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Feelings and Perceptions of Happiness and Sadness Induced by Music: Similarities, Differences, and Mixed Emotions

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The authors examined similarities and differences between (1) listeners' perceptions of emotions conveyed by 30-s pieces of music and (2) their emotional responses to the same pieces. Using identical scales, listeners rated how happy and how sad the music made them feel, and the happiness and the sadness expressed by the music. The music was manipulated to vary in tempo (fast or slow) and mode (major or minor). Feeling and perception ratings were highly correlated but perception ratings were higher than feeling ratings, particularly for music with consistent cues to happiness (fast-major) or sadness (slow-minor), and for sad-sounding music in general. Associations between the music manipulations and listeners' feelings were mediated by their perceptions of the emotions conveyed by the music. Happiness ratings were elevated for fast-tempo and major-key stimuli, sadness ratings were elevated for slow-tempo and minor-key stimuli, and mixed emotional responses (higher happiness *and* sadness ratings) were elevated for music with mixed cues to happiness and sadness (fast-minor or slow-major). Listeners also exhibited ambivalence toward sad-sounding music.

Keywords: music and emotion, music perception, emotion perception, emotional responding, mixed emotions

For many years, scholars have speculated that music is the language of emotions (e.g., Brown, 2000; Huron, 2006; Maslow, 1976; Meyer, 1956; Mithen, 2006). In line with this view, people often listen to music because of its emotional impact (Knobloch & Zillman, 2002; Panksepp, 1995; Sloboda, 1992), which can be intense (Gabrielsson, 2001; Gabrielsson & Lindström Wik, 2003; Goldstein, 1980; Panksepp, 1995). Moreover, associations between specific musical characteristics and emotions are well established (for reviews, see Gabrielsson & Juslin, 2003; Juslin & Laukka, 2004), especially for happiness and sadness. Listeners tend to associate faster tempi and major modes with happiness, and slower tempi and minor modes with sadness (Crowder, 1984; Dalla Bella, Peretz, Rousseau, & Gosselin, 2001; Gagnon & Peretz, 2003; Gerardi & Gerken, 1995; Gregory, Worall, & Sarge, 1996; Gundlach, 1935; Hevner, 1935, 1937; Hunter, Schellenberg, & Schimmack, 2008; Juslin, 1997; Kastner & Crowder, 1990; Peretz, Gagnon, & Bouchard, 1998; Rigg, 1937, 1939, 1940; Scherer & Oshinsky, 1977; Webster & Weir, 2005; Wedin, 1972).

The goal of the present investigation was twofold. We sought to determine how listeners' happy and sad emotional responses to music are similar to and different from their perceptions of happiness and sadness expressed by music. We also examined whether music evokes mixed happy and sad feelings and perceptions. There is virtual consensus that listeners can often perceive and decode emotions conveyed by music. Most scholars also agree that listeners respond emotionally to music (for reviews, see Juslin & Laukka, 2004; Juslin & Västfjäll, 2008), although the phenomenological nature of the link between music and emotion remains a matter of some debate (e.g., Konečni, 2008; London, 2002; Zentner, Grandjean, & Scherer, 2008).

Previous studies that measured both feeling and perception responses to music are inconclusive about how these two responses are similar and different. In one study (Kallinen & Ravaja, 2006), listeners made 32 emotional ratings—16 involving felt emotions, 16 involving perceived emotions—for each of twelve 1-min musical excerpts. In general, listeners reported feeling what they perceived. Perceived emotions were stronger than felt emotions when listeners made ratings of arousal and activation, but felt emotions were stronger for pleasantness. Requiring participants to make 32 ratings for each musical stimulus raises doubts, however, about the validity of the measures collected relatively long after stimulus presentation. In another study (Vieillard et al., 2008, Experiment 1), the researchers collected feeling and perception responses to music designed to convey happiness, sadness, fear, or peacefulness, but the manipulation was between- rather than within-subjects, which precluded determination of how feeling and perception responses covary among individual listeners. Indeed, the researchers reported a rather counterintuitive finding, namely that actual emotional responses were stronger than listeners' perceptions of emotions, particularly for sadness. In other studies (Evans & Schubert, 2008; Schubert, 2007b), perceptions were stronger than feelings but the small number of stimuli (i.e., 5 or fewer) precluded the possibility of assessing how perceptions and feelings covaried for the typical listener.

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In two additional studies (Juslin & Laukka, 2004; Zentner et al., 2008, Study 2), participants indicated retrospectively the *frequency* with which they generally feel and perceive emotions in response to music. In general, perceiving emotions were more frequent than actual feelings. By contrast, the focus of the present investigation was on how the *magnitude* of happy and sad feelings and perceptions elicited by musical stimuli covary in the laboratory under highly controlled conditions. Our listeners were asked to provide self-reports of their affective and perceptual responses to musical stimuli, specifically how happy and how sad the music made them feel, and how happy and how sad the music sounded. Identical scales for the feeling and perceiving judgments allowed for direct comparisons between the two measures.

A separate issue in emotion research involves the structure of emotions and the dimensions upon which different emotions vary (e.g., Diener & Iran-Nejad, 1986). According to Russell's (1980) *circumplex* model, emotions can be mapped in two-dimensional space, with one dimension corresponding to arousal (level of activity) and the other to valence (positive or negative). A person can feel positive with low (calm) or high (energetic) levels of arousal, or negative with low (bored) or high (angry) arousal levels. For many studies of music and emotion (e.g., Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005; Husain, Thompson, & Schellenberg, 2002; Khalfa, Roy, Rainville, Dalla Bella, & Peretz, 2008; Kreutz, Ott, Teichmann, Osawa, & Vaitl, 2008; Schellenberg, Nakata, Hunter, & Tamoto, 2007; Thompson, Schellenberg, & Husain, 2001; Vieillard et al., 2008), the circumplex model provides an adequate account of response patterns. For example, when listeners are asked to group different musical excerpts based on their emotional similarity, multidimensional scaling solutions reveal a dimensional organization largely (but not completely) consistent with the model (Bigand et al., 2005).

Some emotion researchers (e.g., Cacioppo & Berntson, 1994; Diener & Iran-Nejad, 1986; Watson, Clark, & Tellegen, 1988) have argued, however, that human affective responding can be more complex and nuanced than the circumplex model allows (see also Juslin & Västfjäll, 2008, and Zentner et al., 2008, for similar arguments about emotional responding to music). Because the valence dimension is bipolar, *mixed* (i.e., simultaneous positive *and* negative) responding is precluded. This position is inconsistent with empirical evidence demonstrating that positive and negative affect (i.e., corresponding to opposite poles of the putative valence dimension) are activated simultaneously in some circumstances (Hemenover & Schimmack, 2007; Larsen, McGraw, & Cacioppo, 2001; Larsen, McGraw, Mellers, & Cacioppo, 2004; Schimmack, 2001, 2005; Schimmack & Colcombe, 2007; see also Diener & Iran-Nejad, 1986), although both emotions are not typically felt strongly at the same time (Diener & Iran-Nejad, 1986). Rather, one response (i.e., the *dominant* response; e.g., sadness) is usually stronger than the semantically opposite response (i.e., the *conflicting* response; e.g., happiness).

In most previous examinations of musical emotions (for reviews see Gabrielsson & Lindström, 2001; Juslin & Laukka, 2004), participants could *not* report mixed emotions because the methods required them to link musical pieces with a specific adjective, or to rate the pieces using bipolar scales that ranged between two "opposite" emotions. On bipolar scales, it is impossible to distinguish mixed from neutral responding. In our view, music may be an ideal domain for evoking ambivalent responding because, for example, one dimension (e.g., major mode) can be a cue for happiness, while at the same time, another dimension (e.g., slow tempo) can be a cue for sadness. Hunter et al. (2008) examined the possibility of mixed emotional responding to music by asking listeners to report how happy *and* how sad they felt in response to musical excerpts, using separate unipolar rating scales (ranging from "not at all" to "extremely") for happiness and for sadness. The musical excerpts were selected to vary in tempo (fast or slow) and in mode (major or minor). As in previous research, excerpts with consistent cues to happiness (fast-major) received higher happiness ratings and lower sadness ratings, whereas excerpts with consistent cues to sadness (slow-minor) showed the opposite pattern. A more important and novel finding was that compared to excerpts with purely happy or sad cues, excerpts with mixed affective cues (fast-minor or slow-major) received greater simultaneous happiness *and* sadness ratings (i.e., mixed feelings).

Hunter et al.'s (2008) stimuli were 30-s instrumental excerpts taken from recordings that included a variety of musical styles (classical, alternative, jazz, electronic, etc.). Although the authors controlled for extraneous cues as much as possible, their use of ecologically valid stimuli (i.e., real music) meant that the music varied on multiple dimensions other than tempo and mode. In the present investigation, we sought to determine whether the findings of Hunter et al. could be replicated using more controlled musical stimuli, and whether perceptions of emotions would be similarly mixed in conditions with conflicting cues to happiness and sadness. In line with stimulus manipulations of previous studies (e.g., Hevner, 1936; Juslin, 1997; Rigg, 1940), our stimuli comprised multiple versions of the *same* musical excerpts, which varied in tempo and mode using MIDI (Musical Instrument Digital Interface). For half of the excerpts, cues from tempo and mode were consistent, suggesting the same feeling. Half of the consistent stimuli had two cues for happiness (fast tempo and major mode); the other half had two cues for sadness (slow tempo and minor mode). The remaining excerpts had inconsistent affective cues, either slow tempo in major mode or fast tempo in minor mode. After each excerpt, participants made six ratings. They rated how happy and how sad the music made them *feel*, their *perceptions* of the happiness and sadness expressed by the music, and how much they *liked* and *disliked* the music.

Hypotheses

In principle, feeling and perceiving ratings could be associated in a variety of ways (i.e., positively, negatively, or no association), but the bulk of the evidence points to a positive association (Evans & Schubert, 2008; Gabrielsson, 2002). Accordingly, we predicted that feeling ratings would be correlated positively and strongly with the corresponding perceiving ratings. We also expected that listeners would make a distinction between the two sets of ratings, providing higher perceiving ratings than feeling ratings (Evans & Schubert, 2008; Kallinen & Ravaja, 2006; Konečni, 2008; Schubert, 2007b), and that listeners' feelings would be mediated by their perceptions. These predictions were motivated by the available literature and by several additional factors. For example, the controlled laboratory environment and the computer-generated stimuli made it unlikely that listeners would have intense emotional responses. In some instances, listeners might readily recognize the affective valence of a musical piece without actually

responding affectively at all. Moreover, the difference between perceiving and feeling judgments should be particularly large for stimuli that are structurally unambiguous (i.e., with consistent happy or consistent sad cues), such that the emotion conveyed by the stimulus is similarly clear. The extensive literature on negative mood regulation (e.g., Rusting & DeHart, 2000; Singer & Salovey, 1988) also led us to expect that mild feelings of happiness would be easier to induce in the laboratory than mild feelings of sadness, and that the difference between feeling and perceiving ratings would be larger for ratings of sadness compared to ratings of happiness.

The results of Hunter et al. (2008) motivated additional predictions, namely that mixed feelings would be elevated in response to music with inconsistent rather than consistent cues to happiness and sadness, and that perception ratings would be similarly mixed in conditions with mixed cues. In other words, we predicted cross-over interactions: higher mixed ratings for major over minor stimuli presented at a slow tempo, and for minor over major stimuli presented at a fast tempo. We also expected that perceptions of mixed happy and sad emotions would be stronger than mixed happy and sad feelings, and that mixed feelings would be mediated by mixed perceptions.

Although mixed liking and disliking ratings might vary as a function of our stimulus manipulations, we did not expect these ratings to be systematically higher for conditions with mixed happy and sad cues. In other words, the liking and disliking ratings served as control measures (as in Hunter et al., 2008; Schimmack, 2001) in the sense that (1) they were also measured with two unipolar scales, and (2) their inclusion allowed us to test whether observed mixed responding was simply an artifact of asking listeners to rate *any* semantic opposites separately in response to music with conflicting cues to happiness and sadness. Finally, we predicted that listeners would like happy- more than sad-sounding music, with disliking ratings showing the opposite pattern (Gosselin et al., 2005; Hunter et al., 2008; Husain et al., 2002; Khalfa et al., 2008; Schellenberg, Peretz, & Vieillard, 2008; Thompson et al., 2001). Nonetheless, because listeners often enjoy and choose to listen to sad-sounding music, we expected that responding to sad-sounding music would in general be more ambivalent than responding to happy-sounding music (Schellenberg et al., 2008; Zentner et al., 2008).

Method

Participants

Forty-nine undergraduates (11 men, 38 women) enrolled in an introductory psychology class participated in a study on "music and emotions" for partial course credit. They were recruited without regard to musical training. On average, they had 3.8 years of musical training (SD = 4.7; range = 0–18) and 4.3 years of playing music regularly (SD = 5.4; range = 0–22) but the distributions were positively skewed. For example, more than half of the participants (55%) had little or no musical training (i.e., 0 to 2 years of lessons), and only 16% had played music regularly for 8 years or more.

Apparatus

Stimuli were created with Cubase sequencing software installed on an iMac computer, which was connected with MIDI (Mark-of-the-Unicorn) to a Roland JV-90 multitimbral synthesizer. We used four factory-preset timbres: two string instruments (violin—WEXP A72 and cello—WEXP A84) and two wind instruments (clarinet—WEXP B56 and flute—B73). Stimuli were presented over high-quality stereophonic headphones (Sony MDR-CD370) while participants sat in a sound-attenuating booth. A customized program created with PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993) controlled stimulus presentation and response collection.

Stimuli

The music stimuli were instrumental so that lyrics could not influence listeners' responses. The stimuli were excerpts from eight two-part pieces composed by J. S. Bach for harpsichord (see Table 1). These pieces were selected because they would be unfamiliar to most of our participants yet not particularly foreign sounding, and because Bach wrote these pieces in both major and minor modes at different tempi, which made our stimulus manipulations more ecologically valid than they would have been otherwise. Five of the eight pieces were originally written in major mode; the other three were written in minor.

The excerpts were constructed note by note from the musical scores using the sequencing software and MIDI (with pitch and temporal relations exactly as notated, and attack of notes held constant), and subsequently manipulated with the same software. The stimuli had no expressive cues other than those we manipulated on the computer. The different versions were created in a 2 × 2 factorial design, varying in tempo (fast or slow) and mode (major or minor). For each of the eight pieces, the fast-tempo excerpt was twice as fast as the slow-tempo excerpt, with the slow-tempo excerpt simply repeated for the fast version so that it was the same overall duration. A one- or two-note bridge between repetitions (composed by a trained musician) ensured a natural sounding transition. Each excerpt began at the beginning of a musical phrase and ended at the end of a phrase, with the additional constraint that it sounded natural but slow when timed to be 30 s without a repetition, yet natural but fast when it included a repetition (experimenters' judgment). Although the tempi in Table 1 are in beats

Table 1
Pieces Composed by J. S. Bach From Which The Stimuli Were Excerpted

Piece	Original key	Slow tempo (bpm)	Fast tempo (bpm)
Invention 7	E minor	45	90
Invention 8	F major	48	96
Invention 10	G major	80	160
Invention 12	A major	45	90
Invention 13	A minor	41	82
Invention 14	B flat major	52	104
Invention 15	B minor	52	104
Partita 1	B flat major	87	174

Note. bpm = beats per minute.

per minute (bpm), the perceived tempo was a function of the number of notes per unit time. For example, pieces with many 16th (or shorter) notes sounded faster than pieces with few or no 16th notes, even though they may have had a similar tempo in terms of bpm. A stimulus duration of 30 s was selected because it is long enough for listeners to experience an emotion (Hunter et al., 2008) yet short enough to allow for multiple trials during the testing session, and to make it unlikely that participants would feel different emotions sequentially while listening to a single stimulus.

The mode manipulation involved raising or lowering individual notes by one semitone, specifically the third scale degree (*mi*—one semitone lower for minor than for major), as well as the sixth (*la*) and seventh (*ti*) scale degrees in some instances according to music-theoretic principles. Thus, there were 32 different stimuli (8 pieces $\times$ 2 tempi $\times$ 2 modes), each 30 s in duration. In order to increase interest in the testing session, we created two different versions of each stimulus: one in a woodwinds timbre, the other in a strings timbre. Both timbres included two voices that corresponded to the higher and lower voices in each piece (written originally for the right and left hands, respectively). The woodwinds had a flute (higher) and a clarinet (lower); the strings had a violin (higher) and a cello (lower). The timbre manipulation was of no theoretical interest.

Procedure

Participants were tested individually in the sound-attenuating booth. The 32 excerpts were presented in random order, constrained so that two versions of the same piece were never presented in succession. There were four excerpts from each piece (fast-major, fast-minor, slow-major, slow-minor) and eight different pieces in each of the four cells defined by the tempo and mode manipulations. Half of the excerpts were in the woodwinds timbre, the other half were in the strings timbre, with the timbre manipulation counterbalanced with manipulations in piece, tempo, and mode. After each excerpt, six questions appeared sequentially on the monitor in a standardized order: (1) How HAPPY did the music make YOU feel? (2) How SAD did the music make YOU feel? (3) How HAPPY did the music SOUND? (4) How SAD did the music SOUND? (5) How much did you LIKE the music? and (6) How much did you DISLIKE the music? Upper-case typeface (as shown) was used to highlight differences among questions. Below each was a five-point response scale with each number accompanied by a verbal description (1 = "*Not at all*," 2 = "*Slightly*," 3 = "*Moderately*," 4 = "*Very*," 5 = "*Extremely*") so that the unipolar nature of each scale was emphasized throughout the test session. Responses were self-paced. After submitting a response to one question, the next question appeared. After responding to the sixth and final question, participants clicked on the mouse to hear the next musical excerpt.

Data Analysis

Correlations might seem like an obvious way to distinguish between bipolar and unipolar models of happiness and sadness, with strong and weak negative correlations between happiness and sadness ratings providing support for bipolarity and unipolarity, respectively. There are problems with this approach, however, when unipolar scales (e.g., ranging from "*not at all happy*" to "*extremely happy*") are used (Russell & Carroll, 1999; Schimmack, 2001). Strict bipolar responding means *no* sadness whenever any happiness is reported, regardless of the degree of happiness, and *no* happiness whenever *any* sadness is reported, regardless of the degree of sadness. To illustrate, if each possible happy rating (e.g., 1, 2, 3, 4, or 5) occurred equally often for music that sounded happy (i.e., with sad ratings always equal to 1), and each possible sad rating occurred equally often for music that sounded sad (happy ratings always equal to 1), the correlation between these 10 pairs of happy and sad ratings would be $-.5$, exactly half-way between a perfect negative association and no association even though this pattern of responding indicates *no* mixed feelings. In short, the magnitude of the correlation coefficient is uninformative about ambivalent responding.

Accordingly, researchers have devised various alternative measures of "objective" ambivalent responding (i.e., measured with two semantically opposite variables). The different methods are highly intercorrelated (rs $\geq$ .8) and each predicts "subjective" ambivalence (i.e., when participants are asked directly to rate their ambivalence) with similar levels of accuracy (Priester & Petty, 1996). In the present study, we used the most common method, Kaplan's (1972) *Conflicting Reactions Model*, which was simplified conceptually by Schimmack (2001) without changing it mathematically. The resulting minimum (MIN) statistic is simply the minimum of two ratings on unipolar scales (i.e., the conflicting response). To illustrate, when listeners provide a rating of 4 on a scale measuring happiness and a rating of 3 on a sadness scale, their MIN score for the trial would be 3. Similarly, a happiness rating of 4 and a sadness rating of 1 would give a MIN score of 1. In other words, the MIN statistic provides a measure of shared activation (e.g., *simultaneous* happy and sad responding), defined as the degree of activation on one scale that is equaled or exceeded on a second scale. By convention, if a scale's minimum value is 1 rather than 0 (as in the present experiment), 1 is subtracted from each MIN score so that 0 corresponds to no mixed emotions. In principle, MIN scores could range from 0 to 4 in our data but based on previous research (Diener & Iran-Nejad, 1986; Hunter et al., 2008; Larsen et al., 2004; Schimmack, 2001), we expected that values of 2 or higher would be rare.

Results

On each of the 32 trials, listeners made six ratings (happy feelings, sad feelings, happy perceptions, sad perceptions, liking, and disliking). For each trial, an additional three ratings of mixed responding (mixed happy/sad feelings, mixed happy/sad perceptions, mixed liking/disliking) were derived from the original ratings using the MIN statistic. Preliminary analyses examined associations among these nine outcome measures. Correlations between each pair of measures were calculated separately for each listener (i.e., treating the 32 stimuli as the experimental unit), with median values provided in Table 2. (Because Pearson's r is not distributed normally, the median is a better measure of central tendency than the mean.) For the typical listener, reliable negative associations were observed between feeling happy and feeling sad, between perceiving happiness and sadness, and between liking and disliking. These findings are consistent with previous studies (Diener & Iran-Nejad, 1986; Hunter et al., 2008; Larsen et al., 2004; Schimmack, 2001), which reported that "opposite" emotions are

Table 2
Median Correlations Among Pure and Mixed Rating Scales Calculated Separately for Each Listener

	2	3	4	5	6	7	8	9
1. Happy feelings	−0.60†	0.83†	−0.69†	0.59†	−0.50†	0.05	−0.04	−0.20
2. Sad feelings		−0.63†	0.82†	−0.30	0.32	0.36*	0.10	0.20
3. Happy perceptions			−0.76†	0.39*	−0.36*	−0.07	0.08	−0.11
4. Sad perceptions				−0.29	0.32	0.13	0.26	0.11
5. Liking					−0.65†	−0.14	−0.08	−0.11
6. Disliking						0.03	0.00	0.43*
7. Mixed feelings							0.55†	0.08
8. Mixed perceptions								0.07
9. Mixed liking/disliking								

Note. $N = 32$ excerpts.
† $p < .01$. * $p < .05$.

not simultaneously high. Significant positive correlations also confirmed that how happy an excerpt sounded predicted how happy it made listeners feel, whereas music perceived to sound sad tended to evoke sad feelings. Liking ratings tended to be higher and disliking ratings tended to be lower for music that sounded and made listeners feel happy. By contrast, the degree to which the excerpts sounded or made listeners feel sad was not associated with either liking or disliking, which is consistent with the proposal that listeners tend to be ambivalent about sad-sounding music.

Mixed happy/sad feelings and mixed happy/sad perceptions were also correlated. By contrast, correlations between mixed liking/disliking and mixed happy/sad feelings or perceptions showed almost complete independence (rs $< .1$). There were two significant correlations involving pure and mixed measures. Excerpts that evoked sad feelings tended to be accompanied by higher levels of mixed happy and sad feelings, whereas music that received higher disliking ratings tended to be accompanied by higher ratings of mixed liking and disliking. Both of these results highlight listeners' ambivalence toward music associated with negative affect.

Pure Ratings

For each of the six pure outcome variables, each listener had four scores (with each score averaged over 8 of the 32 excerpts), which corresponded to the four cells of the tempo and mode manipulations (fast-major, fast-minor, slow-major, and slow-minor). The first analysis examined happy and sad responding with a four-way repeated-measures analysis of variance (ANOVA) with response (feeling or perceiving), emotion (happiness or sadness), tempo (fast or slow), and mode (major or minor) as independent variables. Descriptive statistics are illustrated in Figure 1. Results from the ANOVA are provided in Table 3. Because the ANOVA tested 15 null hypotheses simultaneously, the alpha level was lowered to .01 for this analysis. Even so, 8 of 15 null hypotheses were rejected and all of the findings were commensurate with predictions.

Significant main effects confirmed that perceiving responses tended to be higher than feeling responses, and that ratings of happiness (felt or perceived) were generally higher than ratings of sadness. A significant two way-interaction between emotion and tempo confirmed that ratings of happiness (felt and perceived) were elevated for excerpts presented at fast tempi whereas ratings of sadness were elevated for excerpts presented at slow tempi. Similarly, the interaction between emotion and mode confirmed that ratings of happiness were elevated for excerpts in major mode whereas ratings of sadness were higher for excerpts in minor

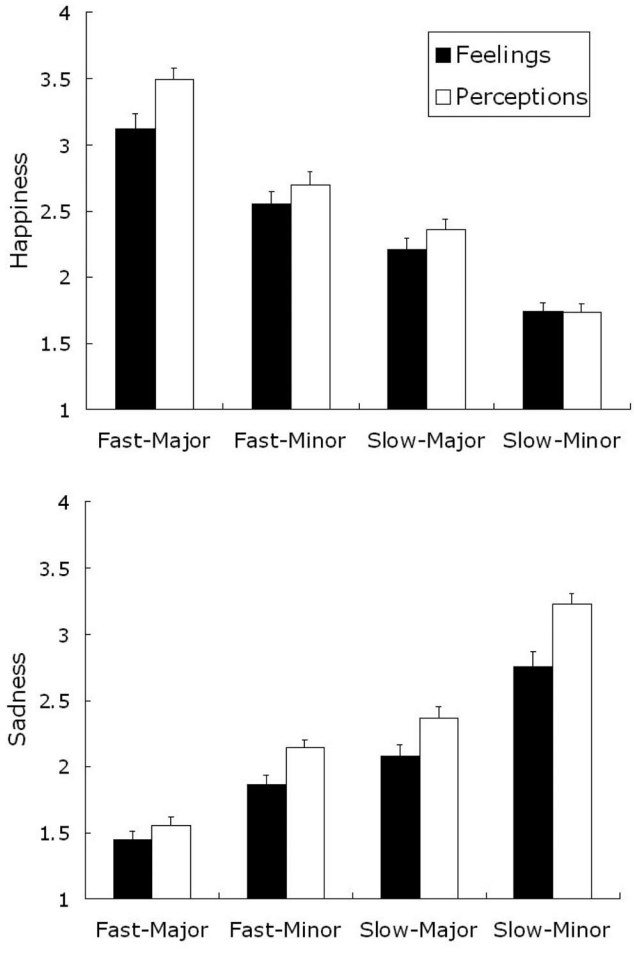

Figure 1. Mean happiness (upper) and sadness (lower) ratings as a function of the response (feelings or perceptions), tempo (fast or slow), and mode (major or minor). Error bars are *SE*s.

Table 3
Results From the Four-Way Analysis of Variance on Pure Happy and Sad Ratings as a Function of Response (Feeling or Perceiving), Emotion (Happiness or Sadness), Tempo (Fast or Slow), and Mode (Major or Minor)

	F	*p*	Partial η^2
Response	36.06	<.0001	.43
Emotion	16.07	<.0005	.25
Tempo	5.72	*ns*	.11
Mode	<1	*ns*	<.01
Response × Emotion	7.26	<.01	.13
Response × Tempo	<1	*ns*	<.01
Response × Mode	<1	*ns*	<.01
Emotion × Tempo	227.84	<.0001	.83
Emotion × Mode	77.45	<.0001	.62
Tempo × Mode	30.59	<.0001	.39
Response × Emotion × Tempo	19.13	<.0001	.28
Response × Emotion × Mode	11.58	<.005	.19
Response × Tempo × Mode	1.08	*ns*	.02
Emotion × Tempo × Mode	1.09	*ns*	.02
Response × Emotion × Tempo × Mode	<1	*ns*	<.01

Note. *ns* = nonsignificant. Each test has 1 degree of freedom in the numerator and 48 degrees of freedom in the denominator ($\alpha = .01$; see text).

mode. In other words, measuring happiness and sadness separately did not affect response patterns reported previously in the literature. A third two-way interaction between mode and tempo indicated that happy and sad ratings were, in general, higher for excerpts with consistent cues to happiness or sadness (fast-major or slow-minor) than for excerpts with conflicting cues (fast-minor or slow-major).

There were two three-way interactions: one among emotion, response, and tempo, and another among emotion, response, and mode. The former indicated that the two-way interaction between emotion and tempo (i.e., higher ratings of happiness for fast-tempo excerpts, higher ratings of sadness for slow tempi) was stronger for perceiving compared to feeling responses. In other words, for happiness, the difference between perceiving and feeling ratings was magnified for excerpts with fast tempi, whereas for sadness, the difference was magnified for excerpts with slow tempi. Similarly, the three-way interaction among emotion, response, and mode indicated that for happiness, the difference between perceiving and feeling ratings was particularly strong for excerpts in major mode, whereas for sadness, the difference was particularly strong for excerpts in minor mode. Considered jointly, these two three-way interactions confirmed that the difference between perceiving and feeling ratings for happiness was strongest for excerpts with two cues to happiness, smallest for excerpts with two cues to sadness, and intermediate for excerpts with conflicting cues. The pattern was simply reversed for sadness ratings: The difference between perceiving and feeling ratings was strongest for excerpts with two cues to sadness, smallest for excerpts with two cues to happiness, and intermediate for excerpts with conflicting cues.

We used hierarchical linear modeling to examine whether listeners' happy and sad feelings were mediated by their happy and sad perceptions. For both happy and sad ratings, the data were consistent with this hypothesis. The musical cues (tempo, mode, and the two-way interaction) had only indirect effects (through happy perceptions) on happy feelings, but no direct effects on happy feelings when happy perceptions were included in the model. Similarly, the musical cues had only indirect effects (through sad perceptions) on sad feelings, but no direct effects on sad feelings when sad perceptions were included in the model. By contrast, the musical cues had both direct *and* indirect effects on perceptions when feelings were considered as a mediating variable.

Descriptive statistics for liking and disliking ratings are illustrated in Figure 2. A three-way repeated-measures ANOVA, with emotion (liking or disliking), tempo (fast or slow), and mode (major or minor) as independent variables, uncovered two significant results. A main effect of emotion indicated that liking ratings tended to be higher than disliking ratings, $F(1, 48) = 28.84$, $p < .0001$, partial $\eta^2 = .38$. Considered jointly with the finding of lower ratings for sadness than happiness, this result confirms that negative affective responses (e.g., sadness, disliking) are relatively difficult to induce in the laboratory compared to positive affective responses (e.g., happiness, liking). There was also a significant interaction between tempo and liking/disliking, $F(1, 48) = 35.61$, $p < .0001$, partial $\eta^2 = .43$. Whereas liking ratings were elevated for fast-tempo excerpts, disliking ratings were elevated for slow-tempo excerpts. More powerful trend analyses revealed an interaction between liking/disliking and the linear effect of the number of cues to happiness or sadness, $F(1, 48) = 22.01$, $p < .0001$, partial $\eta^2 = .31$. Liking ratings increased as the number of cues to happiness (0, 1, or 2) increased and the number of cues to sadness (0, 1, or 2) decreased, $F(1, 48) = 21.08$, $p < .0001$, partial $\eta^2 = .31$, whereas disliking ratings increased as the number of cues to sadness increased and the number of cues to happiness decreased, $F(1, 48) = 17.64$, $p < .0005$, partial $\eta^2 = .27$.

Mixed Ratings

As with the pure ratings, each listener had four ratings (fast-major, slow-major, fast-minor, slow-minor) for each mixed outcome variable (mixed happy/sad feelings, mixed happy/sad perceptions, mixed liking/disliking), with each rating averaged over

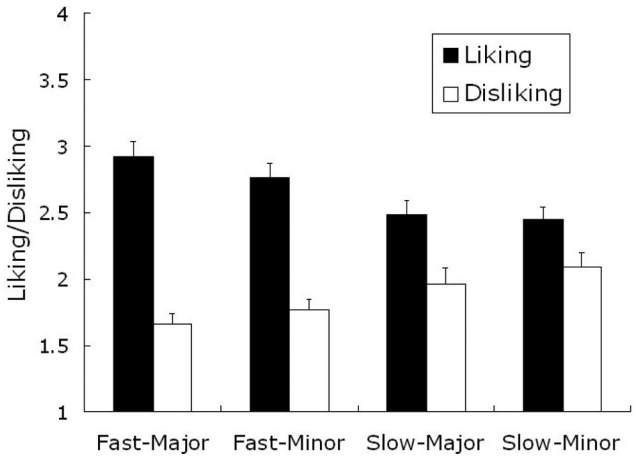

Figure 2. Mean liking and disliking ratings as a function of tempo (fast or slow), and mode (major or minor). Error bars are *SE*s.

eight MIN scores. Descriptive statistics for mixed happy and sad ratings are illustrated in Figure 3 as a function of response (feeling or perceiving), tempo (fast or slow), and mode (major or minor). A three-way repeated-measures ANOVA confirmed that response patterns were in line with our predictions. Mixed happy and sad perceptions were stronger than mixed happy and sad feelings, $F(1, 48) = 22.91$, $p < .0001$, partial $\eta^2 = .32$, and mixed happy/sad responding was higher for slow-tempo compared to fast-tempo excerpts, $F(1, 48) = 5.55$, $p < .05$, partial $\eta^2 = .10$. Most importantly, the two-way interaction between tempo and mode was significant, $F(1, 48) = 19.17$, $p < .0001$, partial $\eta^2 = .29$. Mixed happy and sad ratings were higher in conditions with conflicting cues to happiness and sadness (slow-major or fast-minor) than in conditions with consistent cues (fast-major or slow-minor). A significant three-way interaction, $F(1, 48) = 9.52$, $p < .005$, partial $\eta^2 = .17$, confirmed that the difference between conditions with conflicting or inconsistent cues was larger for perceiving compared to feeling responses. When mixed happy/sad feelings and mixed happy/sad perceptions were analyzed separately, however, the crucial two-way interaction between tempo and mode was evident in both instances, $F(1, 48) = 9.99$, $p < .005$, partial $\eta^2 = .17$, and $F(1, 48) = 23.52$, $p < .0001$, partial $\eta^2 = .33$, respectively.

Hierarchical linear modeling tested whether the musical cues influenced mixed happy/sad feelings when mixed happy/sad perceptions were held constant. The results paralleled those from the pure ratings. Mixed feelings were completely mediated by mixed perceptions, such that the musical cues influenced mixed perceptions, which, in turn, influenced mixed feelings, but there was no direct effect between the cues and mixed feelings when mixed perceptions were held constant. The results were different for mixed happy/sad perceptions, which were influenced directly and indirectly by the musical cues when mixed happy/sad feelings were held constant.

Mixed liking and disliking ratings are illustrated in Figure 4. A two-way (tempo × mode) repeated-measures ANOVA uncovered a main effect of tempo. Mixed responding was higher for slow- than for fast-tempo excerpts, $F(1, 48) = 7.51$, $p < .01$, partial $\eta^2 = .14$. In line with our predictions, mixed liking and disliking ratings were *not* elevated in conditions with conflicting happy and sad cues (i.e., there was no two-way interaction), $F < 1$. Rather, trend analyses confirmed that mixed liking and disliking increased as the number of cues to sadness (0, 1, or 2) increased and the number of cues to happiness (0, 1, or 2) decreased, $F(1, 48) = 8.25$, $p < .01$, partial $\eta^2 = .15$.

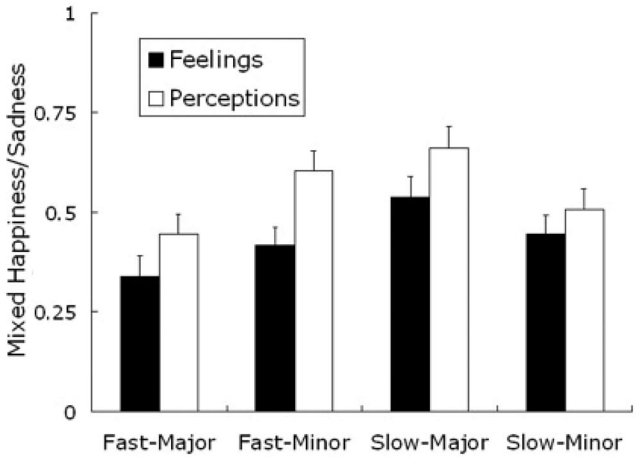

Figure 3. Mean mixed happy and sad responding measured by the MIN statistic as a function of response (feelings or perceptions), tempo (fast or slow), and mode (major or minor). Error bars are *SE*s.

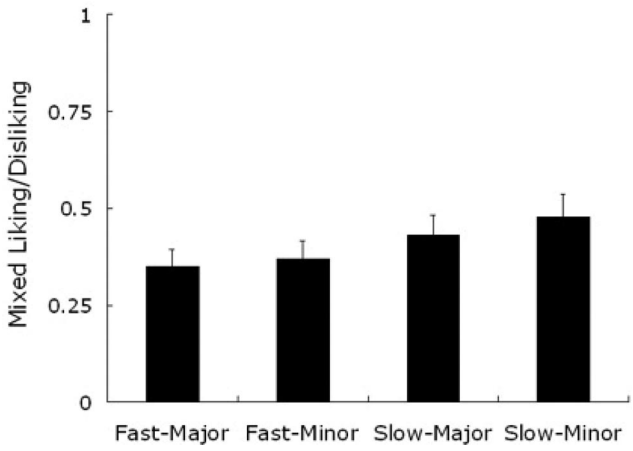

Figure 4. Mean mixed liking and disliking measured by the MIN statistic as a function of tempo (fast or slow) and mode (major or minor). Error bars are *SE*s.

Discussion

Participants listened to excerpts from pieces composed originally by J. S. Bach that were computer-manipulated to vary in tempo and mode. Some excerpts had consistent happy cues (fast tempo, major mode), some had consistent sad cues (slow tempo, minor mode), and others had conflicting affective cues (fast-minor or slow-major). Listeners rated how happy and how sad each excerpt made them feel, how happy and how sad each excerpt sounded, and how much they liked and disliked each excerpt. Happiness and sadness ratings were affected by tempo and mode manipulations in the expected direction regardless of whether we asked for feeling or perceiving responses. Indeed, feeling and perceiving ratings were correlated but not identical. The principal difference was that perceiving ratings tended to be higher than feeling ratings, particularly for happy responses to music with consistent cues to happiness, for sad responses to music with consistent cues to sadness, and for sad responses in general. The other major finding was that mixed happy and sad responses were elevated after listening to music with conflicting as opposed to consistent cues, and that perceptions of mixed happy and sad emotions were stronger than actual mixed happy and sad feelings.

Our findings suggest that the distinction between feeling and perceiving emotions when listening to music is primarily one of quantity (or intensity) rather than one of quality, and that listeners' feelings are mediated by their perceptions. This does not mean that feelings induced by music will always be in-line with perceptions of the emotion conveyed by the music. A specific learned association for a particular song (e.g., a happy-sounding song associated with a break-up with a former lover) could evoke an unrelated or opposite feeling to that expressed by the music (Konečni, 2008). A preexisting

mood might also interfere with the feelings induced by music (e.g., a strong negative mood might prevent musical induction of happy feelings).

Can we be certain that listeners in the present study were distinguishing and reporting their feelings and perceptions of happiness and sadness accurately? Positive evidence in this regard comes from our data, which revealed consistent and systematic differential responding between the feeling and perceiving measures. Results from other studies provide additional evidence that the distinction is relatively easy for music listeners to make (Evans & Schubert, 2008; Schubert 2007a, 2007b). For example, physiological arousal influences listeners' feeling ratings but not their perceiving ratings (Dibben, 2004). Moreover, participants provide different estimates of the frequency with which they feel or perceive emotions in response to music, specifically that perceptions are usually more frequent than feelings (Juslin & Laukka, 2004; Zentner et al., 2008). Considering our findings jointly with these others, we speculate that differences between feeling and perceiving ratings stem from instances when (1) participants recognize the intended emotion of a piece without actually feeling the emotion, (2) the perception is more or less obvious but the feeling is relatively subtle, or (3) the feeling is a consequence of a manipulation (e.g., exercise) or association that has no effect on listeners' perceptions.

How do our results bear on theories of music and emotion? One view (Davies, 2001) argues that music evokes emotions in a two-stage process. In the initial stage, listeners are said to recognize associations between musical cues and specific emotions, much like they might recognize an association between a weeping-willow tree and sadness. Emotional responding is evoked *contagiously* in a second stage, in the same way that being around someone who is depressed can make one feel sad (Joiner & Katz, 1999). In line with this view, our data indicate that emotional responding to music is mediated by listeners' perceptions. Lundqvist, Carlsson, Hilmersson, and Juslin (2009) proposed a similar interpretation after measuring physiological and behavioral responses to music that was selected to express happiness or sadness, although they did not measure perceptions. Future research could investigate the contagion hypothesis further, possibly by using more fine-grained response-time measures or very brief stimuli.

A somewhat different view (Konečni, 2008) holds that music-induced emotions are mediated by learned associations, but that these are restricted to idiosyncratic associations between specific pieces of music and past experiences with emotional significance. Our results suggest, however, that associations between emotions and musical characteristics such as tempo and mode are sufficient to evoke emotional responses from listeners. Listeners may also respond emotionally to music when their musical expectancies are violated, as Meyer (1956) proposed many years ago. Although there is some evidence in line with this view (Steinbeis, Koelsch, & Sloboda, 2006), our data imply that emotional responding can also be a direct consequence of associations with tempo and mode without the presence of unexpected musical events.

By measuring affective responses using separate unipolar scales for happiness and for sadness, our results improve our knowledge about the dimensional structure of emotions in general, as well as of emotional responding to music in particular. As in previous research, faster tempi and major mode were associated with higher happy ratings, whereas slower tempi and minor mode were associated with higher sad ratings. More importantly, we replicated Hunter et al.'s (2008) finding of mixed happy and sad feelings in response to recordings with inconsistent affective cues and extended this finding (1) to computer-manipulated music that varied in tempo and mode, and (2) to mixed perceptions of how the music sounded. Our finding of elevated mixed ratings in conditions with conflicting affective cues for two sets of ratings (i.e., those involving happiness and sadness) but not for the third set (liking and disliking) clarifies that mixed responding was not an artifact of the response format. In short, mixed emotional responding to music is both systematic and predictable from characteristics of the music.

Although Russell's (1980) circumplex model accounts for response patterns in many instances, it cannot account for the entire range of human emotional responding because positive and negative valence (and related terms like happiness and sadness) are correlated but not completely redundant dimensions. Indeed, evidence of mixed emotional responding to music converges nicely with findings from studies that used nonmusical stimuli. These studies have examined responses to positive and negative visual images presented simultaneously (Schimmack, 2001, 2005), to movies that conveyed both happiness and sadness (e.g., *Life is Beautiful*, Larsen et al., 2001), to scenarios with positive and negative affective content (e.g., graduating from college, Larsen et al., 2001), and to outcomes that had both good and bad consequences for the participant (e.g., winning or losing large or small amounts in a gambling task, Larsen et al., 2004). Consistency across domains suggests that ambivalent emotional responding to music is similar to ambivalence in general.

Our results also shed light on an issue that was tangential to our central goals: why do listeners like sad music? Although experimental participants routinely prefer happy- over sad-sounding music (Gosselin et al., 2005; Hunter et al., 2008; Husain et al., 2002; Khalfa et al., 2008; Schellenberg et al., 2008; Thompson et al., 2001), we know that people often choose to listen to sad-sounding music (Zentner et al., 2008). This apparent conundrum suggests a fundamental ambivalence toward sad-sounding music that operates on a level different from the happy-sad focus of the present study, one that includes liking (or aesthetic preferences) as well as more specific negative emotional responding. Several aspects of our results are in line with this view: (1) liking and disliking ratings were independent of sad feelings and perceived sadness, (2) music that evoked sad feelings or disliking also tended to evoke mixed happy and sad feelings or mixed liking and disliking, respectively, (3) slow music evoked greater mixed feelings as well as greater mixed perceptions of happiness and sadness, and (4) mixed liking and disliking in response to music increased as the number of cues to sadness increased. One goal of future research could be to determine how the typical bias for happy-sounding music interacts with contextual factors. In one study (Schellenberg et al., 2008), the bias was eliminated after listeners completed a demanding task. The appeal of sad-sounding music may increase when listeners are fatigued or in a negative mood state.

Although the present investigation was motivated by basic rather than applied research questions, the findings have clinical and practical implications, particularly for music therapy (Gold, Voracek, & Wigram, 2004) and for the use of music in medical and dental procedures (Standley, 1986). First, our results indicate that controlled musical stimuli varying only in tempo and mode can be used in clinical research to induce emotional responding among listeners. Indeed, the use of MIDI-generated or similarly controlled stimuli should make interpreting results more straightforward than when

participants select their own music, which would vary on multiple dimensions across participants. Second, even if a piece of music is selected for therapeutic purposes because it is unequivocally happy- or sad-sounding, the listener may not necessarily feel happy or sad, respectively, when exposed to it, although the likelihood of a emotional response consistent with the valence of the music increases. Finally, the therapeutic value of sad-sounding music may be underestimated, not only because it can lead to mixed positive and negative responding as the present results and those of Hunter et al. (2008) indicate, but also because its appeal increases among listeners who are in negative mood states (Schellenberg et al., 2008).

In conclusion, the results of the present study indicate that listeners' emotional responses to music parallel their perceptions of the emotions conveyed by music, that emotional responses are typically relatively subtle compared to perceptions, that emotional responses are mediated by listeners' perceptions, that music can elicit mixed feelings and perceptions, and that changes in tempo and mode are sufficient to produce these effects. Nonetheless, the present study also has notable limitations, particularly our exclusive focus on happiness, sadness, liking, and disliking, our use of a single genre of music for the stimuli, and our reliance on self-reports as the sole measure of emotional responding. In order to corroborate and extend the present findings, future research could (1) measure other emotions (e.g., fear, peacefulness), (2) use stimuli from different musical genres (e.g., music from foreign cultures), or (3) incorporate different measures of emotional responding to music, such as indirect behavioral measures (e.g., cognitive abilities that are influenced by affect), physiological measures (e.g., skin conduction responses, facial electromyography), or neurological measures (e.g., evoked potentials, brain imaging). Moreover, associations between feeling and perceiving responses to music are undoubtedly influenced by internal factors (e.g., preexisting moods, specific associations with particular pieces), personal characteristics (e.g., musical preferences, personality differences), contextual factors (e.g., being around friends who like heavy metal), interactions among these variables, as well as by characteristics of the musical piece other than tempo and mode (e.g., orchestration, pitch height). Further exploration is warranted into how these factors influence the association between felt and perceived affect in response to music with consistent or conflicting affective cues.

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