Autumn Leaves. This could be taken to indicate that individuals’ emotive reactions to the same music vary widely and must therefore be qualified as subjective and idiosyncratic. Yet, on a lower level of granularity, these terms are all related members of the ‘nostalgia complex’, just as feelings of
‘spirituality’, ‘inspiration’ and ‘thrills’ variously instantiate ‘transcendence’. (On the next level up, Fig. 1 shows that ‘nostalgia’ and ‘transcendence’ are equivalent subcomponents of ‘sublimity’.) In other words, the taxonomic map of the GEMS provides a tool for understanding when different emotive terms refer to truly
different emotions, and when they reflect minor variations of the same core affect or even random variations in word usage.

As noted earlier, another challenge for the measurement of music-evoked emotion resides in music’s transience. Most studies have adopted the post-performance approach to emotion assessment, whereby a single retrospective rating is provided after stimulus exposure. Our ‘chills’ study addressed this challenge by using real-time self-reporting (of instances of chills) and physiological measurement. New tools are constantly being created to capture the moment-by-moment fluctuations of affective experience, even in concert settings. For instance, Stephen McAdams, Bradley Vines, Sandrine Vieillard, Bennett Smith and Roger Reynolds (2004) asked more than 100 listeners to continuously rate the felt ‘emotional force’ in a concert premiere of Reynolds’s piece *The Angel of Death*; the group also studied the work’s structural and textural features. The experiment was run in two cities (Paris and La Jolla, California), where audience reports were captured through small, purpose-built ‘response boxes’. On both occasions, participants were taught how to use the rating paradigm before the concert and given an opportunity to rehearse it on a trial work. Results from both concerts showed that it was possible in such settings to extract significant mean ratings – moreover, ratings related to musical structure – of ‘emotional force’.

Attempts have also been made to measure listeners’ responses through more ‘objective’ methods. For example, motor expression of emotions, especially in the face, can be used to indicate emotional arousal. There is good evidence that activation of the zygomaticus major muscle (which produces smiling) is consistently linked to positive experience. In contrast, the corrugator muscle (which produces frowning) generally indicates puzzlement or irritation; this reaction has also been reported in infants exposed to sensory dissonance. Emotional reactions can also be inferred from the listener’s posture, particularly that of the head and upper body. However, except when dancing, adults are usually quite self-controlled in their facial and postural expressions to music, which may partially explain the dearth of conclusive studies in this field.

The most important advances have been made in measurement of those physiological reactions to music that may indicate an underlying emotional response. However, quite apart from the difficulty of using such invasive methods with more than a handful of listeners, the data are generally hard to interpret. This is not surprising, as it has proven to be difficult to identify physiological markers such as heart rate, breathing rate or electrodermal responses for the major basic emotions (except, to some extent, for intense states of anger and fear). The situation is similarly complex with neurobiological readings. The power and usefulness of magnetic resonance imaging can hardly be gainsaid; nevertheless, it is doubtful whether current brain imaging techniques are sensitive enough to detect brain activation patterns that correlate with changes in complex aesthetic emotions. A recent study conducted with my colleagues at the neuroscience laboratory in Geneva nonetheless revealed some interesting
brain activation patterns related to the GEMS emotions. For example, ‘joy’ was seen to correlate with activation of the left ventral striatum and the insula, regions that are typically related to the experience of strong rewards such as food, sex, and the consumption of drugs. In turn, ‘tenderness’, ‘nostalgia’ and ‘peacefulness’ were associated with activation patterns in the right striatum, hippocampus, ventromedial prefrontal cortex, the anterior cingulated cortex, and the visual cortex. These areas have been shown to relate to memory and self-reflective processes (the activation of the visual cortex could indicate mental imagery evoked during these music-induced experiences). More striking still, ‘wonder’ and, to a lesser extent, ‘transcendence’ involved blood flow increases across all of these areas. Thus, the enigmatic power and experiential richness of music-induced emotion noted ever since Homer first described it appears to be subtended by a similarly rich and powerful activation pattern in emotive brain sites.\textsuperscript{45}

\textbf{IV. The Primary Musical Emotions in Context}

The present article, in which a number of earlier associated studies are reported, hopes to have shown that a phenomenon which is generally consigned to the anecdotal or impressionistic can be amenable to an empirical and systematic approach. In what follows, some broader implications of the current findings shall be discussed. Our inductive methodology has empirically differentiated musically inducible emotions into nine clusters, at the heart of which we find the dazzling emotions first described in the \textit{Odyssey}. These findings refute the common view, popularised by Eduard Hanslick (1854) and now pervasive in music aesthetics,\textsuperscript{46} that music cannot arouse distinct emotions. To be sure, this tradition often concedes that music may well induce a kind of diffuse excitement or admiration. Nevertheless, listeners’ reports of specific emotions are dismissed as the result of an attribution error. The claim is that listeners mistake cognitive perceptions of expressed emotion for something which they actually feel. Yet this claim is hard to square with the evidence that felt emotions often differ from perceived emotions and rarely mirror them.\textsuperscript{47} That is not to say, however, that perceived and felt emotions do not influence each other.\textsuperscript{48} The claim, rather, is that what listeners feel cannot be fully explained by what they hear. More important, perhaps, these felt emotive states correlate with relatively specific activation patterns in emotive brain sites.\textsuperscript{49}

A legitimate objection might be made that some of the emotive states in our taxonomy are not true emotions. For instance, ‘transcendence’ is perhaps more accurately characterised as an altered state of consciousness, while ‘peacefulness’ feels closer to a mood than to an emotion proper. Such questions are difficult to answer in the absence of a commonly recognised definition of what emotions actually are. In a recent survey, 33 world authorities in emotion studies responded to a request to define emotion; as expected, there was no consensus.\textsuperscript{50} One point of agreement, however, was that emotions have more than one psychological or
behavioural manifestation: in addition to subjective feeling, they also involve action tendencies, physiological arousal, cognitive appraisals and expressive motor behaviour. In the final analysis, our own project can claim only to have identified feelings – experiential substrates of ‘candidate emotions’.

Whether these feelings should be called emotions or not is a largely definitional matter. We have argued that these feelings do represent emotions, however, they are examples of ‘aesthetic’ rather than ‘utilitarian’ emotions. Utilitarian emotions are those which fulfil the aforementioned traditional criteria for emotions. They are triggered by the need to adapt to specific situations which are perceived or appraised to be of central significance to the individual’s interests and well-being. Such emotions tend to be high-intensity reactions which prepare an individual for action. In contrast, music elicits emotions in situations which have absolutely no relevance to the individuals’ moral or material self-preservation. As such, only rarely do they lead to specific goal-oriented responses. With this adaptational modus operandi of common emotions suspended, music (as well as the other arts) evokes emotion in different ways.

Appraisal mechanisms continue to operate, but they relate now to forms, relationships, visual imagery and memories rather than to material events. Physiological changes triggered by the music outside the listener’s conscious awareness may lead him or her to experience feelings for no apparent reason, seemingly ‘out of the blue’ (Robinson 2011). Because the triggers of aesthetic emotions are much less specific than are triggers in adaptational encounters with the real world, these emotions often occur in blended form. A final feature of aesthetic emotions is that individuals enjoy them for their own sake, a behaviour that has been characterised as ‘savoring’ (Frijda and Sundararajan 2007, p. 229). In the case of music, the listener behaves a little like a wine taster. The listener savours the nuances of the music’s emotional stirrings for their own qualities, just as the wine taster savours the delights of different vintages. Utilitarian emotions, on the other hand, are not savoured. When engaged in everyday utilitarian transactions, we react emotionally and are in constant need of regulating our emotions as situations demand, with little time or interest left for emotive savouring. It remains to be understood why evolution favoured two emotive systems, as it were: one instrumental, designed to master our adaptational encounters with the environment; and one aesthetic, connected with our appreciation of more abstract forms of human conduct. One possibility is that engagement with complex forms and relationships, as demanded by the arts, has an intellective survival value. And this is why such engagement was rewarded in *Homo sapiens* with the experience of a particular kind of emotion.

Given the differences between aesthetic and utilitarian emotions, it is not surprising that the GEMS model diverges in crucial respects from the basic-emotion model. Conversely, it is logical that basic emotions align better with perceived emotions – because music is capable of symbolically mimicking a broad range of human expressive behaviour, including negative behaviours such
as fear, anger, despair and pride. There is plenty of evidence that listeners can discriminate whether a piece expresses anger rather than joy, or fear rather than sadness. However, distinguishing between some emotional connotations of music is unlike feeling the emotions. Some works of Schubert can assuredly be dark or uncanny. Nevertheless, pace Spitzer (this issue), they cannot reproduce the real-life aversive context necessary for the experience of true fear, nor do they afford a context for goal-orientated action. At most, the listener will feel ‘apprehension’ – an emotion which falls into the ‘tension’ category of our taxonomy.

This essay has attempted to particularise primary music-evoked emotions as well as the conditions which elicit them. Needless to say, these conclusions are tentative, and they may apply to certain types of listeners and of music more than to others. Also, as important as emotions are in the context of music, it should be kept in mind that people engage in music for reasons other than emotion. Where emotional experiences are concerned, we found that emotions are less easily aroused by music than is generally believed, and reasons for this were analysed in Part II. What may be pervasive and universal, then, is perhaps not so much the actual experience of music-evoked emotion as is the quest for music’s emotional rewards. The uniqueness and relative scarcity of this experience is, in turn, what makes musical emotions so desirable. If gold were commonplace, no one would get excited about it. If music emotions were like other emotions, they would be emotionally redundant – a dispensable experience that might have ceased to fuel humans’ pursuit of music a long time ago.

NOTES


2. See Kivy (1990); see also Davies (1994) and Matravers (this issue) for an overview.


5. See Russell (1980).


7. See Zentner, Grandjean and Scherer (2008), Study 1.

8. Ibid., Study 2.

9. See Juslin and Laukka (2004); see also Laukka (2007).

11. *Ibid*.


13. See, for instance, Maslow (1976); Keltner and Haidt (2003); and Huron (2006).


15. See Trost, Ethofer, Zentner and Vuilleumier (2011); see also Salimpoor, Benovoy, Larcher, Dagher and Zatorre (2011).


23. For an overview, see Justlin and Sloboda (2010), Chs 29 and 30.


27. See Gowensmith and Bloom (1997).


32. See Rentfrow and McDonald (2010).


34. See Zentner (2011).

35. See also Justlin and Västfjäll (2008); and Konečni (2008).

36. See Scherer and Oshinsky (1977); and Gabrielsson and Lindström (2010).

37. See Guhn, Hamm and Zentner (2007).

38. *Ibid*.


40. See Zentner and Eerola (2010b).


42. See Justlin and Sloboda (2010), Ch. 11.
44. See Stemmler (2003).
46. See Kivy (1990); Meyer (1956); Pratt (1952); and especially Davies (1994) for an overview.
47. See Evans and Schubert (2008); Kallinen and Ravaja (2006); and Zentner, Grandjean and Scherer (2008), Study 2.
52. See also Matravers (1998); and Ridley (1995).
55. See Gabrielsson and Lindström (2010).
56. The Geneval Emotional Music Scale discussed in this article can be found on the author’s research web page at http://www.zentnerlab.com/psychological-tests/geneva-emotional-music-scales.

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Marcel Zentner is a Senior Lecturer in the University of York’s psychology department. He has written three books and several book chapters, as well as articles in such professional journals as *Nature* and *PNAS: Proceedings of the Natural Academy of Sciences*. His main areas of research are temperament, emotion and music perception.

ABSTRACT

In his *Odyssey*, Homer described a particular kind of music-evoked emotion, a tapestry of wonder, dazzle, entrancement and enchantment which has been largely ignored in recent work on music and emotion. In this article, our work on the characterization and classification of music-evoked emotion, which allowed us to identify 45 emotion terms relating to emotive states typically and recurrently induced by music, will be recapitulated. A model with nine emotion clusters, sometimes referred to as the GEMS model, provides a higher-order representation of the interrelationships between these emotive states. Strikingly, the first of these basic music emotions, ‘wonder’, is akin to the emotion described by Homer 2,800 years ago. After elucidating the other primary music emotions, I will turn to the question of how emotions are elicited by music and will present our ‘induction rule model’ as an explanatory frame. This will be followed by a brief overview of measures of music-induced emotion, where I will present some new findings on the neurobiology of the GEMS emotions. In the final section these empirical findings will be contextualised within current psychological and philosophical views of music and emotion.