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Chapter 5

From mimesis to catharsis: expression, perception, and induction of emotion in music

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Musical communication is often considered to be a transmission process through which meaning of some kind is conveyed from one person to another. Opinions vary drastically on the nature of the meaning, and on exactly 'who' or 'what' is doing the conveying. However, as pointed out by Meyer (1956) and Serafine (1980), the meaning–transmission idea is also evoked by formalists, who implicitly assume that there is some meaning to be received or 'decoded' by a listener. The question is: What does music communicate? Although this book provides a number of different answers to this question, probably the most common notion about what music communicates is emotion. Music is often referred to as 'the language of emotions' (e.g. Cooke 1959). This idea is not entirely accurate (there is not a semantics in music), but it does capture one important feature, namely that music is often seen as an effective means of expressing and inducing emotions:

'Nearly everyone enjoys listening to music. Why? Undoubtedly, because music moves the emotions. But this answer replaces one puzzle with two: how does music communicate emotions, and why do we enjoy having our emotions stirred in this way? No one knows...'

(Johnson-Laird 1992, p. 13)

Johnson-Laird's final sentence is perhaps overly pessimistic. As we shall see later in this chapter, researchers are making *some* progress, at least, in explaining how music communicates emotions to listeners (see also Juslin and Sloboda 2001).

This chapter aims to provide a review of important theoretical concepts as well as empirical findings regarding musical emotions that may serve as a background to some of the following chapters of this volume, several of which touch upon emotional aspects of musical communication. Because it is sometimes hard to clearly distinguish instances of communication from

instances of non-communication in regard to musical emotions – and because researchers often disagree about how emotional communication should be defined – I will deliberately cast a wide net on research on musical emotions that can help us understand musical communication. This will pave the way for a serious consideration of whether music really can be conceived of as a channel of emotional communication. The so-called ‘transmission model’ of music has been criticized by some authors (Swanwick 1985). This chapter might be construed as an attempt to convince a skeptic that there *is* a sense in which music communicates emotions to listeners – which is *not* to say that this is the sole or main value of music (Budd 1989).

The structure of this chapter is as follows: First, I critically examine the notion of music as a means of communication of emotion, and present some relevant evidence concerning this issue. Then, I provide a working definition of emotions and some conceptual distinctions for the study of musical emotion. Following that, I review mechanisms through which music may express and induce emotions, respectively. Finally, I consider various objections to music-as-communication and provide an agenda for future research. The discussion is generally limited to Western music, especially classical and popular music from the eighteenth century to present day.

Music as communication of emotion

Working definition of communication

Johnson-Laird (1992) offers a useful working definition of communication. First, he notes that communication is a matter of *causal influence*; that is, a communicator influences his or her recipient, one way or another (e.g. a musician influences the auditory impressions of a listener). However, Johnson-Laird notes that the concept of communication also calls for something more: a communicator has a *message* to transmit. Specifically, the communicator constructs an internal representation of some aspect of the world, such as an emotional state, and then – *intentionally* – carries out some symbolic behaviour that conveys the content of that representation. The recipient must first perceive this symbolic behaviour, and then recover from it an internal representation of the content it signifies. Like all symbolic behaviours, the communicative behaviour is arbitrary in at least one sense: different symbolic conventions could, in principle, have been used to convey the same contents. Yet, in any concrete instance of communication, the symbolic behaviour used may reflect natural principles, human conventions, or a combination of the two. The important thing is that there is a shared ‘code’ among senders and receivers (Shannon and Weaver 1949).

Communication in music

Application of the aforementioned definition of communication to music requires that we clarify the relationship between expression and communication. Figure 1 illustrates the ‘chain’ of musical communication as it is commonly conceived by music researchers, and may help us to compare various definitions of expression and communication. Moving from left to right, Fig. 5.1 shows (1) the composer’s intention (e.g. the notation); (2) the performer’s intention; (3) the acoustic features of the music; (4) the listener’s perception of these features (involving both the detection of the features and the recognition of relevant patterns in them); and (5) the (possible) induction of mental states as an effect of this perception. Each of these aspects is, of course, embedded in a particular context, but the context is rarely modelled explicitly.

It is important to note that different definitions of expression and communication focus on different aspects. Particularly, they differ with regard to how many of these aspects are required in order for a particular instance to qualify as a case of ‘expression’ or ‘communication’. It may seem natural to include *all* of the aspects in any definition of expression or communication, but this is seldom done explicitly, or in actual practice. More often, only sub-sets of the aspects are taken into account. The most extreme example is provided by researchers of expression in music performance, who often define ‘expression’ simply in terms of the large and small variations in timing, dynamics, timbre, and pitch that form the *microstructure* of a performance (e.g. Palmer 1997).

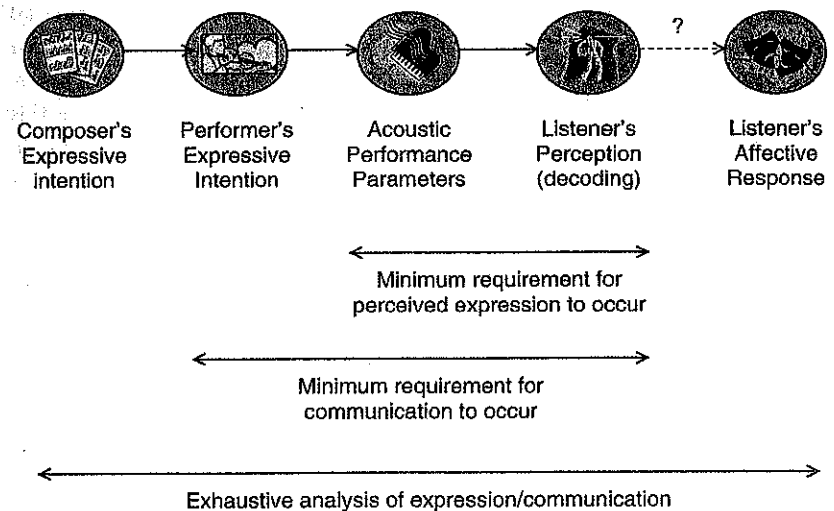


Fig. 5.1 Different aspects of the chain of musical communication of emotion.

This view implies that acoustic features alone are sufficient to define musical expression. This notion is problematic, however. Although musical expression originates in performers' and composers' behaviours, it is more appropriate to define expression from the listener's perspective: 'Expression's domain is the mind of the listener' (Kendall and Carterette 1990, p. 131).

In this chapter, *expression* refers to a set of perceptual qualities (e.g. structural, emotional, motional) that reflect psycho-physical relationships between 'objective' properties of the music, and 'subjective' – or, rather, objective but partly person-dependent – impressions of the listener. Expression does not reside solely in the acoustic properties of the music (different listeners *may* perceive the expression differently), nor does it reside solely in the mind of the listener (different listeners *usually* agree about the general nature of the expression in a piece of music). Expression depends on both of these factors, in ways that, although complex, can be modelled in a systematic fashion (see Juslin 2000). Our perception of expressive music reminds us, somehow, of the ways humans express their states of mind in real life; why would we otherwise use the term expression in the first place? We have a tendency to perceive *expressive form* even in inanimate objects. For instance, a tree may be sad-looking (e.g. Davies 1994). Sometimes, the perception of expressive music also evokes an *emotion* in the listener (he or she is 'moved'), though such a response is not *required* for a listener to hear the music as expressive (Davies 1994). Musical expression is often measured in terms of *listener agreement*: music is expressive of a certain quality to the extent that there is some level of agreement among listeners about the expression (presumably because there is something in the actual music that gives rise to similar listener impressions). Though studies of expression may well benefit from analyses of composers' or performers' intentions, perception of expression – as defined here – does not require that there is an expressive intention on the part of the composer or performer (Juslin 2003).

The concept of *musical communication* (of emotion for instance), in contrast, goes further: Communication, I propose, requires that there is both a composer's (or performer's) *intention* to express a specific concept and *recognition* of the same concept by a listener. The accuracy of the communication may be indexed in terms of the extent to which the composer (or performer) and the listener agree about the expression of the music: is the expression perceived as intended? That a definition of communication should include the composer's intention, the performer's intention, the acoustic features of the music, and the listener's perception is, perhaps, not controversial. The critical question is whether communication requires that the music, in addition, *induces* emotions in the listener (cf. Fig. 5.1). A review of the literature reveals that different authors have used the concept of emotional communication differently.

Some authors view communication in terms of perception (e.g. Juslin 1997a; Thompson and Robitaille 1992); that is, emotions are expressed by musicians and perceived by listeners – induction is 'optional'. Other authors limit the concept to instances where the emotion expressed is also *induced* in the listener. Both uses of the term could be legitimate, depending on the circumstances. Therefore, in this chapter, I shall review empirical findings regarding both perception and induction of emotions.

Does music communicate emotions?

Although some readers might find it obvious that music communicates emotions, this notion has been questioned by certain authors (Hanslick 1854/1986). On what basis can we really claim that music involves emotional communication? A natural point of departure is to consult listeners and musicians. Studies of popular music have revealed that listeners emphasize the role of music-as-communication: 'Popular musicians are loved, and even worshipped, not only for their abilities to write songs and perform them publicly, but for their ability to "speak" to their audiences. Even an artist whose only contact with the audience is through the sales of millions of compact discs and tapes communicates "personally" with each listener' (Lull 1992, p. 3). Such an impression is confirmed by recent findings from a questionnaire study featuring 141 listeners, aged 17–74, who responded to various questions about musical expression, communication, and emotion (Juslin and Laukka 2004). The majority of listeners (>67 per cent) reported (a) that they experience that music (or musicians) communicates with them, and (b) that music communicates emotions (as indicated by their own free responses to an open-ended question). All of the listeners believed that music can express emotions (as compared to, for instance, 51 per cent for 'personality characteristics') and 76 per cent of the listeners claimed that music expresses emotions 'often'.

Similarly, a questionnaire study featuring 135 expert musicians from three countries (England, Italy, Sweden) revealed that the majority of the musicians defined expression mainly in terms of 'communicating emotions' and 'playing with feeling' – as indicated by their own free responses (Lindström *et al.* 2003). When directly asked about whether music expresses emotions, 99 per cent of the musicians confirmed that this is the case. Moreover, 83 per cent of the musicians claimed that they try to express specific emotions in their musical performances 'always' or 'often'. These results are confirmed and extended in recent research by Minassian *et al.* (2003). They conducted a questionnaire study featuring 53 expert performers of classical music, and explored which factors were statistically associated with an optimal performance. Performances judged as optimal tended to be those where the performer (a) had a clear

intention to communicate (usually an emotional message), (b) was emotionally engaged with the music, and (c) believed the message had been 'received' by the audience. Finally, an interview study by Burland and Davidson (2004) showed that performers in pursuit of a professional performing career were more inclined to think of music as a vehicle for communication than were performers in pursuit of a non-music career.

Numerous biographies and interviews with performers (both classical and popular) confirm that they often conceive of musical expression in terms of emotions and communication (Boyd and George-Warren 1992; Carreras 1991; Denski 1992; Menuhin 1996; King 1996; Persson 2001; Schumacher 1995). Apart from the fact that listeners and musicians appear to conceive of music in terms of emotional communication, there is also evidence that music really *can* communicate emotions to listeners. The following sections will be devoted to reviewing this evidence.

Key distinctions in musical emotion

The study of musical emotion has generally suffered from conceptual confusion. To enhance the cumulateness of research efforts, and to promote fruitful debate, it may be heuristic to adopt a number of conceptual distinctions. These distinctions may help researchers to specify in a much more precise fashion *what* they are investigating and *how*. First, we need a working definition of emotion. There are many different ways to define emotions, but most emotion researchers would probably agree that emotions can be seen as relatively brief and intense reactions to goal-relevant changes in the environment that consist of many *sub-components* (Oatley and Jenkins 1996, Ch. 4):

- ◆ cognitive appraisal (e.g. you appraise the situation as 'dangerous')
- ◆ subjective feeling (e.g. you feel afraid)
- ◆ physiological arousal (e.g. your heart starts pounding)
- ◆ emotional expression (e.g. you scream and call out for help)
- ◆ action tendency (e.g. you are strongly inclined to run away)
- ◆ emotion regulation (e.g. you try to calm yourself)

Different researchers of musical emotion focus on different components, as these enter into the musical communication process. For instance, some focus on the emotional expression of the performance; others focus on the cognitive appraisal of the music that induces an emotion, or on how the induced emotion influences physiological measures; still others focus on how music may be used to regulate emotions. It is important to note that what counts for one emotion component, theoretically and empirically speaking, does not necessarily hold for another component.

Researchers disagree as to whether emotions are best conceptualized as *categories* (Ekman 1999), *dimensions* (Russell 1980), or *prototypes* (Shaver *et al.* 1987). Different theories of emotion have been adopted in studies of music, and it is fair to say that there is currently no theoretical paradigm that dominates studies of emotion in music. Most researchers have not explicitly adopted one or the other of these approaches, but their implicit orientation can still be inferred from the way in which they have operationalized listener responses. For example, the researcher who asks the participants to respond by choosing an emotion from a list of emotion labels is implicitly assuming that there are discrete emotion categories.

There are also different *sources* of emotion in music (Sloboda and Juslin 2001); that is, there are different 'psychological mechanisms' that may give rise to emotional responses through their interactions with music (see pp. 102–4 for some examples). Note that what counts for one particular source of emotion may not count for another source, and different theories may be required to explain each source. Furthermore, different sources of emotion may involve and be affected by a number of *causal variables*. Indeed, a serious problem is the manifold determinants of musical emotions. Gutheil (1952, Appendix A) listed, in a systematic fashion, all the variables that might potentially influence musical emotions, and this list may be unprecedented to this day. Given this complexity – later more concisely formulated as *an interaction between the music, the person, and the situation* (e.g. Jørgensen 1988; see also Gabrielsson 2001) – it is important that researchers are careful in how they select causal variables to include in their study.

Finally, it is important to make a distinction between *perception* and *induction* of emotions. We may simply perceive emotions in the music, or we may actually feel emotions in response to the music. This distinction, known since ancient Greece, is often but not always made in modern research. It is crucial to make this distinction for three reasons. First, the underlying mechanisms may be very different depending on the process involved. Second, measuring induced emotion is more difficult than measuring perceived emotion, and the methods must be adapted accordingly. Third, the types of emotions typically expressed and perceived in music could be rather different from the set of emotions typically induced by music.

Mechanisms of musical communication of emotion

Human communication commonly begins and ends with conscious messages. However, the intervening mental processes are almost completely unconscious (Johnson-Laird 1992). Indeed, the fact that many of the processes that underlie musical communication of emotion are implicit helps to 'mystify' the nature of musical expression to musicians (e.g. Denski 1992). However, a large

number of studies have studied the mechanisms by which music communicates emotions to listeners. In the following overview, I adopt the previously noted distinction between perception and induction of emotion. This division must not be taken to imply that the two processes never occur together. On the contrary, they *do* co-occur, although perhaps not always in the simple one-to-one relationship (e.g. 'perception of sadness induces sadness') one may be tempted to believe.

Expression and perception of emotion

Can music express specific emotions? Emotion perception is relatively easy to measure and is a 'cognitive' process in the sense that it may well proceed without any emotional involvement on the part of the listener. In principle, a listener might perceive *any* emotion in a piece of music, and in a sense, it may be inappropriate to claim that the listener is 'wrong'. However, researchers are usually interested in cases where emotions in music are perceived *similarly* by many listeners (or perceived in the way *intended* by a composer or a performer), perhaps because such common impressions relate strongly to the nature of the music. Can music express various emotions in this way? This issue has been examined in terms of (a) *listener agreement* (where the music is said to express a particular emotion 'reliably' when there is a certain level of agreement among listeners about what the music expresses) and (b) *accuracy* (which refers to listeners' 'correct' recognition of emotional expression according to some 'independent criterion' such as the composer's or the performer's intention). The latter index corresponds better to the established meaning of the word communication, although most previous research has relied on measures of agreement, because it is usually difficult to obtain reliable indices of composers' expressive intentions. It can be argued that listener agreement is a necessary but not sufficient condition for communication to occur, in that a performer can hardly be described as successful in communicating a particular emotion to a group of listeners if the listeners totally disagree about the emotion expressed. On the other hand, even if there *is* listener agreement, listeners' judgements may not correspond with the performer's expressive intention, in which case the communicative process is still unsuccessful.

The results from over a hundred studies have suggested that listeners are generally consistent in their judgements of emotional expression in music. That is, listeners' judgements are systematic and reliable, and can thus be predicted with reasonable accuracy. However, there is usually high agreement among listeners about the *broad* emotional category expressed by the music, but less agreement concerning the nuances *within* this category (Campbell 1942; Downey 1897; Juslin 1997c). Hence, the precision with which music can

convey different emotions is clearly limited. Listeners' agreement about the perceived expression varies depending on many factors (e.g. the piece of music, the musical style, the response format, the procedure), yet perception of emotions in music is robust in that listener judgements are only marginally affected by musical training, age, and gender of the listener (e.g. Gabrielsson and Juslin 2003). That musical training is not required to express (Yamasaki and Juslin 2002) or recognize (Juslin 1997a) emotions in music suggests that general mechanisms of perception of emotion are involved – a hypothesis that is supported by the finding that abilities to decode emotions in music are correlated with measures of *emotional intelligence* (Resnicow *et al.* 2004).

Most studies have focused on discrete emotions. Attempts to reduce perceived emotions to a smaller number of dimensions have typically yielded dimensions corresponding to those obtained in other domains of emotion, such as *activation*, *valence*, and *potency* (Kleinen 1968; Nielzén and Cesarec 1981; Wedin 1972), but also some dimensions that probably are more typical for music (e.g. *solemnity*), and that might reflect a distinction between 'serious' and 'popular' music in the music excerpts used. Much of music's expressiveness lies in the *changes* in musical features over time, and a dimensional approach may be particularly suitable for describing gradual movements of the musical expression in the 'affective space'. Thus, there has recently been some progress in tracing listeners' perception of emotions in music over time, using 'continuous response formats' (Schubert 1999; Sloboda and Lehmann 2001). One interesting development is the use of synthetic facial expressions to display changes in perceived valence and activation (Schubert 2004).

However, while generally attractive, two-dimensional models of perception of emotion have certain problems associated with them. One such problem is that positive and negative affect may be two, partly independent dimensions (Cacioppo and Gardner 1999). If this is true, certain states cannot be properly represented by a two-dimensional space with a single 'valence' dimension. In addition, two dimensions may not adequately differentiate some emotions such as anger and fear that occupy a similar position in the affective space, but that really sound and feel very differently with respect to music. Therefore, findings obtained with continuous response formats need to be corroborated using other response formats (for an example, see Schubert 1999).

Knowledge gained from experimental studies of emotional expression is complemented by information gained from more 'impressionistic' studies of expression, for example, in sociology (Harris and Sandresky 1985; Middleton 1990), musicology (Cook and Dibben 2001), philosophy (Davies 1994), and psychoanalysis (Noy 1993). Freed from the constraints of operationalization (i.e. the translation of theoretical concepts into concretely defined measures)

researchers are able to address more subtle and complex aspects of musical expression, although obviously with more uncertainty regarding the underlying causal relationships.

That listeners tend to agree about the emotional expression in music is one thing, but to what extent can music composers and performers actually *communicate* specific emotions to listeners? Few studies have explicitly investigated the extent to which composers can communicate specific emotions to listeners. However, a rare exception is the study by Thompson and Robitaille (1992). They asked five highly experienced musicians to compose short melodies that should convey six emotions: joy, sorrow, excitement, dullness, anger, and peace. They were required to rely on such information (pitch, temporal and loudness information) that is contained in musical scores. Deadpan performances of the resulting compositions by a computer sequencer were played to fourteen listeners moderately trained in music. They successfully recognized the intended emotions in the pieces. Thus, it would seem that music composers can really convey *some* emotions reliably.

Several studies have investigated the extent to which *performers* can communicate emotions to listeners. These studies have provided fairly precise estimates of the communication accuracy. In the most extensive review of emotional expression in music performance to date (see Juslin and Laukka 2003) including 41 studies, a meta-analysis of the communication accuracy showed that professional performers are able to communicate five emotions (happiness, anger, sadness, fear, tenderness) to listeners with an accuracy approximately as high as in facial and vocal expression of emotions. The overall decoding accuracy was equivalent to a raw accuracy score of $p_c = .70$ in a forced-choice task with five response alternatives (i.e. the mean number of emotions included in studies thus far). In accordance with what has been found in studies that use listener agreement as the dependent variable (as mentioned earlier), the evidence from performance research indicates that the communication process operates in terms of broad emotion categories, whereas finer distinctions within these categories are difficult to communicate reliably without additional context provided by, for instance, lyrics, program notes, or visual impressions.

What are the reasons for music's inability to communicate more specific emotions reliably? There are, in fact, several reasons: first of all, music's ability to communicate emotions is heavily dependent on its similarity to other forms of non-verbal communication and the kinds of emotions that are possible to communicate through *those* channels (cf. Clynes 1977; Davies 1994; Juslin 1997a); for instance, the patterns of communication accuracy for various basic emotions in music seem to closely mirror those of emotional speech (Juslin and Laukka 2003). Secondly, the musical features involved in communication of

emotions are only *probabilistically* related to the emotions and are partly *redundant* (e.g. Juslin 2001), which limits the complexity of the information that can be conveyed (Shannon and Weaver 1949). Finally, because precision of communication is not the only criterion by which we value music, communicative reliability is frequently compromised for the sake of other virtues of music, such as beauty of form. Thus, for instance, emotion may be only one of many components of expression in music performance (Juslin 2003; Juslin *et al.* 2002).

How does music express different emotions? There are numerous features of music that have been reported to be suggestive of discrete emotions. Table 5.1 shows an updated summary of these features for the most commonly studied emotions. As can be seen in Table 5.1, the features include tempo, mode, harmony, tonality, pitch, micro-intonation, contour, interval, rhythm, sound level, timbre, timing, articulation, accents on specific notes, tone attacks and decays, and vibrato. Note that there are *different configurations of musical features for different emotions* as predicted by a categorical approach to emotion. Note also that the same feature can be used in a similar manner in more than just one emotional expression (e.g. fast tempo is used in both anger and happiness). Hence, each feature is neither necessary nor sufficient, but the larger the number of features used, the more reliable the communication (e.g. Juslin 2001). The relationships between features and emotions are only *probabilistic* (i.e. uncertain) and are therefore best thought of as correlational, as captured by the *Lens Model* (Juslin 1995). Most of the investigated features are rather simple, whereas more complex features (e.g. harmonic progression, melody, musical form) remain to be thoroughly investigated in future research. In addition to the overall features described in Table 5.1, there are several kinds of *musical ornaments* (e.g. the trill, the appoggiatura) that may be used to express emotions, as discussed in many treatises on interpretation (e.g. Bach 1778/1985) and as also demonstrated in recent research (Timmers and Ashley 2004).

What are the *origins* of these relationships between musical features and different emotions? There is no simple answer to this question, but the relationships most likely have several origins. Performance features such as tempo, loudness, and timbre, many of which music has in common with the non-verbal aspects of speech (Juslin and Laukka 2001), may largely reflect a speech code. We recently made a systematic comparison of 104 studies of emotional speech and 41 studies of emotion in music performance (Juslin and Laukka 2003). Results showed among other things that performers use primarily the same emotion-specific patterns of acoustic parameters that are used in emotional speech (as originally argued by Spencer 1857). This is one example of cross-modal similarities in expressive form between different non-verbal communication channels, which has been suggested by several authors (e.g. Clynes 1977; human movement is

Table 5.1 Summary of musical features correlated with discrete emotions in musical expression

Emotion	Musical features
Happiness	fast tempo, small tempo variability, major mode, simple and consonant harmony, medium-high sound level, small sound level variability, high pitch, much pitch variability, wide pitch range, ascending pitch, perfect 4th and 5th intervals, rising micro intonation, raised singer's formant, staccato articulation, large articulation variability, smooth and fluent rhythm, bright timbre, fast tone attacks, small timing variability, sharp contrasts between 'long' and 'short' notes, medium-fast vibrato rate, medium vibrato extent, micro-structural regularity
Sadness	slow tempo, minor mode, dissonance, low sound level, moderate sound level variability, low pitch, narrow pitch range, descending pitch, 'flat' (or falling) intonation, small intervals (e.g. minor 2nd), lowered singer's formant, legato articulation, small articulation variability, dull timbre, slow tone attacks, large timing variability (e.g. rubato), soft contrasts between 'long' and 'short' notes, pauses, slow vibrato, small vibrato extent, ritardando, micro-structural irregularity
Anger	fast tempo, small tempo variability, minor mode, atonality, dissonance, high sound level, small loudness variability, high pitch, small pitch variability, ascending pitch, major 7th and augmented 4th intervals, raised singer's formant, staccato articulation, moderate articulation variability, complex rhythm, sudden rhythmic changes (e.g. syncopations), sharp timbre, spectral noise, fast tone attacks/decays, small timing variability, accents on tonally unstable notes, sharp contrasts between 'long' and 'short' notes, accelerando, medium-fast vibrato rate, large vibrato extent, micro-structural irregularity
Fear	fast tempo, large tempo variability, minor mode, dissonance, low sound level, large sound level variability, rapid changes in sound level, high pitch, ascending pitch, wide pitch range, large pitch contrasts, staccato articulation, large articulation variability, jerky rhythms, soft timbre, very large timing variability, pauses, soft tone attacks, fast vibrato rate, small vibrato extent, micro-structural irregularity
Tenderness	slow tempo, major mode, consonance, medium-low sound level, small sound level variability, low pitch, fairly narrow pitch range, lowered singer's formant, legato articulation, small articulation variability, slow tone attacks, soft timbre, moderate timing variability, soft contrasts between long and short notes, accents on tonally stable notes, medium fast vibrato, small vibrato extent, micro-structural regularity

Note. Shown are the most common findings in the literature. For further details, see Gabrielsson and Juslin (2003), Juslin and Laukka (2003), and Juslin and Lindström (2003).

another candidate for explaining musical expressiveness, e.g. Davies 1994). Speech prosody may also help to explain some of the emotional connotations associated with melodic contours (e.g. Fónagy and Magdics 1963; Papoušek 1996), which seem to play an important role in the early interactions of infants and caregivers. Various other aspects of composed musical structure are not as easily explained. However, features of a piece of music that are usually indicated in the notation of the piece (e.g. harmony, tonality, melodic progression) are likely to reflect to a larger extent characteristics of music as a human art form that follows its own intrinsic rules and that varies from one culture to another. Some of the effects of composer-features (e.g. consonance/dissonance) may originate in psycho-physical relations between acoustic properties and basic perceptual mechanisms (Cooke 1959), but most probably reflect cultural conventions developed over the long course of music's history, and are in that sense more or less 'arbitrary'. At this stage of the historical development, these alternative but not mutually exclusive explanations are not easily teased apart.

Do we have sufficient knowledge about emotional expression in music to be able to actually model the communication process mathematically? Indeed, there have been successful attempts at *quantifying* various aspects of the emotional communication process, using a modified version of Brunswik's *Lens Model* (Juslin 1995, 2000). This model can help us understand many crucial issues concerning expression of emotion in music. One important goal in this domain is to better understand how composed and performed cues *interact* in expression of emotion (Juslin 1998, p. 50). The problem, of course, is the enormous complexity: there are so many musical features and their potential interactions to consider (see Table 5.1). Hevner's (1935, 1936) pioneering work was important, though she lacked a number of modern research tools, such as computer synthesis and certain multivariate techniques, that may be needed to make real progress. How can we approach the complex interplay between musical features in a practically feasible way?

We have recently proposed an *Expanded Lens Model* (Juslin and Lindström 2003; Fig. 5.2). The Lens Model was originally applied only to performance features (Juslin 2000). However, in the expanded version, both composer cues and performance cues are included to make it possible to explore their relative contributions. In addition, important interactions between performer and composition cues are included as predictors in the model. The goal is also to be able to model the emotion judgements of individual listeners. As in our previous research (Juslin 1997b, 2000), we are using a statistical approach based on multiple regression analysis. Contrary to popular belief, it is actually possible to investigate the relative contributions of interactions between predictors within the framework of multiple regression analysis. Recent studies

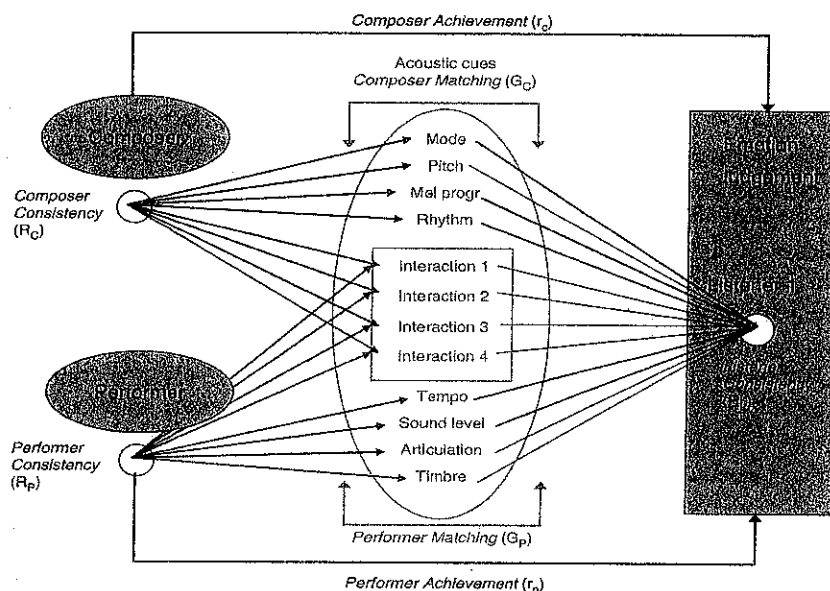


Fig. 5.2 Extended Lens Model (ELM) of musical communication of emotions. (Adapted from Juslin and Lindström 2003)

based on this framework, using both analysis and synthesis (e.g. Juslin and Lindström 2003), indicated that a large amount of the variance in listeners' emotion ratings could be explained by a linear combination of the main effects alone (typically around 75–85 per cent). Furthermore, results indicated that interactions between composed and performed features made small (but not negligible) contributions to the predictive power. Thus, an important lesson from this investigation was that, although there *are* interactions among musical features, we should not overstate their importance; they may be fewer and smaller than previously believed. (Further evidence that judgements of affective qualities of music reflect mainly an additive combination of musical features were reported by Makris and Mullet 2003.)

Much work remains to be done in order to fully understand musical expression, but it can be concluded that people can express and perceive different emotions in music (cf. Fig. 5.1).

Induction of emotion

Does music induce emotions in listeners? It might appear obvious from everyday experience that music induces emotions in listeners. Anecdotal evidence

on the emotional powers of music is certainly abundant; yet we know better than to accept such reports at face value. Is there scientific evidence supporting the idea that music can induce emotions? Emotions are inferred on the basis of three kinds of evidence: (a) *self-report*, (b) *expressive behaviour*, and (c) *physiological reaction*. Empirical evidence of emotional reactions to music comes from several strands of research which are summarized in Table 5.2.

Table 5.2 Examples of evidence of emotional reactions to music from various strands of research.

Type of research	Finding
<i>Experiments</i>	Music produces differentiated effects on self-report, physiology, and behaviour (Davis and Thaut 1989; Kallinen 2004; Krumhansl 1997; Nyklíček <i>et al.</i> 1997; Panksepp, 1995; Pignatello <i>et al.</i> 1989; Pike 1972; Vaitl <i>et al.</i> 1993; Waterman, 1996; Västfjäll, 2002).
<i>Qualitative interviews</i>	Listeners employ music to regulate, enhance, and change qualities and levels of emotion. They show considerable awareness about the music they need to hear in different situations to induce particular emotions (DeNora 2001; Gomart and Hennion 1999).
<i>Brain imaging and EEG</i>	Listeners' responses to music involve subcortical and cortical regions of the brain that are known from previous research to be involved in emotional reactions (Altenmüller <i>et al.</i> 2002; Blood and Zatorre 2001; Peretz 2001; Schmidt and Trainor 2001).
<i>Field studies</i>	Music influences consumer behaviour, helping, and interpersonal attraction and conflict (Fried and Berkowitz 1979; Honeycutt and Eidenmüller 2001; May and Hamilton 1980; North and Hargreaves 1997a; North <i>et al.</i> 2004).
<i>Questionnaires</i>	Music serves various emotional functions in everyday life: to change moods; to release emotions; as a source of comfort; to match current mood; as a source of enjoyment; to relieve stress, etc. (Behne 1997; Juslin and Laukka 2004; Panzarella 1980; Roe 1985; Sloboda 1991; Sloboda and O'Neill 2001; Zillman and Gan 1997; Wells 1990).
<i>Music therapy</i>	Music facilitates the expression, identification, and experience of emotions; improves the control of one's own emotional behaviour; helps to 'trigger' emotionally-laden memories of past events; and helps to diagnose patients' psychiatric conditions (Thaut 1990).
<i>Ethnographic research</i>	Emotional response to music is a 'universal' phenomenon, typically involving feelings of happiness and arousal, although the particular forms of engaging with music may differ from one culture to another (Becker 2001; Blacking 1973).