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Emotions Evoked by the Sound of Music: Characterization, Classification, and Measurement

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One reason for the universal appeal of music lies in the emotional rewards that music offers to its listeners. But what makes these rewards so special? The authors addressed this question by progressively characterizing music-induced emotions in 4 interrelated studies. Studies 1 and 2 (n = 354) were conducted to compile a list of music-relevant emotion terms and to study the frequency of both felt and perceived emotions across 5 groups of listeners with distinct music preferences. Emotional responses varied greatly according to musical genre and type of response (felt vs. perceived). Study 3 (n = 801)—a field study carried out during a music festival—examined the structure of music-induced emotions via confirmatory factor analysis of emotion ratings, resulting in a 9-factorial model of music-induced emotions. Study 4 (n = 238) replicated this model and found that it accounted for music-elicited emotions better than the basic emotion and dimensional emotion models. A domain-specific device to measure musically induced emotions is introduced—the Geneva Emotional Music Scale.

Keywords: emotion, feeling, music, emotion induction, music preferences

Music is present in every culture, and it plays a prominent role in people's everyday lives. According to a recent report, the prevalence of most leisure activities, such as watching TV or movies or reading books, has been overtaken by music listening (Rentfrow & Gosling, 2003). To occupy such a gigantic space in human lives, music must be uniquely rewarding to its listeners. But what makes music so rewarding? Since ancient times, the emotive qualities induced by music have been invoked as a possible explanation. For example, drawing from Plato's *Republic*, Aristotle gave relatively detailed descriptions of the emotional effects of different musical modes. Whereas the Mixolydian mode tended to make people sad, the Phrygian mode inspired enthusiasm (*Politics,* book VIII*).* Starting with Hellenic philosophy, the topic of music and emotion has long remained the philosopher's domain, as documented by the impressive number of theories about music and emotion (e.g., Budd, 1985; Davies, 1994; Robinson, 2005).

Only relatively recently has theorizing about music's potential to elicit (or alter) mood and emotion been sidelined by empirical research (e.g., Juslin & Sloboda, in press; Juslin & Zentner, 2002; Scherer & Zentner, 2001, for overviews). Among other things, this research has shown that music is an effective means of mood induction in the laboratory (see Västfjäll, 2002; Westermann, Spies, Stahl, & Hesse, 1996, for reviews), a means of mood manipulation to alter consumer behavior (e.g., Alpert & Alpert, 1990; Bruner, 1990, for reviews), and also a tool for the treatment of emotional disorders (see Gold, Voracek, & Wigram, 2004, for a review). Investigators have also shown that, in everyday life, music is predominantly used for mood and emotion regulation (e.g., Laukka, 2007; Saarikallio & Erkkilä, 2007; Sloboda & O'Neil, 2001). Further testifying to the powerful emotional effects of music, affective reactions to music have been observed in infants as young as 4 months of age (e.g., Zentner & Kagan, 1996, 1998). Moreover, tentative evidence suggests that brain regions activated by emotional music are similar to those that are activated by strong rewards such as sex, food, and drugs of abuse (e.g., Blood & Zatorre, 2001; Menon & Levitin, 2005). Taken together, the evidence suggests that one important reason for music's universal appeal lies in the emotional rewards that it offers to its listeners.

However, despite rapidly expanding research on music and emotion, a deeper understanding of the emotive states evoked by music is hampered by preconceived ideas about the links between emotions and music (Konecni, Brown, & Wanic, 2008) as well as a lack of well-supported concepts, definitions, and measures (Scherer & Zentner, 2001). For example, there is at present no systematic, empirically derived taxonomy of musically induced emotions. As a consequence, researchers apply models and measures from nonmusical areas of emotion research to the study of musically induced emotions. In addition, there is little consensus regarding the processes that lead from a musical stimulus to an experienced emotion, despite a time-honored tradition of theorizing about such processes (e.g., Ellsworth, 1994; Juslin & Västfjäll, in press). In our view, the latter problem is partly a consequence of the former. That is, before our understanding of the mechanisms of emotion induction by music can be successfully advanced, it might

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be helpful to know something about the nature of music-induced emotion itself. Which emotive states are most (and least) frequently induced by music? Are these states specific emotions? How can we adequately classify and measure them? How do these "music emotions" relate to extramusical emotional experience? And, finally, do music-induced emotions differ sufficiently from everyday emotions to warrant a domain-specific classification? The overarching goal of the present series of studies was to address these questions.

Current Emotion Models: A Procrustean Bed for Music-Induced Emotions?

In current studies on musical emotion induction, participants are typically asked to listen to music and then to rate predetermined affect terms to describe what they feel in response to the music. Almost invariably, these terms reflect either basic (or discrete) emotion theory such as *angry, fearful*, *surprised*, *happy*, and *sad* (e.g., Baumgartner, Esslen, & Jäncke, 2006; Etzel, Johnsen, Dickerson, Tranel, & Adolphs, 2006; Kallinen, 2005; Krumhansl, 1997) or, alternatively, the terms derived from the affective circumplex and its variants such as *bored*, *alert*, *hopeless*, *energetic*, *sleepy*, and *satisfied* (e.g., Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005; Dibben, 2004; Gomez & Danuser, 2004; Gorn, Pham, Sin, 2001; Grewe, Nagel, Kopiez, & Altenmüller, 2007; Witvliet & Vrana, 2006). Although it would seem that music should be capable of inducing a much more nuanced range of emotive states than these labels imply, studies in the area continue to rely on categorical or dimensional approaches to emotion. In the absence of systematic descriptive work on the nature and organization of musically induced emotion, such reliance is understandable. However, for reasons to be described next, these approaches may not be suited to capture the essence of musically evoked emotions.

Discrete or basic emotion theory (Ekman, 1992; Izard, 2007) focuses on a small number of evolutionarily continuous basic emotions, in particular, anger, fear, joy, disgust, sadness, happiness, shame, and guilt. These emotions have major functions in the adaptation and adjustment of the individual to events that have potentially important consequences for his or her physical and psychological integrity. The antecedents of these emotions are environmentally determined conditions that have perceived or real implications for the individual's well-being. Depending on the appraisal of the behavioral meaning of these events for the goals of the individual, these emotions tend to prepare various action tendencies (fight or flight in the case of threat, recovery and reorientation in the case of loss, reparative actions in the case of violations of social conventions). Such emotions tend to be high-intensity, sometimes emergency, reactions mobilizing bodily systems. In contrast, musical antecedents do not usually have any obvious material effect on the individual's well-being and are infrequently followed by direct external responses of a goal-oriented nature (Krumhansl, 1997).

It is plausible that these two radically different kinds of eliciting conditions will lead to different kinds of emotional experience. A promising theoretical frame for understanding these differences is provided by the theory of emotion refinement (Frijda & Sundararajan, 2007). The authors distinguish between "coarse" and "refined" emotions, noting that "the latter are more felt than acted upon and thus do not obviously manifest themselves in overt behaviors like attack, embrace, or flight; may not show pronounced physiological upset; are often about complex events or subtle event aspects; and are not done justice by common emotion labels" (Frijda & Sundararajan, 2007, p. 227). They further note that common emotion theories may be better suited to account for coarse emotions rather than refined emotions.

A description of emotional effects of music limited to valence and arousal gradations as basic dimensions of emotion (e.g., Russell, 2003; Watson, Wiese, Vaidya, & Tellegen, 1999) precludes assessment of the kind of qualitative differentiation required by the study of the emotional effects of music (Collier, 2007). Although we do not question that emotional ratings of music can, to an extent, be accounted for by arousal and valence dimensions, this result adds little to an understanding of those emotional qualities that make music's emotional effects so uniquely rewarding. The possibility that canonical emotion labels might be a procrustean bed for musically evoked emotions has prompted a few researchers to rely on emotional descriptors that seem musically more plausible (e.g., Batel, 1976). Although these approaches may be more valid phenomenologically, they have been eclectic in nature, with choice of emotion labels depending on the authors' particular views of musically induced emotions rather than on a systematic, empirically founded taxonomy of music-relevant emotion terms (Scherer, 2004).

Previous Research Into Musical Emotions

The general notion that emotions generated by music may have special characteristics compared with day-to-day emotions, or with emotions generated by other arts, may be traced to the 19th century. In *The Power of Sound*, Gurney (1880) stated that "The prime characteristic of Music, the alpha and omega of its essential effect [is] its perpetual production in us of an excitement of a very intense kind, which yet cannot be defined under any known head of emotion" (p. 120). One of the first attempts at characterizing musically induced emotions empirically goes back to Weld (1912), who had eight music students listen to phonographic records of a selection of 24 pieces, 3.5 to 4.5 min long. However, he found the emotions reported by his subjects to be so wildly heterogeneous that he threw in the towel, noting that "it seems impossible from the data at hand to furnish a systematic classification of the moods which were experienced" (Weld, p. 283). A more successful attempt to develop a music-specific classification of emotions was undertaken by Hevner (1936). She developed the *adjective clock*—a circle consisting of eight clusters with 6–11 supposedly acquainted adjectives in each cluster. It was called a clock because adjacent clusters were supposed to deviate slightly by cumulative steps until reaching a contrast in the opposite position—for instance, Cluster 2 "happiness" versus Cluster 6 "sadness." In the following decades, several authors (e.g., Campbell, 1942; Farnsworth, 1954; Watson, 1942) further elaborated this taxonomy. In his 1964 review article, Rigg (1964) noted that "discrepancies in the use of terms are not sufficiently serious to prevent a comparison of the results of various research workers" (p. 429) and that "to those who may view this field as one capable of yielding only nebulous results, it may come as a surprise to find general agreement" (p. 429). This amounted to a judgment in defense of Hevner's original conception.

In the early 1970s, Wedin (1972) proposed that emotions to music can be accounted for by three bipolar emotion factors: gaiety versus gloom, tension versus relaxation, and solemnity versus triviality. Drawing from the work summarized by Rigg (1964), Asmus (1985) first compiled a list of music-relevant affect terms, and, after applying factorial analyses of the ratings of three excerpts of music, concluded that musical feelings could be described along nine dimensions of affect. In the subsequent 2 decades, attempts to develop comprehensive taxonomies of music-induced emotion faded and were replaced by investigations focusing on specific aspects of emotional responses to music, such as thrills (e.g., Guhn, Hamm, & Zentner, 2007; Konecni, Wanic, & Brown, 2007; Panksepp, 1995), strong experiences elicited by music (Gabrielsson, 2001, 2006), uses of music in everyday life (Juslin & Laukka, 2004; Laukka, 2007; Sloboda & O'Neill, 2001) or neuroimaging of emotion in music (e.g., Koelsch, Fritz, von Cramon, Müller, & Friederici, 2006).

The aforementioned research tradition made valuable contributions to an understanding of music-specific affects—for example, by pointing to the possibility that canonical emotion labels may not do justice to the emotions evoked by music. However, for various reasons to be described next, this research had little impact on current practices to study musically induced emotions. First, earlier work on dimensions of musical affect focused on emotional characteristics of music as *perceived* by the listener (see Rigg, 1964, for a review). For example, in Wedin's (1972) landmark study, listeners were not asked to describe the feelings that the music aroused in them. Rather, they were asked to describe the *music in emotional terms*. A more recent characterization of basic dimensions of musical affect beyond valence and arousal was also based on listeners' perceptions of emotional connotations of the music, not on anything the listeners felt themselves (Collier, 2007). As pointed out by Sloboda (1992), "The relevance of these [earlier] studies to emotional experience, however, is not proven. It is possible to make character judgments on the basis of conventional characteristics without experiencing any emotion whatsoever" (p. 36). In the meantime, several studies have shown that felt and perceived emotions do indeed differ substantially. For example, Zentner, Meylan, and Scherer (2000) found that various kinds of positive emotions can be both aroused by music and perceived by music, but that negative emotions tended to be much more often perceived than felt. This finding has been supported by recent work showing that music rated as fearful or sad still tends to produce positive affect (Kallinen & Ravaja, 2006; see also Gabrielsson, 2002).

Second, a systematic investigation of musically evoked emotions should, ideally, begin with a compilation of affect terms that represent the entire spectrum of affective states that can be experienced in response to music. Unfortunately, most of the early research reports left out critical information about the criteria of selection for musically relevant affect terms. Asmus (1985), for example, provided neither information on the interjudge agreement in the initial selections of music-relevant affect terms, nor a specification of the kind of music on the basis of which the judges selected the terms. These shortcomings could have led to an incomplete or biased compilation of music-relevant affect terms, as was pointed out by Gabrielsson (1998) in a review of the literature: "Procedures followed for this purpose are not always explicitly described and are rarely, if ever, based on some theory, rather on the researcher's own experiences and ideas and material used by earlier researchers" (p. 2).

A third limitation of previous work consists of the procedures used for data processing and validation. For example, most of the music-specific emotion clusters summarized in Rigg's (1964) extensive review article were developed before advanced methods of scale and model building became a routine requirement for psychological research. Thus, classificatory decisions were primarily driven by subjective and semantic considerations, as illustrated in the following argument: "To the writer, it seems a mistake to put 'agitated' with 'triumphant' together because the former is unpleasantly toned while the latter is 'happy'" (Rigg, p. 434). Other kinds of validity problems consisted of the use of highly selective samples of listeners and musical excerpts of music. For example, Asmus (1985) based his classification on ratings of three music excerpts provided by high school and college students.

The fourth, and perhaps most important, limitation of the previous work in this area was a lack of interest in looking at the findings on music-related emotion from the broader context of general emotion theory and research. More specifically, emotional experience in music-listening contexts was not compared with emotional experience in nonmusical everyday-life contexts. Relatedly, whether conventional emotion frameworks such as basic emotion theory or dimensional approaches to emotion could do justice to emotions induced by music remains at present unclear. As a consequence, the notion that music-related emotions might be of a special kind, requiring a domain-specific representation, remains unproven. In the light of the limitations of previous work—failure to distinguish felt from perceived emotion, vague criteria for selection of affect terms, lack of methodological rigor, and the absence of contextualization of the musical emotions within the broader context of emotion research—it is not surprising that researchers have tended to ignore it, relying instead on basic emotion theory or the affective circumplex when studying affective responses to music.

Overview of the Present Studies

In the current series of studies, we reconsidered a domain-specific approach to music-induced emotions by (a) trying to avoid those conceptual or methodological pitfalls that undermined the acceptance of previous domain-specific models and (b) contextualizing our findings on musically induced emotions within other current models of emotion. Four interrelated studies were carried out for this purpose. Studies 1 and 2 were conducted to compile a list of music-relevant emotion terms and to study the frequency of both felt and perceived emotions across five groups of listeners with distinct music preferences. Study 2 also examined whether there is a difference between the frequency of experience of emotion in everyday contexts and in music contexts. From the findings, we derived emotion terms suited to describe felt emotions across a variety of musical styles. Our aim in Study 3 was, first, to extend findings from Study 2 regarding emotions typically elicited by music by using a larger and more representative sample of listeners and examining emotion ratings that were provided when listeners were exposed to actual performances; second, we examined the differentiation, or structure, of musical emotion ratings based on confirmatory factor analytic procedures. In Study 4, we attempted to replicate the findings from Study 3 with a different

sample of listeners and music excerpts. In addition, we compared the differential validity of the current domain-specific framework vis-à-vis two global frameworks to classify emotion—the basic emotion and dimensional emotion models. From these studies, we derived a measure to assess musically induced emotion.

Before turning to the detailed description of the four studies, a definitional note regarding the term *emotion* is in order. In the present text, the term *emotion* (or *emotional*) will be used in the restricted sense of *feeling*, that is, how an emotion feels to us. In the research reported here, we studied the *subjectively experienced feeling of the emotion*. We are aware that the concept of emotion is often used in a broader sense (including cognitive processes, bodily changes, action tendencies, and facial and vocal expressions). As pointed out earlier, however, some emotions may be more felt than acted on, and these emotions may not have obvious behavioral, expressive, or physiological manifestations. Hence, it seemed appropriate to start studying musically induced emotions as an experiential phenomenon. Emotions thus identified include emotions with behavioral or physiological manifestations, without excluding those emotional states that may not have these overt expressions but still represent highly characteristic reactions to music.

Study 1

Verbal descriptors of perceived and felt emotion were often confounded in previous studies. The goal of this study was to create a comprehensive list of words genuinely suited to describe experienced or felt emotion.

Method

Participants

A total of 92 students (43 men and 49 women) from an introductory psychology course from the University of Geneva took part in this study as partial fulfillment of a course requirement. The average age was 24 years (range = 18–44).

Materials

A list of 515 terms considered to be candidate labels for the verbal descriptors of felt affect in French was compiled. This list was derived from three sources: (a) a collection of affect terms used in five major languages (see Appendix in Scherer, 1988), (b) terms derived from the affective lexicon (Clore, Ortony, & Foss, 1987; Johnson-Laird, & Oatley, 1989), and (c) an extensive review of emotion terms used in the literature on music and emotion (e.g., Budd, 1985; Cooke, 1959; Davies, 1994; Gabrielsson, 1998; Hevner, 1936; Kivy, 1990; Langer, 1942; Levinson, 1990; Meyer, 1956; Panksepp, 1995; Ridley, 1995; Rigg, 1964; Robinson, 1994; Scruton, 1997; Sloboda, 1992; Storr, 1992; Wedin, 1972). In order not to overtax the attentional capacities of our participants, we divided the list into three parts, each containing a third of the entries. The list was presented both in alphabetical order and reverse alphabetical order, and the two versions were randomly distributed among participants.

Procedure

The rating sessions took place in a lecture hall at the university. Participants were invited to come to three consecutive sessions, so that each participant rated the entire list of 515 terms. Each session lasted approximately 45 min. Participants were asked to rate each term according to the following criterion: "According to you, does this adjective describe an internal affective state with a specific affective 'color' so that, to describe this feeling, you would choose to use this adjective over another one?" There was a binary yes–no answer format. In addition, participants were asked to cross out any term they did not understand.

Results and Discussion

First, terms understood by less than 95% of the participants were eliminated. This was the case for 90 terms, yielding an intermediate compilation of 425 terms. Subsequently, we examined how many participants tended to provide repetitive ratings (all "yes" or all "no"). Seventeen participants answered "yes" to more than 80% of the 425 affect terms, and 7 participants answered "no" to more than 80% of the terms. Because these subjects roughly compensate for one another, their ratings were retained. For the remaining 425 affect terms, we computed proportions of "yes" versus "no" answers. Because our purpose was to obtain a list of adjectives that could be easily understood by a majority of future participants, we decided that at least two thirds (66%) of the participants in this study had to agree on the affective nature of the term for it to be retained. Applying this criterion resulted in a reduction of terms from 425 to 133.

Twenty-eight terms that come up fairly frequently in literature on music and emotion were above the 50% criterion but fell short of the 66% criterion. Examples, followed by the respective percentages of "yes" answers, are *enchanted* (63%), *amused* (60%), *triumphant* (60%), and *inspired* (55%). From the consideration that eliminating potentially music-relevant affect terms was an irreversible step and that the 66% criterion was rather conservative, we retained these terms, as they were still rated as genuinely affective by a majority of participants. While Study 1 was being conducted, 15 new potentially music-relevant affect labels were identified by two music experts and by our own continuous reading of the literature.[1] Again, in the interest of ensuring inclusiveness of our initial selections, we added these terms to the 161 previous terms for a total of 176 terms. In a final step, the compilation was scrutinized for synonyms according to a major French language synonym lexicon (*Larousse*), resulting in the elimination of 30 synonyms and a final list of 146 affect terms to be used in Study 2.

Study 2

Armed with a compilation of potentially music-relevant affect terms, our aim in Study 2 was to examine which of these terms would be actually relevant in relation to music. Addressing this issue required elaborations along three lines. First, to determine the musical relevance of the emotion terms, we examined the frequency of the same emotion states in both musical and extramu-

[1] The experts were a musicologist and a composer who was then also the director the Lucerne Music Conservatory. Both were involved as consultants in the initial phases of the research. Although the 15 new terms were not rated for affectivity in Study 1, ratings regarding the relevance of these terms to describe musical affect were obtained in the next study.

sical, everyday-life contexts. Second, we studied the emotion terms with regard to their relevance for perceived and induced emotion. Thus, there were three ratings conditions: (a) emotions as perceived in the music, (b) emotions as induced by music, and (c) emotions as experienced in nonmusical day-to-day contexts. Third, because emotional responses to music as such cannot be studied, we examined the ways in which feelings vary in response to five genres of music. Because it is practically impossible to define a representative sample of music excerpts for a given genre (e.g., Behne, 1997), we purposefully relied on reports of what the participants felt when listening to their preferred genre of music.

On the basis of this design, three specific questions were addressed: First, are the 146 feelings induced by music with the same frequency as they are perceived as expressive qualities of the music? Second, is the frequency of emotion states in everyday life and music-listening contexts similar? For example, although anger is frequently experienced in everyday life, is it also an emotion that is frequently felt in response to music? Third, does the frequency with which diverse emotive states are induced by music depend on musical genre? For example, is "nostalgia" as frequently induced by classical music as it is induced by pop/rock?

Method

Participants

Participants were 262 undergraduate psychology students at the University of Geneva for whom participation fulfilled a course requirement. Recruitment was carried out over 2 years, that is, from two cohorts, to secure a sufficient number of aficionados for each music genre. Music preferences were assessed by means of a brief survey, which presented a definition of five common music genres: classical, jazz, pop/rock, Latin American, and techno. Classical music was defined as works written during the period from Mozart to Mahler. The reason for narrowing the range of classical works in this way was a concern that baroque, and especially modern classical music, with a range from postromantic to serial music, would lead to excessively heterogeneous categories of reference. Jazz is also a heterogeneous genre, but it can be argued that it is less so than classical music. Thus, this genre was defined as "jazz with the exception of free jazz," free jazz being as removed from mainstream jazz as atonal or serial music is from classical music. Pop/rock music was defined as that on the "current pop charts." Techno music was described as the kind of music typically played in raves and parades (such as the love parade). Latin American music was defined with concrete examples such as salsa, bachata, and merengue. Participants were asked to indicate the genre they were most fond of and most familiar with. Those with multiple preferences were asked to choose the genre they felt most inclined to respond to in the current study. According to the information provided on this survey, participants were attributed to one of five groups: a classical music listener group ($n = 53$), a jazz music listener group ($n = 50$), a pop/rock music listener group ($n = 59$), a Latin American music listener group ($n = 51$), and a techno music listener group ($n = 49$). Students who did not indicate any likings were not included in the study.

Materials and Procedure

Participants were given a rating booklet. On the first page were general questions about age, mother tongue, and music listening habits. This page was followed by two subsequent adjective lists, each containing the same 146 feeling terms derived from Study 1 (see below). Each feeling label was accompanied by a 4-point scale (*never* = 1; *occasionally* = 2; *fairly often* = 3; *frequently* = 4). The rating session took place in a lecture hall at the university. To double-check that each of the participants was rating emotions in relation to the correct genre of music, we reminded the participants in writing and orally of their music preference (e.g., "You have indicated that you like and frequently listen to *x* music . . .").

Participants were instructed to carefully read through the instructions preceding the feeling terms. The instructions explained that the participants were twice handed the same list of emotion terms for two distinct ratings. In one part, participants rated how often they *felt* a given emotion when listening to their favorite music. In a second part, participants had to rate the frequency with which they *perceived* a given emotion while listening to their preferred music. The specific instruction for the feeling ratings read as follows: "Please indicate the frequency at which you *feel* the emotional states described by the terms listed below." For the perception ratings, the instruction was as follows: "Please rate the frequency at which you *perceive* the emotional state described by the terms listed below." We instructed participants to use pure music (without text or lyrics) as a referent when providing their ratings, even though we realized this request would probably be difficult in the case of rock and Latin music. To reduce carryover between the two rating conditions, we administered a 10-min distractor task that was unrelated to the purposes of the study. Order of presentation of the two rating conditions (i.e., felt–perceived) was counterbalanced across subjects.

After participants returned their rating booklet, they were handed a new rating form, again containing the same list of 146 terms and the same rating scale. Participants were asked to provide, at home, ratings of the frequency with which they experienced each of the affect states in their extramusical everyday life. For each rating condition (perceived emotion, felt emotion, everyday-life emotion), the adjectives were listed in two orders, an alphabetical and an inverse alphabetical order, the two versions being randomly distributed across participants.

Results

Data Reduction

Our first aim was to eliminate affect terms that would be unlikely to bear an important relation to music. To this end, we eliminated affect terms that had a mean of less than 2 in both the felt and perceived rating conditions in all five genres of music. We chose this particular criterion because the value of 2 corresponds to *occasionally*. Thus, all affect terms with a value less than 2 were not even occasionally aroused or expressed in any of the current genres. Sixty-five affect terms fell into this category of "nonmusical emotions"—among which were *guilty*, *shameful*, *contemptuous*, *disgusted*, *embarrassed*, and *jealous*. It is interesting that terms relating to *fear* and *anger*, although reported more frequently than the previous terms, were also among the terms that did not meet the criterion for retention. However, given their importance in emotion research in general, and in earlier work on emotion and music in particular, we felt that it would be premature to eliminate these emotion terms on the basis of a single study.

Hence, awaiting further confirmation in the next study, eight terms relating to fear and anger were retained. Thus, from the 146 initial terms, 57 emotion terms were eliminated, yielding a set of 89 emotion terms.

Subsequently, the 89 variables were submitted to exploratory factor analyses. The purpose of these analyses was twofold: first, to reduce the 89 variables to a more manageable set of summary scales to examine the current research questions, and second, to obtain a preliminary look at the differentiation of musical emotions to be used as a point of departure for more rigorous structural tests in Study 3. Because our goal was to derive internally consistent summary scales, we used the alpha-factoring method of extraction. As there is no reason to assume that emotions should be organized orthogonally, we rotated using Promax—a widely used method of oblique rotation. We ran the same analyses on ratings of perceived and ratings of felt emotion terms. In addition, we also ran the analyses on different combinations of music groups (e.g., jazz, pop/rock, and classical vs. techno and Latin American). Following Gorsuch's (1983) advice to "hold sacred only those factors that appear across all the procedures" (p. 330), we retained those factors that emerged consistently across both rating conditions. Nine factors tended to emerge across both rating conditions and these factors also held up across different combinations of musical genres. Only the most discriminating adjectives of each factor were retained, that is, adjectives with high loadings on one factor and relatively low loadings on other factors. One additional scale, "sadness," was added on conceptual grounds because sadness plays a prominent role in both theoretical and empirical work on music and emotion. Table 1 provides an overview of the emotion scales, including their adjective markers and their respective alpha coefficients. The mean scale intercorrelation for the emotion scales in the perceived condition was $r = .34$ (range = .05–.65); in the felt condition, $r = .28$ (range =.23–.61).

Validity of Musical and Extramusical Emotion Ratings

To examine the validity of the current emotion ratings, we submitted them to a comparison with (a) frequency ratings of felt emotion to music obtained in a habitual everyday music-listening context and (b) frequency ratings of emotional experience in everyday life obtained in a study using experience-sampling procedures. Laukka (2007; see also Juslin & Laukka, 2004) obtained ratings of felt emotions to music in everyday-life contexts from a sample of older Swedish listeners ($N = 500$; age range = 65–75 years). For two reasons, meaningful comparisons could be drawn across both studies. First, of the 45 emotion terms used in the Swedish study, 36 (80%) were also rated in the current study; second, the range of the rating scale was the same (1–4). We correlated across the mean frequencies of the same 36 emotion terms in the Swedish and the current sample and found an appreciable degree of concordance ($r = .90$). The intraclass correlation coefficient (ICC) for absolute agreement, which is not only sensitive to the order of scores but also to their absolute magnitude, yielded a similar coefficient (ICC = .89). The strong concordance bolsters our confidence in the validity of the current findings.

The validity of the current everyday-life emotion ratings was compared with the frequency ratings of emotional experience in everyday life obtained in a recent large-scale study using experience-sampling procedures (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000). Specifically, we correlated the mean frequencies for the 19 emotion terms of the large-scale study with the mean frequencies obtained for the same emotion terms in the current study. As was the case with the musical emotion ratings, the congruence was substantial ($r = .92$, ICC = .84), suggesting that the current assessment reflects the frequency of experiencing specific emotions in everyday life adequately.

Frequency of Induced Versus Perceived Emotions

To examine whether frequency ratings of perceived and of felt affect differ significantly, we ran a 2×5 multivariate analysis of variance (MANOVA) with emotion modality (perceived vs. felt emotions) as the independent within-subject factor and the five musical genres (classical, jazz, pop/rock, Latin American, and techno) as the independent between-subjects factor. The 10 emotion scales were the dependent variables. This analysis yielded a highly significant main effect for emotion modality, $F(10, 248) = 47.98$, $p < .001$, and a significant effect for genre of music, $F(40, 942) = 13.59$, $p < .001$. In addition, and as anticipated, there was also a significant interaction term of Emotion Modality $\times$ Style of Music, $F(40, 942) = 3.42$, $p < .001$.

These results suggest, first, that ratings of perceived emotion differ significantly from ratings of felt emotion. Second, the results suggest that emotion ratings differ significantly as a function of

Table 1
Extracted Factors, Their Most Discriminating Adjective Markers, and Cronbach's Alphas for All Three Rating Conditions

Factor	Adjective markers	α		
		Perceived	Felt	Everyday
1. Tender Longing	Affectionate, softened up, melancholic, nostalgic, dreamy, sentimental	.84	.82	.68
2. Amazement	Amazed, admiring, fascinated, impressed, goose bumps, thrills	.75	.81	.74
3. Tranquility	Soothed, calm, in peace, meditative, serene	.82	.84	.71
4. Joy	Joyful, happy, radiant, elated, content	.87	.80	.87
5. Activation	Disinhibited, excited, active, agitated, energetic, fiery	.79	.84	.75
6. Power	Heroic, triumphant, proud, strong	.79	.78	.71
7. Sensuality	Sensual, desirous, languorous, aroused (sexually)	.71	.78	.65
8. Transcendence	Ecstatic, spiritual feeling, mystical feeling, illuminated	.73	.75	.69
9. Dysphoria	Anxious, anguished, frightened, angry, irritated, nervous, revolted, tense	.85	.83	.82
10. Sadness	Sorrowful, depressed, sad	.79	.74	.76

musical genre. The complete findings are illustrated in Figure 1A. Significance levels attached to the specific comparisons are based on paired *t* tests. On the whole, emotions were reported to be more frequently perceived than felt. This was particularly the case for the negative scales "sadness" and "dysphoria" (see Figure 1A). In addition, a number of emotions were about as frequently perceived as they were felt—such as "tender longing" and "amazement." Finally, certain emotions appeared to be more frequently felt than perceived—at least in classical music and in jazz. Indeed, as is indicated by the significant emotion modality by musical genre interaction, the relationships between felt and perceived emotions varied substantially across listeners with different music preferences.

Everyday-Life Emotions Versus Music-Induced Emotions

To compare everyday-life emotions with music-evoked emotions, we ran a 2 × 5 MANOVA with emotion context (everyday-life emotion vs. felt musical emotion) as the within-subject factor and the five music listener groups as the between-subjects factor. This analysis yielded a highly significant main effect for emotion context, $F(10, 244) = 71.71$, $p < .001$; a significant effect for genre of music, $F(40, 927) = 7.04$, $p < .001$; and a significant interaction term of Emotion Context × Genre of Music, $F(40, 927) = 5.50$, $p < .001$. These findings indicate that frequency ratings of felt musical emotions and everyday emotions differ significantly from each other. As is illustrated in Figure 1B, the Emotion Context × Genre interaction indicates that the discrepancy between musical and everyday emotion is not the same across groups with different music preferences.

Emotions Induced by Various Musical Genres

Ratings of felt emotions to music varied tremendously according to the type of music being rated. To ensure that reports of emotions to music were not confounded with dispositional emotionality, we controlled for the latter. Specifically, we first conducted one-way analyses of variance (ANOVAs) on the everyday emotion ratings for each of the 10 emotion scales. Post hoc group tests among the five music groups (based on Tukey's HSD) indicated that of the 100 possible comparisons (see Figure 1), only 5 were significant. To ensure that even these minor differences could not bias the results, we subtracted the day-to-day emotion occurrence ratings from the music-elicited emotion occurrence ratings and ran the analyses on the basis of these adjusted scores.

A more integrative picture of the manifold differences depicted in Figure 1 can be obtained by reorganizing the current data using procedures similar to those employed by Rentfrow and Gosling (2003) in their research on music preferences. Specifically, we conducted a factor analysis on the current five genres, finding that jazz and classical music loaded on one dimension, techno and Latin American on a second dimension, and pop/rock on a third, separate dimension. This finding is reminiscent of the findings by Rentfrow and Gosling (2003), who found that both jazz and classical music loaded highly on a Complex/Reflective factor, electronic music such as techno on an Energetic factor, and rock on a separate factor named Rebellious. From these patterns, we created three emotion composites, a complex/reflective emotion composite—the average of the tender longing, amazement, spirituality, and peacefulness scales; an energy/activation composite—averaging across activation terms; and a rebellious emotion composite—the average of revolt and anger-related terms.[2] We found that the complex/reflective emotions were experienced most frequently by jazz and classical music listeners, the energetic emotions most by the techno and Latin American music listeners, and the rebellious emotions most by the pop/rock music listeners.[3]

Discussion

Several outcomes of this study deserve attention. Among many emotions habitually experienced in day-to-day life, several were reported only very rarely in response to music. Specifically, guilt, shame, jealousy, disgust, contempt, embarrassment, anger, and fear—these and other negative emotions—were reported to be regularly experienced in everyday life but to be practically never aroused by music. This finding is in accord with recent research showing that negative emotions are experienced only very rarely in response to music (Juslin & Laukka, 2004; Laukka, 2007). The findings for positive emotions were more mixed; in particular, they were more dependent on the nature of the music. For example, the emotional states relating to amazement and peacefulness were reported more frequently in response to music than to everyday life, but only by classical and jazz music listeners. In turn, the emotional states relating to activation were more prominent in response to music compared with everyday experience by listeners of techno and Latin American music.

A further goal of this study was to examine differences between felt and perceived emotions. Generally speaking, emotions were less frequently felt in response to music than they were perceived as expressive properties of the music. For example, a number of negative emotions, although not reported to be felt in response to music, were reported to be fairly often perceived as expressive properties of the music (see Figure 1). This was especially the case for fear, sadness, or anger–irritation (although less so for guilt, shame, and embarrassment). One possible explanation for this outcome is that music may express emotions by symboli-

[2] Even though our pop/rock group did not stand out in terms of levels of dysphoria-related emotions in general (see Figure 1), when we created a more specific composite, based on revolt and anger-related terms, the current pop/rock group exhibited comparatively higher levels of these rebellious emotions. This composite (not shown in Figure 1) was created by averaging across the following five terms: *aggressive*, *angry*, *enraged*, *irritated*, and *revolted* (Cronbach's alpha for the scale was .78).

[3] To statistically test the predicted genre–emotion affiliations, we ran a one-way ANOVA specifying the expected differences based on contrasts. With respect to the complex/reflective emotion composite, the contrast between the classical and jazz groups and the three other groups was significant, $t(1, 256) = 7.97$, $p < .001$ (contrast weights: 3, 3, −2, −2, −2), indicating more frequent experience of reflective/complex emotions in jazz and classical music listeners compared with listeners of the other three genres. Using the analysis the same way as before, we found that the techno and Latin American groups reported significantly higher activation states compared with the other three groups, $t(1, 256) = 5.96$, $p < .001$. Finally, we anticipated that pop/rock listeners would report more rebellious emotions compared with listeners from the other groups. Using the composite based on revolt and anger-related terms as the dependent variable, a one-way ANOVA with a contrast between rock and the remaining genres was significant, $t(1, 256) = 3.18$, $p = .002$ (contrast weights: 4, −1, −1, −1, −1).

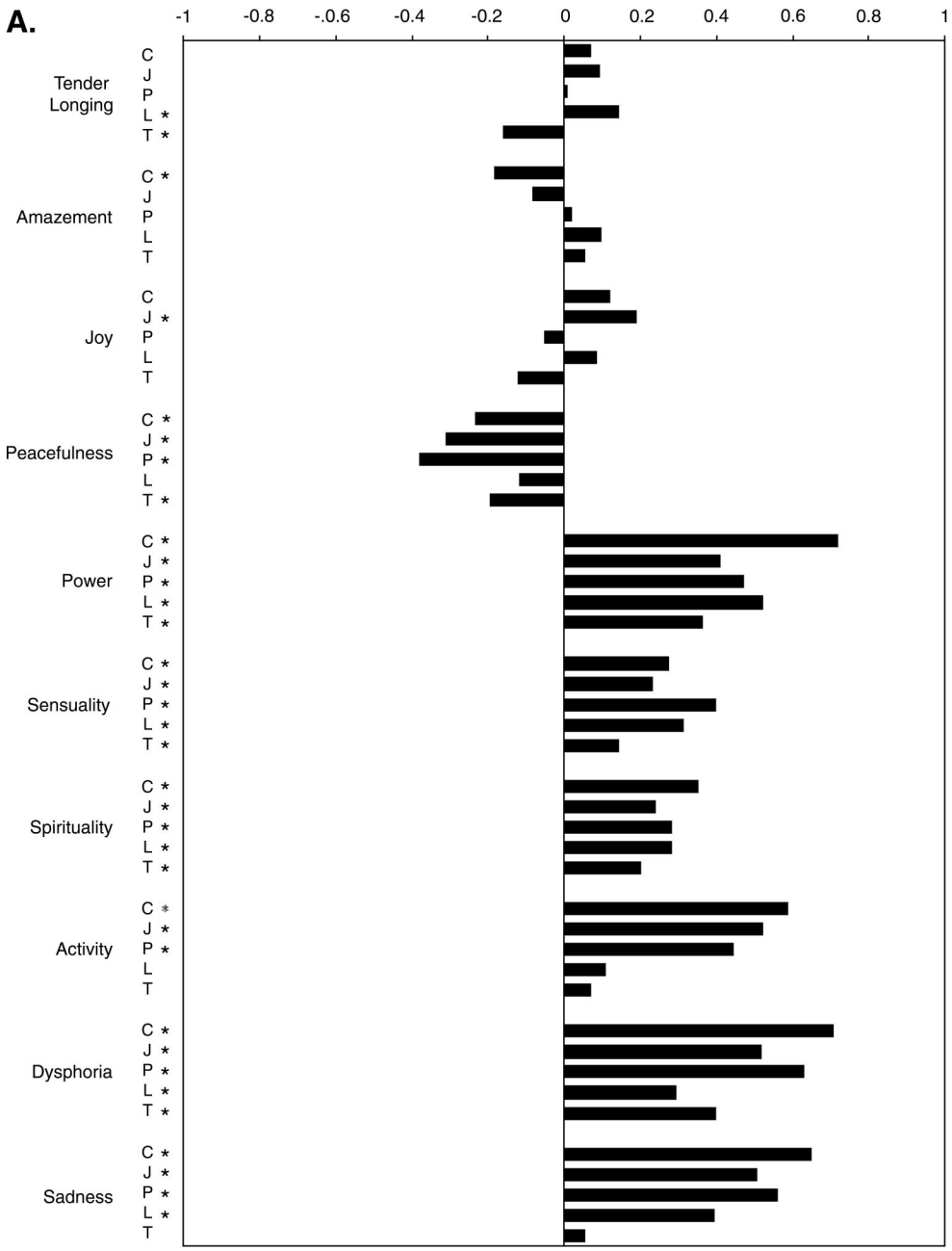

Figure 1. (A) Differences in frequency ratings of felt emotion versus perceived emotion by musical emotion factor and musical genre group. Numbers are difference scores, where the mean felt emotion ratings were subtracted from the mean perceived emotion rating. Thus, bars to the left of the midpoint (0 = no difference) indicate emotions more frequently felt than perceived, whereas bars to the right of the midpoint indicate emotions more frequently perceived than felt. C = classical; J = jazz; P = pop/rock; L = Latin American; T = techno. *$p < .05$.

cally mimicking a broad range of human expressive behavior, including negative behaviors. However, the perceptions of negative emotional characteristics do not readily translate into felt negative emotion because the listener in most music-listening contexts is safely removed from threats, dangers, or the possibility of losses.

A few limitations should be noted. The primary reason for including listeners of various types of music was to ensure that our selection of descriptors of musically induced emotions would not be biased toward a specific genre of music. For this purpose, using generic definitions of music genres and preferences seemed adequate, but findings regarding the emotional effects specific to various genres of music have to be interpreted with some caution. Second, although the current ratings of music's emotions converged well with the findings from

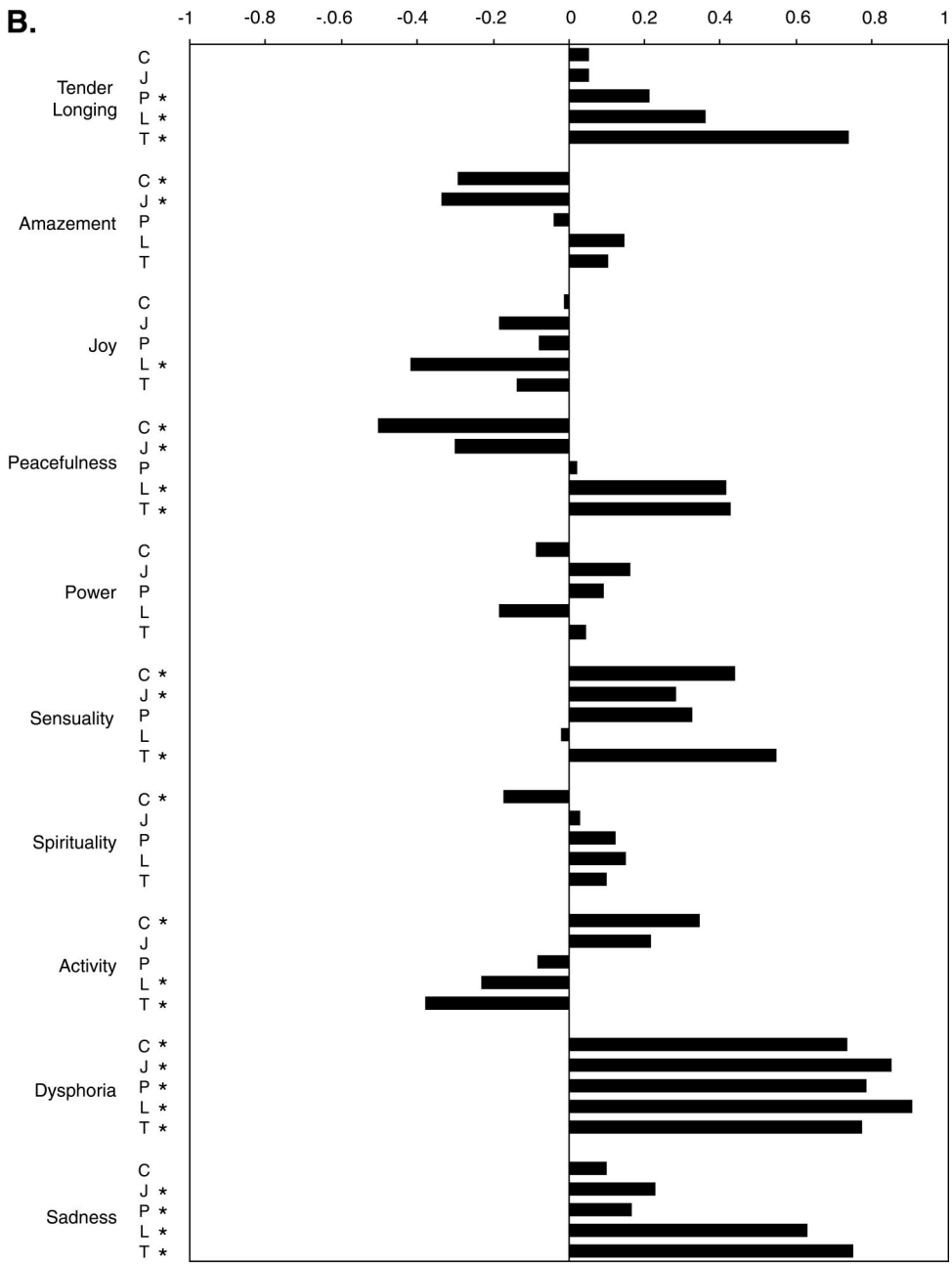

Figure 1. (B) Differences in frequency ratings of felt musical emotion versus everyday (felt) emotion by musical emotion factor and musical genre. Bars to the left of the midpoint indicate emotions more frequently felt in response to music than in everyday life. Bars to the right of the midpoint indicate emotions more frequently felt in everyday contexts than in music-listening contexts. C = classical; J = jazz; P = pop/rock; L = Latin American; T = techno. *$p < .05$.

studies with a high degree of ecological validity, it should be kept in mind that participants provided emotion ratings by imagining, rather than actually hearing, their music of preference. Finally, the factor analyses of the retained music-relevant emotion terms provide only preliminary insights into the differentiation of emotional responses to music and require more rigorous tests. The next two studies were designed to respond to this requirement.

Study 3

Our goal in Study 3 was twofold. The first aim was to extend findings from Study 2 regarding emotions typically elicited by music by using a larger and more representative sample of listeners and examining affect ratings that were provided when listeners were exposed to actual performances. The second aim was to examine whether emotive states induced by music could be dif-

ferentiated into subunits that could serve as a base for a classification of music-evoked emotions. To examine this question, we submitted musical affect ratings to confirmatory factor analytic (CFA) procedures. The research was carried out 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, it is relatively easy to recruit a large sample because of the profusion of visitors, and the performances of the festival cover a relatively broad spectrum of musical genres.

Method

Participants

Participants were recruited from the audiences of a variety of concerts. The rating form (see below) was handed to approximately 2,000 listeners.[4] A total of 801 participants (337 men, 440 women, and 24 unspecified) returned the questionnaire. The average age of the listeners was 44.8 years (SD = 16.5, range = 12–88).

Materials

Eighty-nine emotion descriptors were identified as music relevant in Study 2. However, the particular context of the current study imposed restrictions on the quantity of emotion labels and rating gradations that could be used without overtaxing the attentional resources of our participants. To reduce the number of terms to a more manageable set of entries, we identified terms with similar meanings using various synonym functions available on the Web. Subsequently, these terms were presented to a sample of 63 first-year students who were asked to indicate which of the equivalent terms (mostly 2–3) they thought was the most appropriate to describe feelings induced by music. Twenty-four emotion terms were judged to be less appropriate than their sister terms, resulting in 65 emotion terms.[5] *To feel like dancing* was added to this list for a total of 66 terms (see Table 2, first column).[6] To ensure that no important emotion label was missing in this compilation, we instructed participants in Study 3 to add any terms they thought were missing from the list in a space reserved for this purpose. For similar practical reasons, the rating procedure had to be simplified. Thus, rating instructions asked listeners to focus on a piece, excerpt, or passage that had affected them (in any way—positive or negative), to scan the list of emotion labels, and to rate only those terms that matched their experience somewhat or a lot (0 = *no chosen emotion label*; 1 = *emotion experienced somewhat*; 2 = *emotion experienced a lot*).

Procedure

The music festival took place in different venues (e.g., concert halls, outdoor stages) where music of various styles was performed. Performances of the festival covered a relatively broad array of musical genres, with classical music of various periods (from Renaissance to contemporary) occupying a large place. To cover a broad spectrum of performances, a team of 10 research assistants was specifically trained for this event. Before the start of any given performance, 2 assistants held up a sign "University of Geneva, Music and Emotions Study." The assistants approached the spectators to briefly explain the goals of the study and asked them whether they would be willing to fill out a questionnaire. Interested listeners were given the questionnaire and a pencil. The form fit on a single sheet, with instructions on the front and the rating list containing the 66 emotion terms on the back. Two different random order versions of the list were distributed. Participants were instructed to rate the emotion terms and to return the questionnaires by putting them in the cardboard boxes provided for this purpose at the venue exits.

Results

Of the 801 questionnaires that were returned, 72% related to a broad range of classical music, 11% to rock music, 10% to world music, and 7% to jazz. The percentage of listeners reporting to have felt any of the emotions printed on the rating sheet *somewhat* or *a lot* are presented in Table 2. Percentages were calculated for the entire sample and for each genre of music separately. Because classical music was overrepresented as a result of the festival's emphasis on classical music, we used the average across the four within-genre percentages as a criterion for elimination. This average appears in Table 2 as "weighted percentage." As in Study 2, we eliminated affect terms that were chosen by less than 5% of the participants to rate their affective reaction, with one exception (see Table 2). The exception was the term *sorrowful*, which was retained in order to have a second item for the factor Sadness (see below). An analysis of the terms that were cited in the free-response spaces revealed that only a handful of items were cited more than three times that were also nonsynonymous with the provided terms. These terms were *admiring*, *fascinated*, *overwhelmed*, and *tearful*.

Earlier, we discussed how the 10 musical emotion scales reported in Table 1 were derived through a series of exploratory factor analyses. In the present study, we used CFA to test how well the current affect ratings conformed to the original 10 factors. CFA provides a more stringent test of the model's validity because, unlike exploratory factor analysis, the model is specified prior to data analysis. Consistent with our original conceptualization, we first tested a model that consisted of 10 factors, as reported in Table 1 (Model 1). This original conceptualization was tested against an alternative model.

Because the primary aim of the factor analyses in the previous study was data reduction and not model construction, we left aside

[4] Because of the huge number of rating sheets, we weighted, rather than counted, the number of rating forms before they were handed out and the number of rating sheets that were left after the study (i.e., rating sheets that were not handed out to the participants). The difference was about 2,000, which is the number of rating forms that had been handed out to concert visitors.

[5] An elimination of synonyms was already carried out in Study 1. However, the terms eliminated then were synonyms in a narrow sense. When inspecting the 89 terms left for the current study, we felt that there were still numerous terms that were close in meaning, if not synonymous in the strictest sense.

[6] Although the term *to feel like dancing* may not seem to refer to an emotional state, it is an action tendency—the latter pertaining to the definitional criteria of an emotion (Frijda, 2007a). Also, body entrainment to music is one of the most pervasive and fundamental reactions to music as evidenced by the universal presence of dance.

Table 2
Percentage of Listeners Who Reported to Have Felt Each Affect State Somewhat or a Lot

Affective state	Weighted percentage	Classical	Jazz	Rock	World	Total
Relaxed	44.6	38.8	50.0	46.4	43.0	40.6
Happy	41.5	42.6	46.2	39.3	38.0	43.2
Joyful	39.0	29.5	44.2	42.9	39.2	33.0
Dreamy	37.1	37.2	38.5	33.3	39.2	37.1
Stimulated	35.4	25.7	38.5	34.5	43.0	29.3
Dancing (bouncy)	33.5	16.6	46.2	35.7	35.4	22.3
Enchanted	32.8	36.4	36.5	19.0	39.2	34.8
Nostalgic	32.1	29.5	34.6	23.8	40.5	30.3
Allured	31.0	31.0	25.0	25.0	43.0	31.3
Touched	30.9	45.9	26.9	20.2	30.4	40.2
Free	30.7	24.0	36.5	35.7	26.6	26.3
Calm	28.0	35.2	21.2	22.6	32.9	32.7
Sentimental	27.5	25.5	32.7	19.0	32.9	26.0
Energetic	27.4	22.6	26.9	31.0	29.1	24.5
Filled with wonder	26.5	34.0	21.2	19.0	31.6	31.3
Amused	23.6	12.1	19.2	41.7	21.5	17.0
Passionate	23.4	26.6	25.0	19.0	22.8	25.3
Animated	22.6	19.8	19.2	29.8	21.5	21.2
Melancholic	22.5	26.2	19.2	13.1	31.6	24.8
Light	22.5	23.8	32.7	17.9	15.5	23.1
Moved	21.9	37.9	13.5	11.9	24.1	32.3
Inspired	21.6	17.1	25.0	22.6	21.5	18.6
Dazzled	21.3	23.1	28.8	15.5	17.7	22.0
Serene	21.3	33.3	7.7	25.0	19.0	30.0
Tender	19.8	25.0	21.2	20.2	12.7	23.1
Euphoric	19.7	16.6	23.1	22.6	16.5	17.7
Meditative	18.4	28.6	7.7	10.7	26.6	25.2
Floating	18.3	15.5	23.1	17.9	16.5	16.2
Sweet	18.2	20.5	11.5	15.5	25.3	20.0
Soothed	17.8	26.4	11.5	15.5	17.7	23.5
In love	17.8	14.7	21.2	26.2	8.9	15.7
Sensual	17.5	17.9	25.0	13.1	13.9	17.6
Strong	15.3	13.8	15.4	14.3	17.7	14.3
Spiritual feeling	15.3	20.9	7.7	8.3	24.1	19.0
Affectionate	13.8	15.7	7.7	16.7	15.2	15.2
Exciting	13.7	8.8	11.5	17.9	16.5	10.6
Feeling of transcendence	13.7	17.8	9.6	9.5	17.7	16.4
Mellowed[a]	12.4	19.1	5.8	13.1	11.4	17.0
Disinhibited	12.3	7.6	11.5	23.8	6.3	9.5
Caressing	12.0	17.2	7.7	13.1	10.1	15.5
Shivers (thrills)	11.2	15.7	5.8	10.7	12.7	14.4
Electrified	11.2	9.5	5.8	17.9	11.4	10.2
Agitated	10.6	9.7	5.8	13.1	13.9	10.1
Fiery	10.4	14.5	3.8	11.9	11.4	13.2
Sad	10.2	11.7	1.9	13.1	13.9	11.5
Triumphant	10.1	15.2	5.8	11.9	7.6	13.4
Voluptuous	9.6	14.0	9.6	9.5	5.1	12.4
Goose bumps	9.1	14.0	3.8	8.3	10.1	12.5
Solemn	8.3	15.5	1.9	9.5	6.3	13.0
Languorous	7.8	8.3	5.8	10.7	6.3	8.2
Heroic	7.2	9.5	1.9	8.3	8.9	8.7
Impatient	6.8	6.4	3.8	13.1	3.8	6.5
Serious	6.6	11.9	0.0	8.3	6.3	10.0
Irritated	6.6	5.3	7.7	7.1	6.3	6.5
Proud	6.4	6.7	1.9	9.5	7.6	6.7
Revolted	6.3	3.1	0.0	11.9	10.1	4.5
Annoyed	6.2	5.5	3.8	13.1	2.5	5.9
Nervous	5.5	5.7	3.8	6.0	6.3	5.6
Tense	5.2	8.6	3.8	6.0	2.5	7.5
Bittersweet	4.7	5.9	1.9	7.1	3.8	5.5
Indifferent	4.6	3.4	1.9	11.9	1.3	4.0
Aggressive	4.2	4.1	1.9	10.7	0.0	4.2
Anxious	3.4	5.0	0.0	6.0	2.5	4.6
Sorrowful	3.4	4.7	0.0	3.6	5.1	4.4
Depressed	2.7	3.4	0.0	6.0	1.3	3.2
Angry	2.4	2.9	1.9	4.8	0.0	2.7

[a]*Attendri* in French, which can also be translated as "softened up" or "made tender."

certain subtleties of exploratory analyses for more scrutiny in the current study. Specifically, even though most factors were not sensitive to rating conditions and music genre, there were a few exceptions. For example, the analyses suggested that the factor Tender Longing comprises two related but separable factors, namely Tenderness and Longing (the term *tender longing* was actually chosen to account for the two aspects of the factor). In turn, the existence of Activation as a factor separable from Joy was dependent on the inclusion of the energetic music styles, techno and Latin American music. When we carried out analyses on the less energetic genres (classical, jazz, pop/rock), both facets tended to converge into one single factor that could be termed Joyful Activation. Similarly, the factor Sensuality did not come out when the techno and Latin American music groups were omitted from the analyses. In the formulation of an alternative model, we took these observations into account. Specifically, we combined activation and joy into one single factor of Joyful Activation. Because the factor Tenderness included the terms *in love* and *sensual*, we used it as a substitute for the previous Sensuality factor, which proved fragile in Study 2. These modifications relative to Model 1 yielded a nine-factorial model (Model 2).

MPlus 4.0 (Muthén & Muthén, 2006) software was used to examine the fit of these alternative models. In evaluating model fit, recent research suggests relying on two different types of fit indices, one that is sensitive to misspecified factor covariances and one that is sensitive to misspecified factor loadings—an approach sometimes referred to as the "two-index strategy." The standardized root-mean-square residual (SRMR) is the most widely used index of the former kind, whereas the root-mean-square error of approximation (RMSEA) and so-called incremental fit indices (Tucker–Lewis index, normed fit index, comparative fit index, goodness-of-fit index) are sensitive to the second type of misspecification (Fan & Sivo, 2005; Hu & Bentler, 1999). For models with small deviations from simple structure (such as the current one), the recommendation is to rely on decision rules based on a combination of SRMR and RMSEA because, in contrast to the incremental fit indices, RMSEA does not penalize for model complexity (e.g., Beauducel & Wittmann, 2005). Thus, in addition to the chi-square statistic, we report the SRMR and RMSEA as measures of model fit. Conventional guidelines suggest that RMSEA values of .08 or less represent a reasonable fit and values of .05 or less represent a very close fit in relation to degrees of freedom. Similarly, SRMR values close to .09 represent a reasonable fit and values of .06 or less a close fit (Hu & Bentler, 1999). Finally, the Akaike information criterion is a fit index that indicates the likelihood of a model replicating on a different sample, with lower scores indicating better fit.

As can be seen from the upper part of Table 3, the 10-factorial Model 1 provided a good fit. However, the alternative 9-factorial model (Model 2) provided an equally close fit (the difference in fit between both models was not significant), $\Delta\chi^2(9) = 10.87$, $p > .10$. Thus, we retained the second, more parsimonious 9-factorial model. To ensure that this 9-factorial model would be the best of possible alternatives, we also tested a number of models with lesser latent factors, including only 1 factor. However, we found the alternative models to fit consistently less well than the current Model 2.

Consistent with the notion of separable but related factors, the correlations between the nine factors generally fell in a moderate range (see Table 4). To gain insight into a higher level of organization of these nine factors, we ran exploratory factor analyses to examine which second-order factors could account for the intercorrelations in the primary factors. The analyses yielded two interpretable solutions: a two- and a three-factorial solution. The two-factorial solution separated Wonder, Transcendence, Tenderness, Nostalgia, and Peacefulness from Power, Joyful Activation, Tension, and Sadness (Model A in Table 3). The three-factorial solution suggested combining (a) Tension and Sadness, (b) Joyful Activation and Power, and (c) the remaining factors: Wonder, Transcendence, Tenderness, Nostalgia, and Peacefulness (Model B in Table 3). As can be seen from Table 3, within second-order factor models, the model with the best fit was the three-factorial model (Model B). Indeed, the reduction in chi-square was significant when moving from Model A to Model B, $\Delta\chi^2(2) = 28.82$, $p < .0001$.

In a final model-building step, we eliminated emotion terms that were relatively poor or ambiguous markers of the nine factors using the two following criteria: (a) items that were the poorest markers of the facet as inferred from the corrected item-total correlation and (b) items with the highest cross-loadings as evidenced by the MPlus modification indices. From these criteria, the total number of items could be reduced from 60 to 40 in the final model. As can be seen in the last two rows

Table 3
Summary of Goodness of Fit Indices for Versions of the Musical Emotion Model

	χ^2	*df*	AIC	SRMR	RMSEA
First-order models (number of factors)					
Model 1 (10)	4272.93	1,658	76053	.059	.044
Model 2 (9)	4262.06	1,667	76025	.059	.044
Second-order models (number of first- and second-order factors)					
Model A (9 + 2)	4586.09	1,693	76296	.067	.046
Model B (9 + 3)	4557.27	1,691	76271	.066	.046
Retained first- and second-order factors with reduced items					
First order (9)	2013.85	701	54378	.056	.048
Second order (9 + 3)	2272.61	725	54589	.066	.052

Note. $n = 801$. AIC = Akaike's information criterion; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation. All four first models are nested (with 60 observed variables); the last two are also nested between them (with 40 observed variables).

Table 4
Intercorrelations Among First-Order Musical Emotion Factors

Factor	Wonder	Transcendence	Tenderness	Nostalgia	Peacefulness	Power	Joyful activation	Tension
Wonder								
Transcendence	.44							
Tenderness	.40	.42						
Nostalgia	.34	.33	.50					
Peacefulness	.33	.28	.39	.40				
Power	.40	.42	.31	.19	.06			
Joyful activation	.41	.25	.36	.14	.13	.38		
Tension	.04	.16	.12	.07	–.09	.29	.20	
Sadness	.12	.18	.20	.26	.05	.07	.08	.22

Note. $n = 801$; all correlations $r > .10$ are significant at $p < .01$.

of Table 3, this enhanced parsimony did no harm to the fit indices. The architecture of the final first- and second-order model is illustrated in Figure 2. The 40 items, along with their groupings, provide a taxonomy of musically induced emotions. In addition, and as described in Appendix A, it is also the source for a first version of a new measurement tool for musically induced emotions. We called it GEMS, an acronym for the Geneva Emotional Music Scale.

Discussion

A first aim of Study 3 was to examine whether the selection of music-relevant emotion terms derived from Study 2 would prove equally relevant for a different sample of listeners exposed to live performances of actual music. On the whole, we found that the findings from both studies tended to converge. As in Study 2, the emotion states experienced most rarely in Study 3 were negative states such as feeling angry, indifferent, depressed, and anxious. We also found evidence for the importance of states such as feeling moved, enchanted, filled with wonder, nostalgic, dreamy, tender, and relaxed. The relative frequencies of reported emotion states in Study 3 are of note because, besides confirming the findings of Study 2, they also closely match the reports of felt emotion from the Swedish sample of adults (Juslin & Laukka, 2004) and the elderly (Laukka, 2007) referred to in Study 2. Indeed, feeling moved, nostalgic, relaxed, enchanted, and tender were all among the most frequently reported emotions. *Admiring*, a frequently reported state in the Swedish study, was the term most often added in the free response spaces of the current study. These consistencies across studies are noteworthy considering the differences in samples of listeners, in music-listening contexts, and most likely also in music excerpts.

Our second aim in this study was to take a closer look at the structure underlying ratings of musical affect. The current evidence suggests that affect aroused by music can be empirically differentiated into several subunits. More specifically, we found that a model with nine emotion factors best fit the data. This model presents some distinctive features in comparison with mainstream emotion models such as the discrete emotion model. In contrast to the latter, most of its emotions are positive. Furthermore, it contains emotion categories such as wonder, nostalgia, and transcendence that are not a central part of any current model of emotion. The particular names we chose to label the latent factors deserve a brief comment. We labeled the first factor Wonder because *filled with wonder* (*émerveillé*) proved to be a consistently strong marker of this factor across Studies 3 and 4.[7] Finding the term *happy* among the markers of Wonder may seem surprising. One likely reason is that the meaning of the French *heureux* differs from that of the English *happy*. *Heureux* denotes happiness in the sense of bliss, felicity, and fulfillment, rather than joy or contentment. The former states are not inconsistent with the key markers of Wonder. *Awe* does not exist in French, but the terms characterizing the current Transcendence factor suggest parallels to the English *awe*.

Although some of the current emotion components seem similar to emotion components from other emotion models, similarities in the general factor labels may obscure subtle differences in meaning. For instance, we found that musically induced joy implies an action tendency to dance, which is unlike the common meaning of joy. Thus, joyful activation may be best seen as a form of joyful *entrainment*. This interpretation has support in the preliminary finding that, in infants, motor entrainment to music and to rhythmic sounds is positively correlated with smiling (Zentner & Russell, 2006). Similarly, "musical" sadness may not be quite the same as basic emotion sadness, because the aversive aspects of sadness, such as feeling gloomy, depressed, or unhappy, are only very rarely reported in response to music (see also Laukka, 2007).

Turning to the second-order level, we found that the elating, near-paradisiac character of many of the facets of factor one could be adequately classified as *sublimity*. *Vitality* seemed an obvious choice for the combination of joyful activation and power. For the combination of the two "negative" factors tension and sadness, we chose *unease* as a common denominator. A final noteworthy observation concerns the intercorrelations of the facets as reproduced in Table 4. Although some of these intercorrelations may seem disturbingly high from the point of view of statistical parsimony, in fact, they reveal a crucial aspect of musical emotions: Rather than occurring separately, these are most typically experienced in a blended or coupled manner.

[7] To account for the feelings characteristic of Factor 1, we also considered naming it *incantation*. Incantation originates from the Latin *cantare*, which means nothing other than singing. Thus, the relationship between music and psychological enchantment, enticement, allurement, and so forth appears to be so inextricable as to have become encoded etymologically.

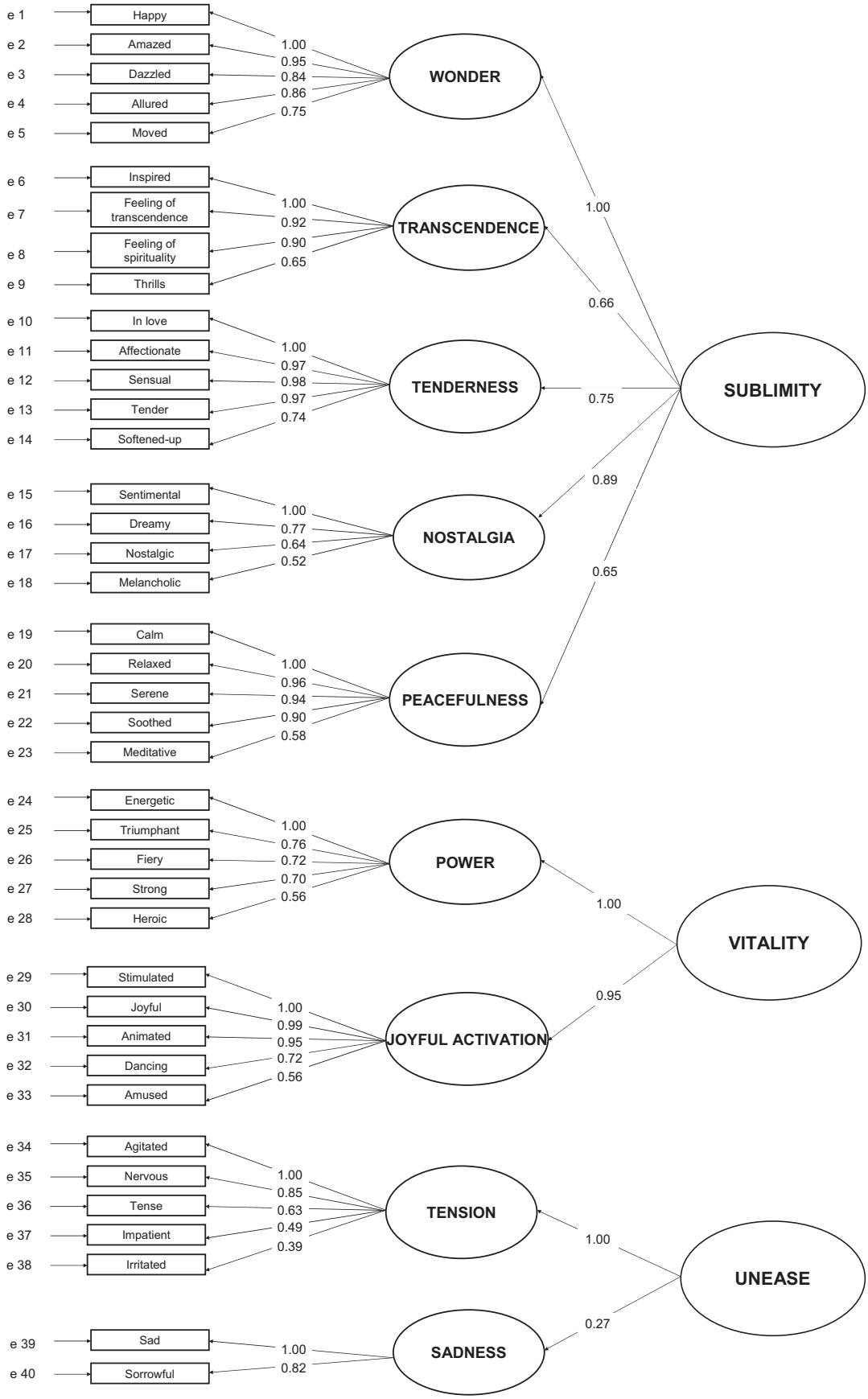

Figure 2. Confirmatory factor analysis on ratings of emotional responses to music. Boxes on the left are items. In the middle are the first-order factors. On the right are the second-order factors. Values on arrows are the standardized parameter estimates.

Study 4

This study was conducted, first, to replicate the factorial structure of music-induced affect as derived from the previous studies. More specifically, we were interested in examining whether the nine-dimensional structure could be replicated (a) with a new and different sample of listeners, (b) with a set of different and exclusively nonlyrical music excerpts, and (c) by using an optimized rating scale that included feeling terms repetitively added by the participants of Study 3 in the free response boxes.

The main objective of Study 4 was to examine the differential validity of the current model vis-à-vis two prominent emotion models that are often relied on in studies of music and emotion: the discrete or basic emotion model and the dimensional emotion model. Although Study 2 and Study 3 strongly suggested that emotions elicited by music are best described in terms of a domain-specific model, the value of conceptual innovations remains limited if these innovations are not matched by advantages relative to earlier (and simpler) conceptions. Three criteria were used to evaluate comparative validity: First, to describe their affective reactions, would listeners more frequently choose emotion terms provided by the musical emotion model compared with emotion terms derived from the basic emotion or the dimensional emotion model? Second, would the musical emotion scales provide higher agreement across listeners than the scales representative of the other two models? Third, would emotion ratings based on the current musical model provide a better discrimination of the music excerpts than emotion ratings based on the discrete and dimensional models? We reasoned that if these questions could be answered affirmatively, the current domain-specific model would be the framework of choice for the study of musically induced emotions.

To achieve these aims, we asked listeners to rate emotions induced by experimenter-selected music excerpts at the university and by additional, but freely chosen, music excerpts at their homes. Participants received two rating forms: For replication purposes, they received a revised form of the GEMS. To examine differential validity, we created a new rating form, labeled the "comparative emotion model checklist," representing the discrete emotion model, the dimensional model, and the musical emotion model.

Method

Participants

Participants were recruited from three sources: (a) members of amateur choirs, (b) those who read an article describing the study that appeared in a widely read Geneva newspaper, and (c) those who read fliers about the research, which were distributed at the entrances of different concert halls in Geneva. A total of 238 listeners (68 men and 170 women) agreed to participate. The average age was 47.2 years (range = 15–80). Choirs received between 120 Swiss francs (80 euros) and 500 Swiss francs (330 euros), depending on the number of participants that they were able to motivate for participation. The announcements specified that liking classical music was a condition for participation. As assessed by a question included in the materials, this was indeed the case: 49.6% listened to classical music every day, 28.7% every week, 12.9% two to three times a month, and the remaining 8.8% once a month.

Materials

Comparative emotion model checklist. This rating form was designed to represent (a) the basic or discrete emotion model, (b) the dimensional emotion model, and (c) the current domain-specific emotion model. The three approaches were represented by three adjacent, vertically arranged checklists. The discrete emotion approach was represented by a French adaptation of Izard's Differential Emotions Scale (DES; Izard, 1990; Ouss, Carton, Jouvent, & Wildlocher, 1990). The DES contains 10 basic emotion terms (*interest*, *joy*, *surprise*, *sadness*, *anger*, *disgust*, *contempt*, *fear*, *shame*, and *guilt*), each basic emotion being measured by three items. The main basic emotion terms were printed in large print and the three items as a subheading in smaller print. The dimensional emotion model was represented by the eight poles postulated by the circumplex theory (activation, unpleasant activation, unpleasantness, unpleasant deactivation, deactivation, pleasant deactivation, pleasantness, pleasant activation)—each illustrated by four affect items (e.g., Russell, 2003; Watson et al., 1999).[8] The pole terms were presented in large print and the four subordinate affect items as a subheading in smaller print. The musical emotion model was represented by the nine musical emotion factors identified in Study 3, again with the nine main emotion terms in large print and four representative adjectives in smaller print (with the exception of *sadness*, which contained only two adjectives). Each of the emotion terms was accompanied by a 5-point scale (1 = *not at all* to 5 = *very much*).

Geneva Emotional Music Scale (GEMS). To the 40 items listed in Figure 2, we added the four terms that were cited more than three times by the participants of the previous study in the space entitled "other emotion states." These terms were *admiring*, *fascinated*, *overwhelmed*, and *tearful* (see Study 3, Discussion). The term *tearful* was used to replace *sorrowful* as a second marker of Sadness, because the latter had a very low frequency of occurrence in the previous study. These modifications led to a total of 43 emotion terms, each of them being accompanied by a 5-point scale (1 = *not at all* to 5 = *very much*).

Stimuli. Sixteen excerpts of nonvocal, classical music were chosen for this study from the following considerations: (a) use in previous studies for the induction of happiness, sadness, fear, and anger (e.g., Västfjäll, 2002; Westermann et al., 1996); (b) extension of these "traditional" excerpts by other excerpts considered to be candidates for inducing the same emotional states by an expert group (one composer, one music theorist, one music philosopher); and (c) potential effectiveness, in a few excerpts, for inducing some of the novel emotion categories identified in Study 3. Each excerpt lasted approximately 2 min. When the length of an excerpt was shorter than 2 min, seconds of silence were added so that rating time was standardized across excerpts. The 16 excerpts are listed in Appendix B. The music was played on a Teac AD 500 CD player going through a Yamaha MX 12/4 mixing board, which was linked to a Crown CE1000 amplifier connecting to two Ramsa WS A200W loudspeakers.

[8] We feel obliged to Lisa Feldman Barrett who was so kind as to confirm the exactitude of this representation.

Procedure

Listeners were randomly allocated to two groups: Participants in the first group ($n = 112$) received the comparative emotion model checklist to rate emotions induced by the 16 mentioned excerpts at the university; in turn, these participants received the GEMS for ratings of emotions evoked by freely chosen excerpts at home. The second group ($n = 124$) mirrored this procedure. Participants of the second group received the GEMS to rate emotions induced by the 16 excerpts at the university and the comparative emotion model checklist for the home ratings. In contrast to the ratings to be provided at the university, the home ratings were optional. The university listening sessions were run in groups at a large, acoustically well-designed auditorium (group size varied; $n = 16–36$). Sessions lasted approximately 1 hr 30 min. Each musical excerpt was played twice with an interstimulus interval of 5 s. To prevent affect carryover from excerpt to excerpt, we presented listeners with 20 s of distracting, emotionally neutralizing sounds (bird and cricket sounds) before each new excerpt. Instructions specified that during the first hearing of an excerpt, participants should relax and monitor their feelings and then do the rating during the second hearing only. Before starting the study, participants had the opportunity to listen to and judge a trial excerpt and to ask questions. The 16 musical excerpts were played in two orders of presentation evenly distributed across participants (1–16 and 16–1).

For the comparative emotion model checklist, participants had to rate their felt emotional reaction to music on all three model checklists (discrete, dimensional, and musical). Subsequently, participants had to indicate which of the three checklists they thought best captured their music-induced feelings. The three lists were presented in three different positions from left to right (ABC, BCA, CAB) to control for order effects. For each order of presentation, the items within the lists were presented in two orders (the top items of one order becoming the bottom items in the second order). Instructions for the GEMS were the same as in Studies 2 and 3 (emphasis on felt rather than perceived emotion).

For the optional home ratings, participants were asked to rate three nonvocal pieces of classical music of their own choice within a time interval of less than 20 min. They were asked to provide additional information such as the name of the composer and of the piece, the context of hearing, and the length of the excerpt. The questionnaires were handed out in a prestamped envelope and participants were asked to return the questionnaire, for which they would be given a gift certificate for a CD valued at 20 Swiss francs (13 euros). Fifty-five participants returned the comparative emotion model checklist, and 57 participants returned the GEMS.

Results

Replication of the Nine-Dimensional Structure of Musical Emotions

To examine how well the nine-factorial model derived from Study 3 would hold up against the current sample of listeners and music excerpts, which differed in many ways from the samples of Study 3, we specified the same nine factors, as illustrated in Figure 2. The adjective items defining each factor were similar, although we integrated the feeling terms from the free response section of the rating form in Study 3 (see Method). Specifically, we allocated *admiring* and *fascinated* to the factor Wonder, *overwhelmed* to Transcendence, and *tearful* to Sadness. Because each participant rated several music excerpts, we carried out the analyses using a CFA designed for repeated measures (MPlus 4.0 using the "complex" feature for repeated measures; see Muthén & Muthén, 2006).

First, we carried out the analyses on the sample that rated the 16 excerpts on the basis of the rating form with the 43 feeling terms. MPlus modification indices suggested relocating *fascinated* from Wonder to Transcendence. The model tested provided a satisfactory fit to the data, $\chi^2(763, N = 118) = 5011.88$ (SRMR = .100, RMSEA = .060). To increase both the number of participants and the sample of music excerpts, in a second analysis, we merged the ratings from the previous sample with the ratings that listeners had to provide for freely chosen music excerpts at home. The results changed only minimally, $\chi^2(890, N = 175) = 6560.56$ (SRMR = .100, RMSEA = .056). These findings, which were based on a new sample of listeners and music excerpts, lend support to the nine-factorial classification system. Mindful of researchers' general preference for shorter instruments, we tested models with a reduced number of items. We found that a reduced 33-item model with 4 items for each factor (except for Tension with 3 items and Sadness with 2 items) also resulted in a similarly good fit, $\chi^2(483, N = 175) = 3912.36$ (SRMR = .093, RMSEA = .059). This version of the GEMS is provided in Appendix A.

Participants' Choice of Emotion Models (Dimensional, Discrete, and Musical)

We now turn to tests of differential validity starting with participants' preferences for each of the three models. Recall that after rating their emotional responses on the three checklists, participants had to indicate which of the three they thought best captured their feelings to each music excerpt. Percentage values can be used to describe relative frequencies; however, because independence of observations is a prerequisite for running chi-square tests on frequency distributions, and each participant provided multiple ratings in the current study, we used a bootstrap procedure to test which model was chosen preferentially. Specifically, the distribution of the means of the frequency of participants' choices was estimated using bootstrapping, with replacement at the participant level using 1,000 iterations. As can be seen from Figure 3A, listeners preferred the domain-specific emotion checklist to describe their music-related emotions. To formally test the significance of the differences between these three distributions, we computed the differences for all iterations between the different models. Differences are significant when the distribution of the differences does not include the 0 value (Davison & Hinkley, 1997; a detailed description of the bootstrap procedure used here is available from the authors).

On the basis of the confidence interval (CI) of the differences between the discrete emotion and the musical emotion models, the null hypothesis of the equivalence of the means could be rejected, $p < .001$, $CI_{(99.9\%)} = 5.31, 7.36$. Similarly, the difference between the dimensional and the musical emotion model was also significant, $p < .001$, $CI_{(99.9\%)} = 3.70, 5.81$. This is notable, given that many of the current excerpts had been used to induce basic

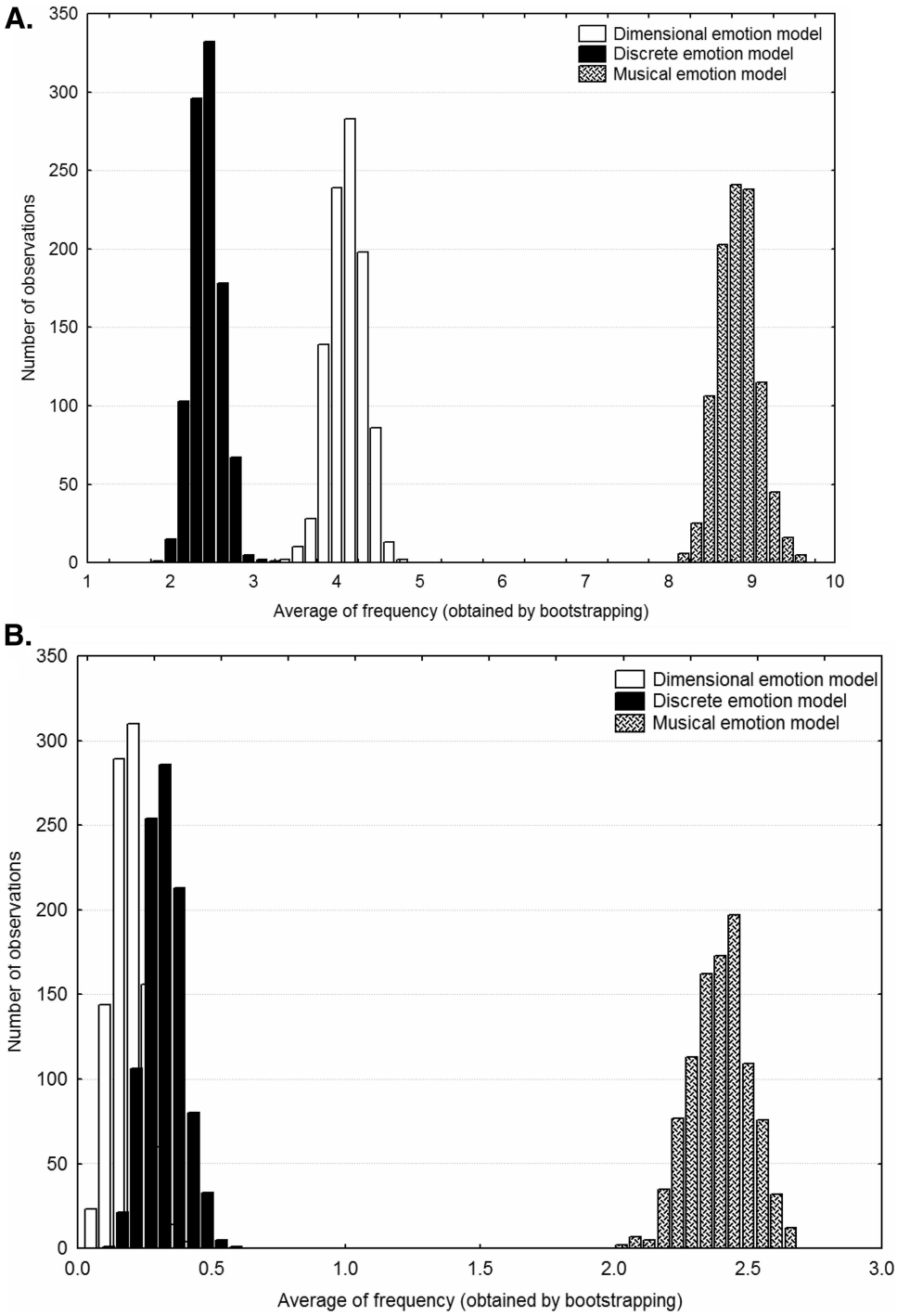

Figure 3. Distributions of the choices for the three models based on resampling. (A) Choices of emotion model to describe the 16 experimenter-selected excerpts of music compared with the proportion of choices for the dimensional emotion scale and the discrete emotion model. (B) Choices of model for freely chosen, participant-selected (nonlyrical) music excerpts.

emotions in previous studies (happiness, sadness, anger, fear). Results for the participant-selected excerpts, which can be seen as a random selection of music excerpts, were similar (see Figure 3B). Specifically, the differences between musical emotion and discrete emotion checklists were significant, $p < .001$, $CI_{(99.9\%)} = 1.58, 2.44$. Similarly, the differences between the music and the dimensional checklist also reached significance, $p < .001$, $CI_{(99.9\%)} = 1.60, 2.62$. Overall, then, listeners clearly preferred to

describe what they felt with the terms representative of the current musical emotion model rather than with the terms representative of the discrete or the dimensional model.

Agreement Across Listeners

Next, we examined how well listeners agreed about the feelings induced by the 16 excerpts when using the three emotion scales. The less adequate an instrument is to capture musical emotions, we reasoned, the poorer the interjudge agreement should be. Consider, as an example, a piece of music that induces nostalgia in a majority of listeners. If the term *nostalgic* is not included in a rating list, some listeners may check *sad*, others *happy*, and still others *in love* if the latter term were provided. Thus, an inadequate rating scale will tend to drive listeners' ratings apart. In turn, if the term *nostalgic* is provided, these listeners will tend to select it, thereby augmenting agreement. From this premise, we predicted that participants would agree best on the emotions elicited by the 16 pieces when using the domain-specific scale. To examine this hypothesis, we computed the average profile agreement. More specifically, on a given variable (e.g., wonder), we correlated each listener's ratings with the ratings of all of the other listeners in the sample across the 16 excerpts. The average consensus for each of the terms from the three different checklists was computed using the single measure ICC (see Rosenthal & Rosnow, 1991, p. 431), and it is shown in Figure 4 (dotted line). The aggregate reliabilities, based on Cronbach's alphas, are represented in the same figure (solid line).

As in the previous analyses, we used a bootstrap procedure to estimate the significance of the differences between the three emotion scales. The difference between the means of Cronbach's alphas of musical and dimensional models reached significance, $p < .001$, $CI_{(99.9\%)} = 0.013, 0.016$, as did the difference between musical and discrete models, $p < .001$, $CI_{(99.9\%)} = 0.049, 0.053$. Note that the difference between the dimensional and the discrete model was also significant, $p < .001$, $IC_{(99.9\%)} = 0.034, 0.039$, indicating that the participants agreed better on emotion occurrence when using the terms provided by the dimensional model compared with those in the discrete emotion model. Overall, then, the domain-specific emotion checklist tended to enhance agreement across listeners in ratings of music excerpts relative to the checklist from the two alternative models.

Discriminative Power

A final test of differential validity consisted of examining which of the three checklists would provide the best discrimination of the

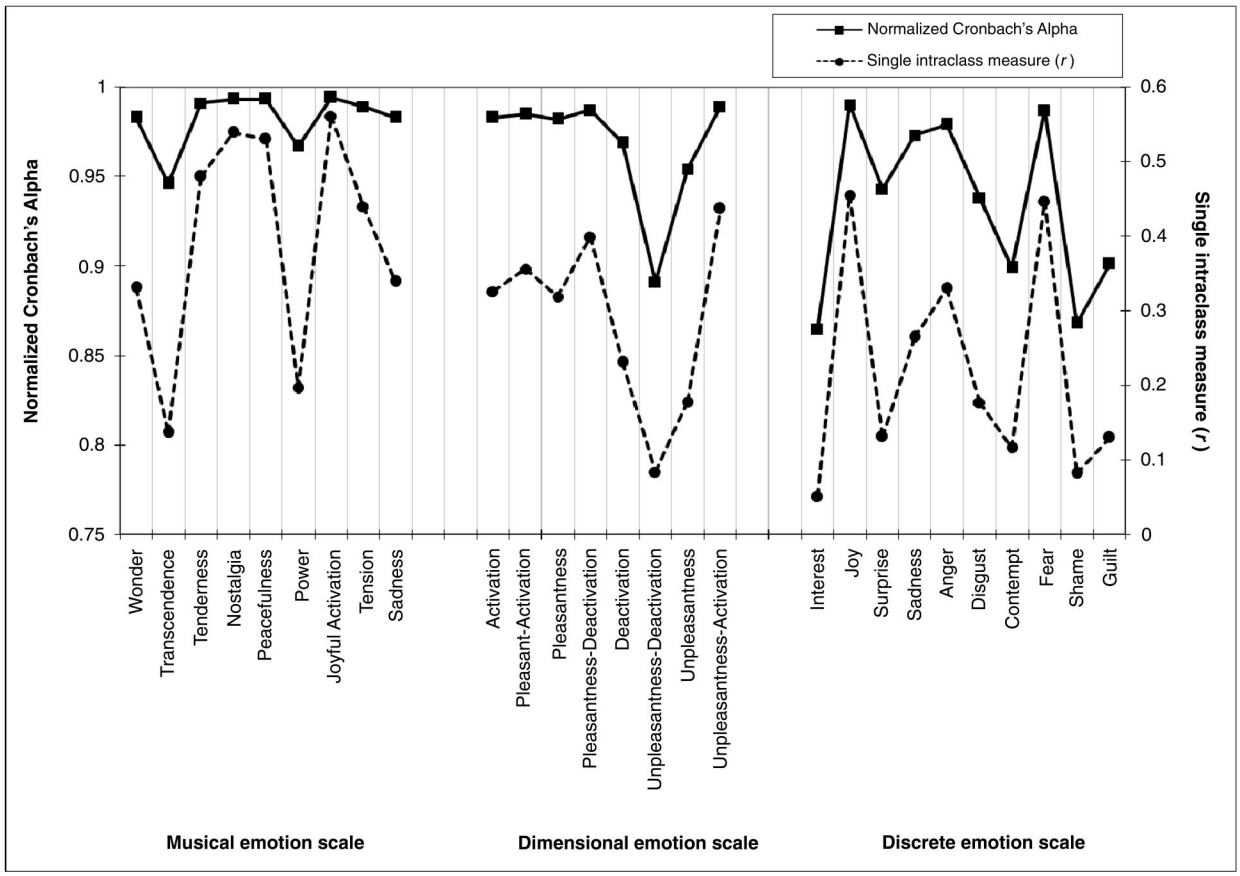

Figure 4. Composite reliabilities based on Cronbach's alpha (left axis); judge-to-judge reliabilities based on the intraclass coefficient (right axis). Reliabilities are higher on average for the musical emotion scale compared with the dimensional and the discrete emotion scales.

musical excerpts. A scale that reflects music-relevant emotions should have a higher power of discrimination compared with a scale that does not. At worst, the latter will provide random results or no discrimination at all. Thus, we hypothesized that the ratings from the musical emotion scale should provide a significantly better discrimination of the 16 musical excerpts used in this study compared with the ratings from the other two emotion scales. To test this hypothesis, we ran cluster analyses on the music excerpts using Ward's method (Ward, 1963). Ward's method is a hierarchical agglomerative cluster analysis technique that sorts cases into groups in a series of steps equal to the number of cases in the sample. Discriminative clarity is indicated by the distances of aggregation (using Manhattan distances), which were larger for the musical model compared with the other two models (see Figure 5).

To test the hypothesis of differential power of discrimination between the three scales, we conducted a bootstrap analysis based on the means of the aggregation distances using the same procedure as described earlier. The differences of mean aggregations between the musical and the dimensional models were significant, $p < .001$, $CI_{(99.9\%)} = 1.23, 3.23$. The same held for the differences between the musical and the discrete emotion models, $p < .001$, $CI_{(99.9\%)} = 2.19, 4.00$, showing that terms that reflect the musical emotion model provide more powerful discriminations of music excerpts than do the terms derived from the discrete or the dimensional emotion model. The differences between the dimensional and the discrete emotion models also reached significance, $p < .001$, $IC_{(99.9\%)} = 0.29, 1.57$, with the terms of the dimensional model providing better discrimination of music excerpts than the terms derived from the discrete emotion model. In sum, then, the most powerful discrimination of musical excerpts was obtained from the ratings of emotion terms provided by the domain-specific checklist.

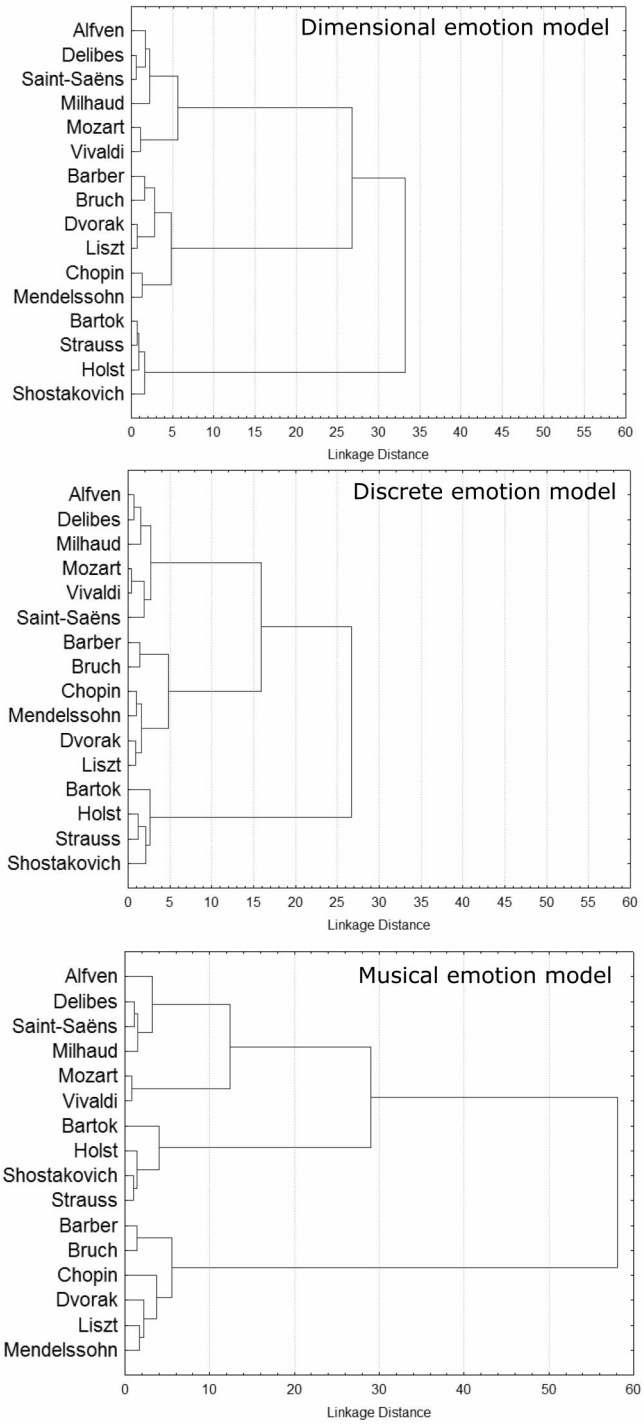

Figure 5. Grouping of the 16 music excerpts (vertical axis) based on cluster analyses. Clearest discriminations of excerpts are obtained with ratings on the musical emotion scales.

Discussion

This study was conducted, first, to replicate the factorial structure of musical affect as derived from Studies 2 and 3 using a new and different sample of listeners. An important consideration is that, as in Study 3, the current sample was not a convenience sample, but included listeners of all ages. Similarly, the nature of the music excerpts varied from those rated in the previous study and did not contain any text or lyrics. Despite these differences, the nine-dimensional classification of music emotions was supported by the current analyses. Our next aim in Study 4 was to examine whether two of the most current models of emotion account for ratings of musical emotions as well as the current domain-specific model does. The answer is no. Indeed, by all three validity criteria, the domain-specific model outperformed the dimensional and the discrete emotion model. The dimensional model tended to provide somewhat better results than the discrete emotion model. Overall, then, the current comparisons of emotion frameworks to examine music-induced emotions quite clearly favor the domain-specific framework.

Still, a number of limitations and questions should be kept in mind. First, the current results should be interpreted in relative rather than absolute terms. For example, agreement across listeners was better when emotions were rated with the music-specific checklist compared with the alternative checklists (see Figure 4). This is in itself a remarkable finding in light of the general notion that the more subtle the required distinctions, the harder it is to achieve reliability. However, even with the domain-specific checklist, agreement was far from perfect, indicating appreciable interindividual variability in emotional responses to a given music excerpt. Second, the current study was about the feeling terms

characteristic of each model rather than about the models *in globo*. Thus, an appropriately cautious conclusion is that the clusters of interrelated feeling attributes characterizing the domain-specific model have greater relevance to music than do the emotion components characteristic of the alternative models tested.

Finally, two questions remain unanswered by the analyses conducted so far: First, can the relative superiority of the domain-specific model also be generalized to the case of perceived musical emotion? Second, domain specificity has only been demonstrated in one sense. What we can say is that the terms reflective of canonical emotion frameworks are less powerful in accounting for musically evoked emotions than a domain-specific model. However, whether the current model would be any less powerful in accounting for everyday emotion experience than the two alternative models remains unaddressed. No separate study was conducted to address both questions. However, in Study 2, listeners did provide ratings of perceived emotions to music, felt emotions to music, and everyday emotions. Thus, by applying findings from Studies 3 and 4 to the ratings obtained in Study 2, these questions can be addressed to a certain extent. The corresponding analyses, reported in Appendix C, provide thought-provoking answers: They suggest, first, that the basic emotion model performs rather well when it comes to ratings of perceived emotions. What is more, they also suggest that the current musical emotion model accounts quite well for emotions experienced in everyday life. How this outcome can be reconciled with the notion of domain specificity is a question we address toward the end of the general discussion.

General Discussion

Summary of Key Aims and Findings

Our overarching goal in the current studies was to contribute to an understanding of music's universal appeal by identifying emotions that are most (and least) frequently induced by music and by deriving and replicating a structural model of music-induced emotions using rigorous analytic techniques. The first three studies strongly indicated that an accurate description of musical emotions requires a more nuanced affect vocabulary and taxonomy than is provided by current scales and models of emotion. Study 4 lent further strong support to our hypothesis that emotional responses to music are best accounted for by a domain-specific model of emotion. A measurement device for this model, the GEMS, was introduced. Several implications, practical and theoretical, ensue from the studies reported here.

On a practical level, a measure that provides a nuanced assessment of music-induced emotion may be useful to all professionals interested in evaluating the emotional effects of music—among others, computer technicians producing software that synthesizes emotional music, neuroscientists studying the neural mechanisms underlying music-induced emotion, music therapists monitoring their patients' emotional responses to music, or film industry professionals evaluating the particular emotional atmosphere evoked by various pieces of music. On a theoretical level, the finding that the range of music-evoked emotion goes beyond the emotions typically captured by global models of emotion challenges the field to expand its traditional borders into new territories of emotional experience. In the following sections, we review the findings in more detail and consider their implications for the field.

Deciphering the Spectrum of Musically Induced Emotions

One of the most obvious differences between the current emotion components and those of the alternative models studied lies in the paucity of negative emotions of the former. Recall that anger, fear, disgust, guilt, and so forth have major functions in the adaptation and adjustment of the individual to events that potentially threaten his or her physical and psychological integrity. When listening to music, however, people tend to become self-forgetful and somewhat detached from everyday concerns. A clear expression of this detachment is that *dreamy* was among the most frequent emotive responses to music in the current studies (see Table 2). As people move into a mental state in which self-interest and threats from the real world are no longer relevant, negative emotions lose their scope.

How can we explain the case of sadness, then? In answering this question, two features of music's sadness should be considered. First, in the current studies that were largely based on instrumental music, reports of felt sadness in response to music turned out to be relatively rare. Reports of sadness to music that are accompanied by a sad text may lead to higher reports of sadness, but such reports are inherently ambiguous. Second, it is far from clear whether everyday sadness is the same as musically induced sadness. Recent experimental evidence suggests it may not be (Konecni et al., 2008). In everyday life, 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 regularly purge their CD collections of sadness-inducing albums. Consistent with this distinction, reports of music-induced sadness were usually dissociated from reports of its aversive components in the current studies. The most frequently reported sadness-like state in response to music was *melancholic* (*mélancolique*). On average, it was reported more than twice as much as the term *sad* and more than five times as much as the term *depressed*. *Melancholic* is a term that listeners may use preferentially to describe the distinctive character of the sadness feeling once the distress that accompanies its appearance in real life is removed.

Levinson (1990) notes that when "feelings are made available to us isolated, backgroundless, and inherently limited in duration—as they are through music—we can approach them as if we were wine tasters, sampling the delights of various vintages. . . . We become cognoscenti of feeling, savoring the qualitative aspect of emotional life for its own sake" (p. 324). The wine-tasting metaphor would apply equally to positive and negative emotions. Thus, the particular coloring of consciousness that is characteristic of sadness and other negative emotions, when stripped from contextual, real-world implications, is one that can be peacefully savored like the bitter taste of whiskey.

Although the previous considerations offer an explanation for the relative scarcity of negative emotional responses and the presence of refined positive emotional responses to music, they do not account for the specific kinds of positive emotions identified in the current research. One possibility relates to the functions of music in both daily life and evolutionary history. One of the striking findings across studies in this area is the prominence that nostalgia occupies in the spectrum of music-induced feelings. This puzzling finding can be better understood in light of the functions that music serves in daily life. For example, one of the most frequently

mentioned functions of music in daily life is as a reminder of a valued past event (North, Hagreaves, & Hargreaves, 2004; Sloboda & O'Neil, 2001). These findings not only suggest a link between functions of music and music-related emotion, but they also point to the mediating role of memory and imagery in musical emotion induction (see Konecni et al., 2008).

Also prominent in the list of musically induced emotions is love, especially as it appears in two different, though complementary, ways. Whereas the tenderness component in our classification relates to feelings of love, affection, and tenderness, wonder relates to the arresting qualities of music: feeling enchanted, charmed, dazzled, amazed. The latter feelings are of seminal importance to attraction and mating, thereby reminding us of Darwin's (1871) evolutionary views on the emotions induced by music. In *The Descent of Man*, Darwin observed that the sounds that some species produce during the mating season seem musical in that they resemble short melodic phrases or songs. Whereas the distal function is the propagation of the species, Darwin proposed, the proximal function of these musical vocal utterances is to call, charm, and excite the opposite sex (p. 880). Current evolutionary theories of the origins of musically induced passions have expanded these views, including the notion that emotive vocal utterances were also used to express triumph over mating rivals and as a means of territorial defense. Hence, the emergence of a power factor in the current model could also be related to evolutionary mechanisms. Although these views are speculative and unlikely to provide a complete answer to the kinds of emotions felt in response to music, they attract increasing interest and may ultimately provide valuable insights into differentiation of musically evoked emotion (e.g., Levitin, 2006; Miller, 2000; Vitouch, in press).

Awe, although an emotion that is sometimes cited in the context of music and other arts (e.g., Haidt & Keltner, 2003; Konecni, 2005), seems to be lacking in the current classification. However, this absence may simply be due to the lack of a French word for *awe*. In substantive terms, transcendence (e.g., feeling overwhelmed, inspired) and wonder (e.g., feeling moved, admiring) are both related to the English awe. Of interest is that the current musical emotion factors do not include a direct equivalent for happiness in a general sense. Rather, musically induced happiness either takes the form of bliss or enchantment—as in wonder—or takes the form of joy combined with a curious, yet universal "affordance" of music: its tendency to elicit motor entrainment—as in joyful activation (see Clayton, Sager, & Will, 2004).

Peacefulness and tension turned out to be further important classificatory units of musically induced affects. Peacefulness and relaxation seem an obvious affective consequence of the prototypical mental state of the music listener—one in which there is a certain detachment from the "real" world with its physical and psychological threats. The factor tension lends itself to two possible interpretations. In the influential writings by Meyer (1956), surprise, tension, and relief were the principal musical emotions because harmonic, rhythmic, and melodic progressions create expectations that are fulfilled or violated (see Huron, 2006, for a modern elaboration). However, like other researchers (Laukka, 2007), we did not find surprise to be among the more important musical emotions. This inconsistency may be linked to a listener's musical expertise: An unexpected shift in tonal key or melody, while evoking surprise in the music expert, may induce a thrill or a sense of wonder in the nonexpert auditor.

A second meaning of tension relates to irritation. We believe that irritation or anger in reaction to music is most likely to arise when people are exposed to music they fail to understand, dislike, or even abhor. A good case in point is heavy metal music, which is generally thought of as a prototype of aggression-inducing music. However, heavy metal music does not evoke anger in people who identify with it; only listeners who do not like heavy metal show elevated levels of anger when listening to it (Gowensmith & Bloom, 1997). The general absence of fear in the spectrum of musically inducible emotions will surprise some readers. However, when people refer to the fear-inducing capacities of music, they usually think of sound tracks in thrillers. Because in the thriller or horror movie, the content of the narrative and the music are hopelessly confounded, it is impossible to know whether the music acts as producer, as amplifier, or as neither. In addition, the wide diffusion of sounds accompanying thrillers may easily have led to fearful reactions occurring, not because of the sounds themselves, but because of a learned association. Hence, although fear and anger reactions to music may occasionally be driven by the inherent qualities of the music, more typically, these emotions arise from conditioning (fear) and from violation of certain tastes or attitudes (anger).

To conclude our analysis of the current musical emotions, it is important to remember that these are not sharply distinct or even mutually exclusive experiential categories. Rather, the intercorrelations indicate that these emotions tend to occur in a blended manner most of the time. For instance, although wonder may be experienced in response to a great variety of music, this feeling might be blended with tenderness in a gentle Mozart *Andante*, with nostalgia in a Chopin *Nocturne*, and with transcendence in a Bruckner symphony. In theory, the existence of such blends should make it more difficult to reliably distinguish between emotions. This concern has been voiced in the past to advocate the use of basic emotions in the study of music. Crude as these emotion categories may be, they ensure satisfactory interrater agreement, which could not be obtained from more nuanced emotions (Juslin, 1997). However, the findings from Study 4 suggest a different picture: It appears that the aptness of the domain-specific scales to the phenomenon to be judged ensures relatively high levels of agreement despite the subtle differences between musical emotions.

Are the Nine Musical Emotions "True" Emotions?

The view that music evokes emotion is not unanimously accepted. Since Hanslick (1854) expounded his ferocious antiemotivist views of music, the notion that music does not, and indeed cannot, induce specific emotions has never lost a certain appeal, especially within music theory and philosophy (e.g., Kivy, 1990; Meyer, 1956; Pratt, 1952; see Davies, 1994, for an overview). Authors in this tradition concede that listeners may feel some diffuse excitement in response to music. However, their reports of specific emotions are seen as the result of an "attribution error"; listeners mistake the emotion they perceive in the music for an aroused emotion. Although this "error" may happen from time to time, the current findings suggest that it is unlikely to be a general tendency. If it were, then instructing listeners to report emotion induction and emotion perception should lead to similar outcomes. Study 2 and other related studies (e.g., Evans & Schubert, 2008;

Kallinen & Ravaia, 2006) indicate that this is not the case. What perhaps most weakens the case for the error theory is the current evidence suggesting that affect aroused by music can be empirically differentiated into several subunits. In the light this evidence, invoking an error mechanism to explain listeners' reports of specific emotive states seems no longer necessary.

Less clear is whether these differentiable emotive states are "true" emotions. This question is difficult to answer, because there is no agreement on what an emotion is (Frijda, 2007b; Kagan, 2007; Scherer, 2005). In a recent survey, 33 internationally known experts in emotion responded to a request to give a definition of an emotion. As was to be expected, there was no consensus (Izard, 2007, p. 271). Still, there is some modest consensus with regard to the view that emotions have more than one psychological or behavioral manifestation: In addition to subjective feeling, they also contain action tendencies, physiological arousal, cognitive appraisals, and expressive motor behavior (Niedenthal, Krauth-Gruber, & Ric, 2006, pp. 6–8). From this perspective, we can only claim to have identified "candidate emotions," as the current differentiation on the feeling level requires "backing" by differentiation on a cognitive, behavioral, or physiological level. We think that work along this line should be exciting. Consider "nostalgia." For the neuroscientist, one of the questions of interest is whether brain areas related to mnemonic activity, such as the hippocampus, are being activated during musically induced nostalgia. In the area of memory and cognition, one interesting question is whether previously learned words relating to nostalgia are being retrieved more readily during or after musically induced nostalgia compared with other emotional music. Behavioral expressions of musically induced affection and tenderness, in turn, could be the subject of research on helping behavior.

However, whether it is judicious to restrict the term *emotion* to those affect states that possess a behavioral–expressive and physiological profile (and to downplay the psychological significance of feeling states without such a profile) has been questioned. First, emotion components often do not cohere (Niedenthal et al., 2006). If they do not cohere, then what should be used as a standard to decide on the presence of an emotion? One possible answer is that various emotion components are elicited by different objects or events (Ellsworth & Scherer, 2003). Consistent with this view, Scherer (2004) suggested distinguishing between utilitarian and aesthetic emotions. Aesthetic emotions appear to share several features with the larger category of refined emotions such as detachment, self-reflexive awareness, and savoring. Emotion refinement theory maintains that as one moves into a mental space that is detached from pragmatic, self-related concerns, emotions lose their urgency but retain their inner structure and action tendencies (Frijda & Sundararajan, 2007). Though authentic emotions, refined emotions will express themselves more in virtual than in overt actions, more in low-intensity than in high-intensity physiological arousal. Furthermore, their objects of appraisal are borrowed from the imaginary rather than from the real. Thus, the emotion component most readily activated in the case of refined emotions may be the experiential one—feeling. From this perspective, it would clearly be wrong to downplay the emotional significance of music-induced feelings, should these feelings fail to be consistently followed by those overt actions or by the neurobiological patterning that is characteristic for certain basic emotions. As we argue next, instead of using mainstream emotion theories as a standard to decide what an emotion is, it might be more profitable to examine what the emotive qualities identified in the current studies can tell us about day-to-day emotional experience.

How Music-Specific Is the Current Emotion Classification?

Although we set out to develop and test a domain-specific model, it is important to note that domain specificity has been demonstrated only one way—in the sense that global models of emotion are less powerful in accounting for musically induced emotions than a domain-specific model. The reverse, however, is less clear: Is the current model any *less* powerful in accounting for everyday emotion than the dimensional model or the basic emotion model? Although this question may seem absurd in light of a model that leaves almost no room for negative emotions, some of the current findings suggest otherwise. Specifically, results from Study 2 showed that emotion states relating to nostalgia, love, wonder, and transcendence are not experienced much less often in nonmusical everyday life contexts compared with music contexts. To the extent that these emotions are frequently experienced in everyday contexts, and indeed perhaps more frequently than negative emotions, the range of application of the current model may extend beyond the domain of music. This possibility is clearly supported by the supplementary analyses reported in Appendix C.

But how could we possibly explain that day-to-day emotional experience fits a model that is derived from emotional responses to music? One possibility is that the aesthetic components of emotional experience in everyday life are vastly underestimated. Day-to-day life not only provides a great variety of inherently aesthetic contexts, such as works of art, fashion, and design, but it is also full of objects and situations that are potential sources of aesthetic appraisals: a falling autumn leave, the chant of spring birds, a perfectly executed penalty shot, a child's radiant smile, the mellow resonance of an intimate conversation, the recognition of a scent from days past, the encounter with splendors of nature during a hike in the Alps. It is possible that emotions felt in response to music are just one example of a much larger category of emotions relating to aesthetically appraised day-to-day objects, situations, and experiences, which, as a whole, occupy much space in human lives.

Caveats and Limitations

The present studies have several limitations. First, from all possible music excerpts and listening contexts, the current music pieces and listening contexts are only a selection. Thus, more research is needed to examine whether the current feeling terms and term groupings generalize to forms of music that differ strongly from the music studied in the current research (e.g., serial music, heavy metal, music from non-Western cultures). Second, although the current procedure to select music-relevant feeling terms is the most rigorous to date, we cannot rule out that our compilation may still lack some relevant feeling terms. Third, it should be borne in mind that our compilation of affect labels and the nine-factorial structure is derived from a statistical, normative approach. Such an approach, although germane to psychological research, is limited because it accounts only for responses in a majority of listeners, whereas select individuals and subgroups may show different emotional response patterns. Ultimately, this

issue relates to the tension between nomothetic and idiographic approaches in psychology. Researchers aiming at idiographic depth can provide open response formats in addition to a "closed" set of descriptors—just as we did in Studies 3 and 4. Future researchers should thus not be prevented from making discoveries that are incompatible with the current model.

Fourth, we have explained why we believe that a first systematic investigation of musically induced emotions benefits from a focus on feeling. But clearly, feeling is not everything. Sometimes, music may arouse behavioral, cognitive, or physiological emotion components in the absence of subjective feeling. And where feeling is absent or difficult to access, measures other than self-report will be asked for (e.g., Västfjäll, in press). Also, many responses to music other than emotional responses are possible, and not all individuals react emotionally to music. For example, Study 2 showed that the frequency of occurrence of a given emotion heavily depends on the genre of music being judged (Figure 1A and 1B). Furthermore, the findings of Study 3 show that even the emotions most commonly evoked by music were experienced by less than 50% of the festival attendants (see Table 2). These findings are entirely consistent with Scherer and Zentner's (2001, p. 365) induction model, according to which elicitation of an emotion by music is a fragile process depending on multiple interacting factors (e.g., musical features, listener features, performance features, contextual features). However, the focus of the current research was not to examine why emotions often fail to be evoked by music. Rather, the current research examined the core features of music-elicited emotions once they have been successfully evoked.

Finally, although our findings suggest that basic emotion and dimensional models are suboptimal for studying musically induced emotions, the supplementary analyses to Study 4 suggest that this outcome may not generalize to perceived emotion. In the end, we do not suggest that the current studies provide an exhaustive picture of the nature and organization of music-induced emotions. However, by cutting a path into a much neglected area of research, we hope to have provided a point of departure from which tomorrow's researchers can achieve a deeper understanding of music's elusive emotions.

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Appendix A

The Geneva Emotional Music Scale (GEMS)

General Remarks

In Table A1, we present two versions of the GEMS, a 40-item version derived from Study 3 and a shorter 33-item version derived from Study 4.[9] The somewhat lower CFA factor loadings and alphas of the longer version most likely result from the virtually binary scale range used in Study 3. Indeed, with the more habitual 5-point rating scale used in Study 4, factor loadings and alphas went up considerably. It is also important to keep in mind that excerpts in Study 4 were more homogeneous (classical only), whereas Study 3 included a broader range of musical genres. Thus, choosing between versions is also a matter of the kind of music being used. We are currently testing the psychometric properties of an English-language version of the GEMS and find that, overall, psychometric values of the English-language version are comparable to those of the original French version.

Instructions

When providing your ratings, please describe how the music you listen to makes you *feel* (e.g., this music makes me *feel* sad). Do not describe the music (e.g., this music is sad) or what the music may be expressive of (e.g., this music expresses joy). Bear in mind that a piece of music can be sad or can sound sad without making you feel sad. Please rate the intensity with which you felt each of the following feelings on a scale ranging from 1 (*not at all*) to 5 (*very much*).

[9] A very short 25-item version of the GEMS, developed from additional CFA analyses, can be obtained from the corresponding author on request.

Table A1. *The Geneva Emotional Music Scale (GEMS)*

Musical emotion factor, associated feeling terms, and CFA factor loadings (in parentheses)	α
Wonder	
Happy (1.00), filled with wonder (.95), allured (.86), dazzled (.84), moved (.75)[a]	.73
Allured (1.00), filled with wonder (.90), moved (.88), admiring (.87)[b]	.89
Transcendence	
Inspired (1.00), feeling of transcendence (.92), feeling of spirituality (.90), thrills (.65)	.64
Fascinated (1.00), overwhelmed (.86), thrills (.82), feeling of transcendence (.80)	.82
Tenderness	
In love (1.00), sensual (.98), affectionate (.97), tender (.97), mellowed (.74)	.70
Mellowed (1.00), tender (.87), affectionate (.83), in love (.81)	.89
Nostalgia	
Sentimental (1.00), dreamy (.77), nostalgic (.64), melancholic (.54)	.64
Sentimental (1.00), dreamy (.92), melancholic (.84), nostalgic (.83)	.88
Peacefulness	
Calm (1.00), relaxed (.96), serene (.94), soothed (.90), meditative (.58)	.70
Calm (1.00), serene (.92), soothed (.92), meditative (.79)	.89
Power	
Energetic (1.00), triumphant (.76), fiery (.72), strong (.70), heroic (.56)	.74
Triumphant (1.00), energetic (.88), strong (.86), fiery (.81)	.82
Joyful Activation	
Stimulated (1.00), joyful (.99), animated (.95), feel like dancing (.72), amused (.56)	.69
Joyful (1.00), animated (.94), bouncy (.91), amused (.87)	.90
Tension	
Agitated (1.00), nervous (.85), tense (.63), impatient (.49), irritated (.39)	.70
Tense (1.00), agitated (.94), irritated (.84)	.89
Sadness	
Sad (1.00), sorrowful (.82)	.36
Sad (1.00), tearful (.96)	.73

[a] Upper rows: GEMS with 40 terms (factor loadings) derived from Study 3. [b] Lower rows: GEMS with 33 terms (factor loadings) derived from Study 4.

(*Appendixes continue*)

Appendix B

Music Excerpts Used in Study 4

1. Alfvén, Hugo. *Midsommarvaka*. Opening [Recorded by the Stockhom Philharmonic Orchestra, Neeme Järvi, conductor]. [CD]. Åkersberga, Sweden: BIS Recordings. (1993)

2. Barber, Samuel. *Adagio for Strings*. Bars 1–14 [Recorded by the Los Angeles Philharmonic Orchestra, Leonard Bernstein, conductor]. [CD]. Hamburg, Germany: Deutsche Grammophon. (1985)

3. Bartok, Béla. *Piano Sonata*. BB88 (Sz 80). First movement, bars183 to end [Recorded by Zoltán Kocsis, piano]. [CD]. New York: Philips Classics. (1997)

4. Bruch, Max. *Kol Nidrei, Adagio for Cello and Orchestra, op. 47*. Bars 9–25 [Recorded by the Nationales Rundfunk-Sinfonieorchester, Antoni Wit, conductor]. [CD]. Bietigheim-Bissingen, Germany: EBS Records. (1991)

5. Chopin, Frédéric. *Concerto for Piano n°1 in e Minor. Second movement. Larghetto*. Bars 13–37 [Recorded by the Chamber Orchestra of Europe, Emmanuel Krivine, conductor; Maria João Pires, piano]. [CD]. Hamburg, Germany: Deutsche Grammophon. (1988)

6. Delibes, Léo. *Coppélia. Ballet in 3 Acts. First act, prélude* [Recorded by the Slovak Radio Symphony Orchestra, Andrew Mogrelia, conductor]. [CD]. Muenster, Germany: Naxos. (1995)

7. Dvorak, Antonin. *Concerto for Cello and Orchestra. Second movement* [Recorded by the Oslo Philharmonic Orchestra, Mariss Janssons, conductor]. [CD]. Warwick, England: EMI Records. (2000)

8. Holst, Gustav. *The Planets, op. 32. Mars*. Bars 1–46 [Recorded by the Berlin Philharmonic Orchestra. Herbert von Karajan, conductor]. [CD]. Hamburg, Germany: Deutsche Grammophon. (1990)

9. Liszt, Franz. *Bénédiction de Dieu Dans la Solitude*. Bars 1–49 [Recorded by Jorge Bolet, piano]. [CD]. New York: Decca Record Co. Ltd. (1985)

10. Mendelssohn, Felix. *Song Without Words, op. 19, No 1*. Bars 3–44 [Recorded by Daniel Barenboim, piano]. [CD]. Hamburg, Germany: Deutsche Grammophon. (1997)

11. Milhaud, Darius. *Scaramouche. Brazileira* [Recorded by Isabelle and Florence Lafitte, piano]. [CD]. Alphée. (1999)

12. Mozart, Wolfgang, Amadeus. *Eine Kleine Nachtmusik. First movement* [Recorded by the Academy of St. Martin in the Fields, Neville Marriner, conductor]. [CD]. Warwick, England: EMI Records. (1997)

13. Saint-Saëns, Camille. *Carnival of Animals. Finale* [Recorded by Martha Argerich and Nelson Freire, piano]. [CD]. New York: Philipps Classics. (1988)

14. Shostakovich, Dimitri. *Symphony n°11 in g Minor op. 103. Second movement.* Bars 1–123 [Recorded by the USSR Ministry of Culture Symphony, Gennady Rozhdestvensky, conductor]. [CD]. New York: BMG Classics. (1999)

15. Strauss, Johann. *Chit-Chat-Polka, op. 214* [Recorded by the Berlin Philharmonic, Herbert von Karajan, conductor]. [CD]. Hamburg, Germany: Deutsche Grammophon. (1981)

16. Vivaldi, Antonio. *The Four Seasons, Spring*. Bars 1–45 [Recorded by I Musici, with Maria Teresa Garatti, Felix Ayo]. [CD]. New York: Philipps Classics. (1993)

Appendix C

Supplementary Analyses to Study 4

The layout of Study 2 is such that it allows testing of how well the basic emotion model and the musical emotion model account for (a) perceived emotion ratings, (b) felt emotion ratings, and (c) everyday emotion ratings. Although at the Study 2 stage we did not yet have a well-grounded musical emotion model and the affect terms were selected to assess emotions to music, not everyday emotion, the pool of affect terms in Study 2 was sufficiently large for us to "reconstruct" a basic emotion and a musical emotion model to some extent (although not a dimensional model). Thus, we went through the variables of Study 2 and defined a musical emotion model using factors and adjectives characteristic of the musical emotion model as developed across Studies 3 and 4. Similarly, we defined a basic emotion model using factors and adjectives characteristic of Izard's DES (this article, p. 508).

Subsequently, we went on to test the fit of these two models to the perceived emotion ratings, the felt emotion ratings, and the everyday ratings via structural equation modeling using MPlus 4.0 (Muthén & Muthén, 2006). As can be seen in Table C1, the basic emotion model provides a relatively good fit to the perceived musical emotion ratings, but not to the felt musical emotion ratings. Conversely, the current musical emotion model provides a good fit to the felt emotion ratings, but not to the perceived emotion ratings. Finally, and somewhat surprisingly, the musical emotion model also provides a relatively good fit to the everyday emotion ratings.

Proceeding to tests of significant differences, the basic emotion model provided a better fit to the perceived emotion ratings than to the induced emotion ratings and also to the everyday emotion ratings, as evidenced by the reduction in chi-square when moving from perceived to felt emotion ratings, $\Delta\chi^2(2) = 313.48$, $p < .0001$, and from perceived to everyday emotion ratings, $\Delta\chi^2(2) = 252.12$, $p < .0001$. The basic emotion model was superior in accounting for ratings of everyday emotion compared with the rating of induced musical emotion, $\Delta\chi^2(2) = 61.24$, $p < .0001$.

Conversely, the musical emotion model provided a significantly better fit to felt musical emotions than to perceived musical emotions, as evidenced by the reduction in chi-square when moving from perceived to felt emotion ratings, $\Delta\chi^2(2) = 100.13$, $p < .0001$. The musical emotion model provided a superior fit to ratings of everyday emotions than to ratings of perceived musical emotions, $\Delta\chi^2(2) = 113.07$, $p < .0001$. It is somewhat surprising that the musical emotion model also provided a slightly better fit to the everyday emotion ratings than to the felt musical emotions ratings, $\Delta\chi^2(2) = 12.07$, $p < .01$, although the latter difference was small in comparison.

Table C1. *Summary of Analyses of Comparative Model Fit*

Model fit	χ^2	*df*	RMSEA
Basic emotion model			
Fit with perceived musical emotion ratings	550	279	.06
Fit with felt musical emotion ratings	863.48	279	.09
Fit with everyday emotion ratings	802.24	279	.08
Summary of comparative fit		Perceived > Everyday > Felt[a]	
Musical emotion model			
Fit with perceived musical emotion ratings	546.32	216	.08
Fit with felt musical emotion ratings	446.19	216	.06
Fit with everyday emotion ratings	433.25	216	.06
Summary of comparative fit		Everyday ≥ Felt > Perceived[a]	

Note. RMSEA = root-mean-square error of approximation.
[a] All differences are statistically significant. However, note that ≥ minor difference, and > substantial difference.

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