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Emotions During Live Music Performance: Links With Individual Differences in Empathy, Visual Imagery, and Mood

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Process theories have argued that empathy and visual imagery are important mechanisms underlying emotional reactivity to music. Transient affective states such as mood may also influence music-induced emotions. The present study describes the emotional experience of participants who attended a live opera performance of Puccini's "Madama Butterfly," and its links with individual differences in empathy, visual imagery, and mood. The opera performance induced blends of emotions characterized by high sublimity, low vitality, and unease on the Geneva Emotional Music Scale. Higher dispositional empathy and visual imagery were associated with increased sublimity and unease, respectively. Positive mood was related to increased sublimity and vitality, as well as decreased unease. These results are in line with recent laboratory research on the mechanisms of music-induced emotions and illustrate once again the feasibility of psychological research during live musical performance.

Keywords: music, emotions, empathy, visual imagery, mood

Emotional responses to music involve the interplay of multiple factors related to music, listener, and situation (Gabrielsson, 2001; Scherer & Zentner, 2001). For instance, individuals differ in their capacity to understand and respond to the emotions they perceive in the environment (i.e., empathy), as well as to associate stimuli from any sensory modality with vivid images in the mind (i.e., visual imagery). Such stable individual differences (i.e., traits) may interact with more transient psychological characteristics (e.g., mood) and contextual features (e.g., location, the presence of others) in influencing emotional reactivity to music (Scherer & Coutinho, 2013). Therefore, real-life situations in which people come together to listen to music offer valuable opportunities to study the psychological underpinnings of emotional responses to music (Zentner & Eerola, 2010). The present study investigates the influence of individual differences in empathy, visual imagery, and mood on emotional responses to music during a live opera performance.

Empathy and Visual Imagery in Music-Induced Emotions

Process theories have identified empathy and visual imagery as two of the most important central "routes" or mechanisms by which music may induce emotions in listeners. For instance, Scherer and Zentner (2001) hypothesized that "mirroring" the emotions perceived in music through controlled and automatic processes of empathy, as well as associating music with images through memory-dependent processes of visual imagery are two important routes by which listeners may experience emotions in response to music (see also Garrido & Schubert, 2010; Scherer & Coutinho, 2013; Walton, 1999). These hypotheses were supported by the results of an experience-sampling study (Juslin, Liljestrom, Vastfjall, Barradas, & Silva, 2008), in which listeners identified emotional contagion (i.e., an automatic form of empathy; Hatfield, Cacioppo, & Rapson, 1993) and visual imagery as among the most important mechanisms by which music induced emotions in their everyday life. Following this study, a theoretical framework known as BRECVEM (i.e., an acronym for seven mechanisms by which music may induce emotions) was developed (Juslin, Liljestrom, Vastfjall, & Lundquist, 2010), which further emphasized the role of emotional contagion and visual imagery in emotional reactivity to music.

Recent laboratory research supports the involvement of empathy and visual imagery in emotional reactivity to music. Several studies reported significant associations between listeners' trait empathy and their capacity to understand the expressive intentions of music performers (Wöllner, 2012), as well as to develop emotions such as sadness or tenderness in response to music (Garrido & Schubert, 2011; Vuoskoski & Eerola, 2011a). The causal involvement of empathy in the generation of emotions to music was supported in an experiment in which the manipulation of empathy resulted in emotional reactivity changes to sad and joyful music, at the subjective and physiological levels (Miu & Balteş, 2012). There is indirect support for the link between visual imagery and music-induced emotions, given that empathy was assessed in several studies (Garrido & Schubert, 2011; Vuoskoski & Eerola, 2011a, 2012) using multidimensional measures that included imagination and fantasy subscales. Also, an experimental study

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using the Bonny Method of Guided Imagery and Music (Bonny, 1995) showed that encouraging participants to experience visual images during music listening improved mood and decreased basal cortisol (McKinney, Antoni, Kumar, Tims, & McCabe, 1997).

Mood and Emotional Responses to Music

The potential influence of listeners' background mood (i.e., a diffuse and relatively long affective state, often without apparent cause) has also been suggested in process theories of emotional responses to music (Scherer & Coutinho, 2013; Scherer & Zentner, 2001). Early evidence (Cantor & Zillmann, 1973) showed that film-induced mood modulated the subsequent appreciation of music according to a "hedonic-contrast" or "excitation-transfer" pattern. However, only recently have these effects started to be systematically investigated. Mood-congruent influences on emotional reactivity to music have been reported for both incidental (Vuoskoski & Eerola, 2011b) and experimentally induced positive or negative mood (Hunter, Schellenberg, & Griffith, 2011). Specifically, negative mood eliminated the typical preference for happy over sad music and made listeners perceive more sadness in emotionally ambiguous music (Hunter et al., 2011).

Music Listening Situation and Emotional Reactivity

Emotional reactivity to music may also be influenced by at least two aspects of the music listening situation: the presence of others and the ambience of the location (North, Hargreaves, & Hargreaves, 2004; Scherer & Coutinho, 2013). Laboratory studies have only recently started to compare between individual and group music listening, and it is not yet clear whether the presence of others facilitates emotions by social feedback related to the emotional qualities of music (Egermann, Grewe, Kopiez, & Altenmuller, 2009; Egermann, Kopiez, & Altenmuller, 2013; Liljestrom, Juslin, & Vastfjall, 2013) or impairs emotions by interfering with the attentional processing of music (Sutherland et al., 2009). In addition, it is possible that group music listening may selectively facilitate prosocial emotions such as happiness–elation, pleasure–enjoyment, and admiration–awe (Juslin et al., 2008; Liljestrom et al., 2013). At any rate, the majority of intense emotional experiences to music may be experienced during live music performance (Lamont, 2011), and this underscores the importance of field studies that focus on group music listening in natural situations. Three field studies described the types of emotions (Study 3 in Zentner, Grandjean, & Scherer, 2008) and the links between emotional arousal and musical structure (McAdams, Vines, Veillard, Smith, & Reynolds, 2004; Vaitl, Vehrs, & Sternagel, 1993) in live music performance. These pioneering results showed that self-report may be successfully used in realistic performance contexts (Zentner & Eerola, 2010).

The Present Study

The present field study investigates, for the first time, the contribution of three key individual differences to emotional responses during a live opera performance. A relatively large sample of participants who attended a live performance of Giacomo Puccini's opera "Madama Butterfly" reported their music-induced emotions using the Geneva Emotional Music Scale (GEMS; Zentner et al., 2008). This self-report instrument captures the blends of negative and positive emotions that are most frequently induced by music (Zentner & Eerola, 2010). Based on self-report assessments of individual differences that were made before the performance, the main aim of this study was to describe the influence of empathy, visual imagery, and mood on music-induced emotions reported during this opera.

"Madama Butterfly" describes a tragic story and, in light of a previous study on a similar opera (Balteş, Avram, Miclea, & Miu, 2011), we expected that this performance would induce a combination of plot-related negative emotions (e.g., sadness for the characters' misfortunes) and performance-related positive emotions (e.g., admiration for singing virtuosity). In line with previous laboratory results (Garrido & Schubert, 2011; Miu & Balteş, 2012; Vuoskoski & Eerola, 2011a; Wöllner, 2012), it was hypothesized that dispositional empathy would be associated with increased emotional experience during the performance, by facilitating spectators' understanding of, and affective responses to, the characters. We also hypothesized that visual imagery would be associated with increased emotional experience by allowing the spectators to imagine places or events evoked by the lyrics (e.g., the aria "Un bel dì vedremo" from the second act of "Madama Butterfly") and associate visual images with the music (see Garrido & Schubert, 2011; Vuoskoski & Eerola, 2011a, 2012). Finally, based on previous findings (Hunter et al., 2011; Vuoskoski & Eerola, 2011b), we expected that mood before the performance would modulate emotional experience in a valence-specific manner (e.g., positive affect would be associated with increased positive and decreased negative emotions).

Method

Participants

One hundred and twenty participants (86 women; age $M = 32.4$, $SD = 17.41$; age range: 18–87 years) participated in this study. These participants responded to advertisements referring to a field study on the psychology of music, distributed in the Babes–Bolyai University campus and the ticket office of the Opera House.

Opera Performance

The study was conducted during a performance of Giacomo Puccini's "Madama Butterfly" at the Romanian National Opera House in Cluj-Napoca, Romania. The performance took place on November 16, 2009. The opera was sung in Italian, but the Romanian surtitles were projected above the stage, visible from every seat.

Briefly, the plot of this opera is focused on the mock marriage of a Japanese girl who naively devotes herself to an American marine officer; unfortunately, Pinkerton, the officer, only wants a temporary relationship during his stay in Japan. Cio-cio-san (aka Butterfly), the main character of the opera, is a 15-year-old girl from a noble, but impoverished, family, who had been forced to become a teahouse girl before she met Pinkerton. Therefore, she believes that her marriage to Pinkerton will save her honor. In the first act, Butterfly marries and dedicates herself to Pinkerton, while abandoning her family and religion. The second act shows Butterfly after 3 years, waiting for the return of Pinkerton who left for

America soon after their marriage, but promised to return. She has a child with Pinkerton (that he does not know about), and fights with social pressure and poverty. Therefore, the tension of the plot increases in the second act of the opera, making the transition from an apparently idyllic love (act one) to helplessness and doubt (act two). In the third act, Pinkerton returns with his "real" American wife and Butterfly accepts that they take her child away. This act culminates in Butterfly's suicide, as an ultimate gesture of honor.

Self-Report Measures

Music-induced emotions were assessed using the long version of GEMS (Zentner et al., 2008). This instrument includes 45 emotion labels that were shown to reliably describe emotional responses to music (Zentner et al., 2008). Participants rated each label using a 5-point Likert scale (1, not at all; 2, somewhat; 3, moderately; 4, quite a lot; 5, very much), with specific instructions to assess the emotions they felt during music listening, and not the emotions that they perceived in music. The scores can be grouped into nine separate emotions (i.e., wonder, transcendence, power, tenderness, nostalgia, peacefulness, joyful activation, sadness, and tension) or three more general factors: (1) sublimity, which includes wonder, transcendence, tenderness, nostalgia, and peacefulness (Cronbach's $\alpha = .88$ in this sample); (2) vitality, which includes power and joyful activation (Cronbach's $\alpha = .92$ in this sample); and (3) unease, which includes sadness and tension (Cronbach's $\alpha = .90$ in this sample; Zentner et al., 2008; see also Trost, Ethofer, Zentner, & Vuilleumier, 2012).

Trait empathy, defined as an accurate affective insight into the feeling state of another, was assessed using the Toronto Empathy Questionnaire (TEQ; Spreng, McKinnon, Mar, & Levine, 2009). This instrument includes 16 highly related items (e.g., "I become irritated when someone cries" or "When someone else is feeling excited, I tend to get excited too") that were carefully selected based on factor analyses from many previous measures of empathic responding to develop a short and reliable one-dimensional measure of empathy (Cronbach's $\alpha = .82$ in this sample).

The Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) was also used. VVIQ includes four groups of four items, which describe specific scenes (e.g., a country scene with trees, mountains, and lake) and situations (e.g., the precise carriage and length of step in walking). Participants are instructed to rate the vividness of the image formed in thinking about each scene on a 5-point scale (1, perfectly clear and as vivid as normal vision; 2, clear and reasonably vivid; 3, moderately clear and vivid; 4, vague and dim; 5, no image at all, you only "know" that you are thinking of an object), first with the eyes open and then with the eyes closed (Cronbach's $\alpha = .94$ in this sample).

Mood was assessed using the general affect scales of the Positive and Negative Affect Schedule—Expanded Form (PANAS; Watson & Clark, 1994). Each general affect scale includes 20 items and allows the assessment of positive and negative affect at the present moment on a 5-point Likert scale (1, very slightly or not at all; 2, a little; 3, moderately; 4, quite a bit; 5, extremely; Cronbach's $\alpha = .83$ in this sample).

Procedure

During the week of the performance, participants came to the laboratory to sign an informed consent and fill in the TEQ and VVIQ, under the supervision of a trained research assistant. In addition, participants were explained the GEMS and how they should use it to rate their emotional responses during the opera performance that they were to attend. Then, approximately 1 hour before the performance, they filled in the PANAS; they were also given three copies of GEMS and instructed to assess their emotional responses to each opera act. It was emphasized that they had to fill in the GEMS immediately after each act and try to ignore distracters. Participants were also instructed to keep a count, on a scratch-paper, of the number of separate chills that they experienced during each act.

Statistical Analyses

Based on the GEMS scores and self-reported chills, the emotional responses that developed during the opera performance were described. Considering that there was no preperformance GEMS assessment for comparison, emotional experience during the performance was analyzed by comparing the observed percentage of participants who rated their experience as "moderate," "quite a lot," or "very much" (i.e., the moderate–high range) on each GEMS dimension, with the expected percentage (i.e., 60%). This approach allowed us to show that the number of participants who experienced moderate–high levels of emotions was different from chance (for a similar approach see Study 3 in Zentner et al., 2008). Across measures, missing values accounted for 11.7% of the data. Effect size was reported as Cohen's d (Student's t tests) or η_P^2 (ANOVA), and the tests were corrected for multiple comparisons using the Bonferroni correction. The associations between the GEMS scores and chills, as well as between individual differences were analyzed using Pearson's correlation. The links between individual differences and emotional responses to the opera performance were analyzed using multiple linear regressions (Enter method), in which the GEMS scores and self-reported chills (aggregated for the entire opera, as well as for each opera act) were regressed on the TEQ empathy, VVIQ visual imagery, and PANAS positive and negative affect. Age and sex were also included in the regression models. All the analyses were run in SPSS.

Results

To facilitate understanding, the following analyses are focused on the three emotional factors (i.e., sublimity, vitality, and unease) rather than the nine underlying emotions from GEMS. The sublimity, vitality, and unease scores were calculated by averaging the corresponding items.

Descriptive Analyses

The sublimity, vitality, and unease scores, as well as the percentage of participants who rated these emotional factors in the moderate–high range are reported in Table 1.

Across acts, the percentage of participants who rated their sublimity in the moderate–high range was significantly higher than chance, $\chi^2(1) = 5.04$, $p < .05$. In contrast, the percentage of participants who rated their vitality, $\chi^2(1) = 60.84$, $p < .01$, and unease, $\chi^2(1) = 32.87$, $p < .01$, in the same range was significantly lower than chance across acts. The average number of chills across acts correlated positively with GEMS sublimity (Pearson's

Table 1
Descriptive Statistics for the Emotional Experience Reported After Each Opera Act

Opera act	GEMS emotional factor scores (% of moderate–high ratings)			Chills (frequency)
	Sublimity	Vitality	Unease	
Act 1	3.22 ± 0.72 (73.7%**)	2.36 ± 0.69 (22%**)	1.96 ± 0.65 (11.8%**)	12.18 ± 1.04
Act 2	3.09 ± 0.66 (54.2%)	2.09 ± 0.56 (9.4%**)	2.24 ± 0.66 (19.7%**)	14.04 ± 1.37
Act 3	3.27 ± 0.79 (85.1%**)	2.2 ± 0.63 (1.6%**)	2.54 ± 0.93 (32.5%**)	16 ± 1.43
Total (across acts)	3.2 ± 0.64 (71%*)	2.22 ± 0.54 (11%**)	2.25 ± 0.64 (21.33%**)	14.07 ± 1.16

Note. GEMS scores are average ratings for items that belong to each emotional factor. Unless otherwise specified, values in cells are means ± standard errors of the means.
* $p < 0.05$. ** $p < 0.01$.

$r = .32$, $p < .01$) and unease scores (Pearson's $r = .29$, $p < .01$) across acts.

A follow-up act-by-act analysis indicated that the percentage of participants who rated their sublimity in the moderate–high range was significantly higher than chance in the first, $\chi^2(1) = 7.82$, $p < .01$, and third, $\chi^2(1) = 26.25$, $p < .01$, acts. The percentage of participants who rated their vitality and unease in this range was significantly lower than chance in all the three acts ($p < .01$ for all tests; see Table 1).

Comparisons Between Opera Acts

Differences in emotional experience between the opera acts were analyzed using repeated measures ANOVA with act as factor. There were significant main effects of act in the ratings of sublimity ($F(2, 232) = 6.85$, $p < .01$, $\eta_p^2 = 0.06$), vitality ($F(2, 224) = 15.61$, $p < .01$, $\eta_p^2 = 0.12$), and unease ($F(2, 228) = 31.15$, $p < .01$, $\eta_p^2 = 0.22$). Follow-up paired samples Student t test (corrected for multiple comparisons) showed that sublimity significantly decreased after the second compared with the first act, $t(117) = -2.54$, $p < .05$, $d = 0.17$, and increased after the third compared with the second act, $t(116) = 3.81$, $p < .01$, $d = 0.26$. Vitality significantly decreased after the second compared with the first act, $t(116) = -5.26$, $p < .01$, $d = 0.44$, and increased after the third compared with the second act, $t(116) = 2.74$, $p < .01$, $d = 0.19$. Unease increased significantly after the second compared with the first act, $t(116) = 4.39$, $p < .01$, $d = 0.39$, and again after the third compared with the second act, $t(114) = 4.68$, $p < .01$, $d = 0.37$. In addition, there were significant differences between chills ($F(2, 238) = 7.54$, $p < .01$, $\eta_p^2 = 0.06$), with significant increases in the third compared with the second act, $t(119) = 3.13$, $p < .01$, $d = 0.12$. In summary, sublimity and vitality changes between the acts followed U-shape trajectories, with decreases in the second act; unease and chills increased constantly, reaching a maximum after the third act.

Individual Differences

As a preliminary step before linear regression, we analyzed the correlations between the predictors. The correlations indicated that multicollinearity was not problematic (i.e., $r < .7$; Table 2). TEQ empathy was positively associated with sex (i.e., being a woman was related to higher empathy) and negatively associated with age. VVIQ was positively associated with PANAS positive affect and negatively associated with age. In addition, PANAS positive affect was negatively associated with PANAS negative affect and age.

Using linear regression, we analyzed the influence of TEQ empathy, VVIQ visual imagery, PANAS positive affect and negative affect on the emotional factors from the GEMS and self-reported chills (see Table 3). Age and sex (dummy coded: men coded 0; women coded 1) were also included as predictors.

There was a significant model that predicted 10.2% of sublimity across acts (see Table 2). Positive affect and age were significant positive predictors. Empathy only approached significance in this generic model ($p = .09$). However, the follow-up act-by-act analyses found a significant model that predicted sublimity in the second act (adjusted $R^2 = .10$, $p < .01$), with empathy ($\beta = 0.23$, $p < .05$), positive affect ($\beta = 0.19$, $p < .05$), and age ($\beta = 0.25$, $p < .01$) being significant positive predictors. Positive affect ($\beta = 0.31$, $p < .01$) and age ($\beta = 0.34$, $p < .01$) were also significant positive predictors of sublimity after the first opera act (model's adjusted $R^2 = .16$, $p < .01$).

Table 2
Correlations Between Empathy, Visual Imagery, Positive Affect, Negative Affect, Age, and Sex

Individual differences	TEQ empathy	VVIQ visual imagery[a]	PANAS positive affect	PANAS negative affect	Age	Sex
TEQ empathy	1	.11	.14	−.08	−.22**	.25**
VVIQ visual imagery[a]	−.11	1	−.17*	.03	.2*	−.08
PANAS positive affect	.14	−.17*	1	−.18*	−.33**	.05
PANAS negative affect	−.08	.03	−.18*	1	−.06	.11
Age	−.22**	.2*	−.33**	−.06	1	−.12
Sex (men coded 0; women coded 1)	.25**	−.08	.05	.11	−.12	1

Note. PANAS = Positive and Negative Affect Schedule; TEQ = Toronto Empathy Questionnaire; VVIQ = Vividness of Visual Imagery Questionnaire.
[a] Owing to the inverse rating on the VVIQ scale, a negative correlation coefficient actually indicates a positive association between the variables, and a positive correlation coefficient actually indicates a negative association between the variables.
* $p < .05$. ** $p < .01$.

Table 3
Regression Coefficients for the Relations Between Individual Differences and Emotional Factors Averaged Across Opera Acts

Criterion (adjusted R^2)	Predictors	B	*SE* B	95% CI	β
Sublimity ($R^2 = .10^{**}$)	Empathy	0.07	0.04	−0.01, 0.15	0.16
	Visual imagery	−0.01	0.01	−0.04, 0.01	−0.09
	Positive affect	0.11	0.04	0.02, 0.2	0.24**
	Negative affect	−0.01	0.04	−0.1, 0.07	−0.03
	Sex (dummy coded)[a]	0.76	0.69	−0.61, 2.14	0.1
	Age	0.06	0.01	0.02, 0.09	0.3**
Vitality ($R^2 = .19^{**}$)	Empathy	0.04	0.03	−0.02, 0.11	0.11
	Visual imagery	−0.01	0.01	−0.02, 0.02	−0.01
	Positive affect	0.17	0.04	0.1, 0.25	0.42**
	Negative affect	−0.04	0.03	−0.12, 0.02	0.11
	Sex (dummy coded)[a]	−1.26	0.59	−2.45, −0.08	−0.19*
	Age	0.02	0.01	−0.01, 0.05	0.13
Unease ($R^2 = .15^{**}$)	Empathy	0.02	0.03	−0.04, 0.08	0.06
	Visual imagery	−0.02	0.01	−0.04, −0.01	−0.23**
	Positive affect	−0.07	0.03	−0.14, −0.01	−0.2*
	Negative affect	0.04	0.03	−0.02, 0.1	0.11
	Sex (dummy coded)[a]	1.56	0.51	0.54, 2.59	0.27**
	Age	0.01	0.01	−0.01, 0.04	0.11
Chills ($R^2 = .07^{*}$)	Empathy	−0.18	0.16	−0.5, 0.13	0.1
	Visual imagery	−0.09	0.05	−0.2, 0.01	−0.16
	Positive affect	0.08	0.18	−0.26, 0.44	0.04
	Negative affect	−0.05	0.16	−0.39, 0.27	−0.03
	Sex (dummy coded)[a]	4.72	2.68	−0.6, 10.04	0.16
	Age	0.21	0.07	0.06, 0.35	0.29**

Note. B = unstandardized regression coefficient; β = standardized regression coefficient; CI = confidence interval; *SE* = standard error of the mean.
[a] 0 = man; 1 = woman.
* $p < .05$. ** $p < .01$.

The regression model that focused on vitality was significant and explained 19.7% of its variance (see Table 2). Positive affect was a significant positive predictor and sex was a significant negative predictor (i.e., being a man was associated with increased vitality). The models that regressed vitality after each opera act on the predictors were also significant (all *p*s <.01), explaining 18% of the variance of vitality after the first act, 12% after the second act, and 9% after the third act. Positive affect was a significant positive predictor of vitality after each act (all *p*s <.01), and sex was a significant negative predictor of vitality after the third act ($\beta = -0.19$, $p < .05$).

There was a significant model that predicted 15.7% of the variance of unease averaged across opera acts (see Table 2). Sex (i.e., being a woman was associated with increased unease) and visual imagery were significant positive predictors, whereas positive affect was a significant negative predictor. Follow-up analyses indicated that sex ($\beta = 0.26$, $p < .01$) and visual imagery ($\beta = -0.21$, $p < .05$)[1] were significant positive predictors, and positive affect ($\beta = -0.2$, $p < .05$) was a significant negative predictor of unease after the second act (model's adjusted $R^2 = .15$, $p < .01$).

The prediction of chills averaged across opera acts was also significant (see Table 2), with age positively predicting 7.2% of the variance of chills. Visual imagery only approached significance ($p = .08$). However, the follow-up analyses found that age ($\beta = 0.32$, $p < .01$) and visual imagery ($\beta = -0.18$, $p < .05$) were significant positive predictors of chills after the third act (model's adjusted $R^2 = .08$, $p < .05$). Also, age was a significant positive predictor ($\beta = 0.37$, $p < .01$) of chills reported after the second act (model's adjusted $R^2 = .14$, $p < .01$); visual imagery and sex also approached significance ($p = .06$) in this model.

Discussion

This study describes the emotional experience reported by participants attending a live opera performance. Results supported our hypotheses on the relations between individual differences in empathy, visual imagery, and mood on the one hand, and emotional reactivity to the opera performance on the other hand. Complementary to recent laboratory investigations, the present results offer ecological support, from a live opera performance, for process approaches to music-induced emotions (Juslin et al., 2010; Scherer & Coutinho, 2013).

Rich and Dynamic Emotional Experience

The emotions reported during this live opera performance were characterized by increased sublimity and decreased vitality and unease. This blend of emotions may be specifically associated with the contemplation of negative events in an aesthetic context. In the present study, participants were carefully instructed to rate the emotions they felt rather than the emotions that the music or the characters expressed. In line with other studies that used the GEMS (Balteş et al., 2011; Trost et al., 2012; Zentner et al., 2008), this research thus illustrates the rich emotional experience induced by music performance.

Repeatedly assessing emotional reactivity allowed us to describe its dynamics throughout the performance. We found that unease, which includes feelings of sadness and tension, gradually increased during this performance, in parallel with chills. This

[1] A negative standardized regression coefficient actually indicates a positive relation between VVIQ visual imagery and the criterion variable.

emotional buildup may have been favored by intertwined musical (e.g., transition from long/sustained to short/discontinuous phrases, and from piano to forte dynamics) and dramatic changes (e.g., the shift of the plot from infatuation to doubt and desperation) which precipitated the tension of the opera after the first act. The significant drop in vitality (e.g., power, joyful activation) and sublimity (e.g., tenderness, peacefulness) reported by the participants after the second act may have reflected the opera turning point. However, such speculations on the relative contributions of musical and nonmusical expressions to the emotional experience of opera spectators should be treated with caution until they are properly tested in laboratory studies, in which exposure to various types of information can be controlled. Previous experimental work suggested that opera singing and acting can jointly contribute to unease, vitality, and sublimity (Balteş et al., 2011), but we are still far from having a scientific quantitative understanding of how opera creators and performers skillfully combine musical and dramatic information to induce emotions in spectators. The value of the present results lies in describing the emotional wealth created by live opera performance and its variance associated with individual differences.

Traits, Mood, and Music

These results generally supported our expectations that individual differences in empathy, visual imagery, and mood would influence the emotions reported during the performance. Some of these influences were specific to certain emotional dimensions or opera acts, and this underscores the advantages of using the multidimensional GEMS to repeatedly assess emotions throughout the performance. For example, higher trait empathy was associated with increased sublimity in the second act, when there were actually lower levels of sublimity in the whole sample. Therefore, the decrease of sublimity may have been attenuated in participants with higher empathy. There are at least two possible explanations for this relation. High-empathy participants may have had more insight into Butterfly's increasing, but covert, doubts about her future. This would suggest that the influence of trait empathy may be strongest when emotional expressions are ambiguous. An alternative explanation is that empathy is associated with the enjoyment of negative emotions in an aesthetic context, as previously reported (Garrido & Schubert, 2011; Vuoskoski, Thompson, McIlwain, & Eerola, 2012). Therefore, it is possible that high-empathy participants developed more sublimity in the second act simply because they tolerated the main character's negative emotions better. Future studies might investigate these alternative mechanisms underlying the relation between empathy and music-induced sublimity.

The second act describes the reveries of Butterfly, using strong visual images such as the entry of Pinkerton's white ship in the port or the nesting of robins in spring. Therefore, it is not surprising that participants with a disposition toward more vivid visual imagery experienced more unease and chills, particularly during the second act. In this act, developing emotions such as sadness and tension probably depended more on imagining what Butterfly evoked in her singing rather than strictly focusing on the events happening on stage. A question that arises is why visual imagery and empathy contributed to distinct emotional dimensions. Unease (associated with visual imagery) and sublimity (associated with empathy) include emotions that may differ on multiple dimensions of appraisal. For instance, sadness (part of GEMS unease) is characterized by low pleasantness, low situational control, and high anticipated effort (Smith & Ellsworth, 1985); nostalgia (part of GEMS sublimity) may be more complex, considering that it has been characterized as a bittersweet emotion (Lazarus, 1991), and both positive and negative emotions during music listening predict subsequent nostalgia (Barrett et al., 2010). The present study focused on emotional blends rather than discrete emotions, but future research might investigate whether dispositional empathy and visual imagery are associated with specific emotional appraisals.

Converging evidence from the three acts indicated the significant influence of positive affect on all the emotional dimensions of the GEMS (i.e., vitality, unease, and sublimity). This is in line with a previous study that found an association between positive affect and emotional reactivity to music (Vuoskoski & Eerola, 2011a). In the present investigation, higher positive affect before the performance was consistently associated with increased sublimity and vitality, as well as decreased unease throughout the opera. Positive affect explained as much as 18% of the level of vitality reported after the first act; this effect remained significant, but gradually decreased in the second and third acts, suggesting that the emotions associated with the performance took over previous mood.

In addition, we found that women reported more unease and less vitality than men, which may be related to a facilitation of emotional reactivity to the same-sex central character of this opera, or the increased emotional reactivity to social stimuli in women (Kring & Gordon, 1998). Age was also positively associated with sublimity and chills reported during the performance. This effect may be explained by increased musical experience that enhances the affective enjoyment of music (Bigand & Poulin-Charronnat, 2006), or positivity biases in the emotional reactivity of the older adults from our sample (Carstensen & Mikels, 2005).

Overall, these results support the process approaches (Juslin et al., 2010; Scherer & Coutinho, 2013) and are in line with several laboratory studies on the influence of empathy (Miu & Balteş, 2012; Wöllner, 2012), visual imagery (Garrido & Schubert, 2010; Vuoskoski & Eerola, 2011a, 2012), and mood (Hunter et al., 2011; Vuoskoski & Eerola, 2011b) on music-induced emotions. It is remarkable that these individual differences predicted up to 20% of the emotional reactivity to the opera performance. However, individual differences only partially explained the interindividual variance of emotional experience in this research. This may be owing to the intrinsic limitations of self-report measures of psychological predispositions (Zentner & Eerola, 2010). The fact that these predispositions only accounted for part of the emotional experience during the opera also highlights that other psychophysiological mechanisms (e.g., musical expectancy, rhythmic entrainment, startle reflex) may be at play (Juslin et al., 2010; Scherer & Coutinho, 2013). This opens the perspective for future field studies during live music performance, which might focus on more mechanisms underlying emotional reactivity to music and use physiological measures (e.g., ambulatory cardiovascular recordings) to complement self-report assessments.

Conclusion

We concur with Zentner and Eerola (2010) in concluding that field studies such as the present one show that using psychological measures to investigate emotions during live music performance is a feasible and useful counterpart of laboratory studies. In line with recent theories and laboratory research, this study supported the links between three key individual differences (i.e., empathy, visual imagery, and mood) and emotional reactivity to live music performance. We hope that these results will give new impetus to future field studies on emotions and music, including opera.

References

Balteş, F. R., Avram, J., Miclea, M., & Miu, A. C. (2011). Emotions induced by operatic music: Psychophysiological effects of music, plot, and acting. A scientist's tribute to Maria Callas. *Brain and Cognition, 76,* 146–157. doi:10.1016/j.bandc.2011.01.012

Barrett, F. S., Grimm, K. J., Robins, R. W., Wildschut, T., Sedikides, C., & Janata, P. (2010). Music-evoked nostalgia: Affect, memory, and personality. *Emotion, 10,* 390–403. doi:10.1037/a0019006

Bigand, E., & Poulin-Charronnat, B. (2006). Are we "experienced listeners"? A review of the musical capacities that do not depend on formal musical training. *Cognition, 100,* 100–130. doi:10.1016/j.cognition.2005.11.007

Bonny, H. L. (1995). Twenty-one years later: A GIM update. *Music Therapy Perspectives, 12,* 125–129.

Cantor, J. R., & Zillmann, D. (1973). The effects of affective state and emotional arousal on music appreciation. *Journal of General Psychology, 89,* 97–108. doi:10.1080/00221309.1973.9710822

Carstensen, L. A., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science, 14,* 117–121. doi:10.1111/j.0963-7214.2005.00348.x

Egermann, H., Grewe, O., Kopiez, R., & Altenmuller, E. (2009). Social feedback influences musically induced emotions. *Annals of the New York Academy of Sciences, 1169,* 346–350. doi:10.1111/j.1749-6632.2009.04789.x

Egermann, H., Kopiez, R., & Altenmuller, E. (2013). The influence of social normative and informational feedback on musically induced emotions in an online music listening setting. *Psychomusicology: Music, Mind, and Brain, 23,* 21–32. doi:10.1037/a0032316

Gabrielsson, A. (2001). Emotions in strong experiences with music. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 431–449). New York: Oxford University Press.

Garrido, S., & Schubert, E. (2010). Imagination, empathy, and dissociation in individual response to negative emotions in music. *Musica Humana, 2,* 1–26.

Garrido, S., & Schubert, E. (2011). Individual differences in the enjoyment of negative emotion in music: A literature review and experiment. *Music Perception, 28,* 279–296. doi:10.1525/mp.2011.28.3.279

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1993). Emotional contagion. *Current Directions in Psychological Science, 2,* 96–100. doi:10.1111/1467-8721.ep10770953

Hunter, P. G., Schellenberg, E. G., & Griffith, A. T. (2011). Misery loves company: Mood-congruent emotional responding to music. *Emotion, 11,* 1068–1072. doi:10.1037/a0023749

Juslin, P. N., Liljestrom, S., Vastfjall, D., Barradas, G., & Silva, A. (2008). An experience sampling study of emotional reactions to music: Listener, music, and situation. *Emotion, 8,* 668–683. doi:10.1037/a0013505

Juslin, P. N., Liljestrom, S., Vastfjall, D., & Lundquist, L.-O. (2010). How does music evoke emotions? Exploring the underlying mechanisms. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of Music and Emotion: Theory, Research, Applications* (pp. 605–642). New York: Oxford University Press.

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: Expression, experience, and physiology. *Journal of Personality and Social Psychology, 74,* 686–703. doi:10.1037/0022-3514.74.3.686

Lamont, A. (2011). University students' strong experiences of music: Pleasure, engagement, and meaning. *Musicae Scientiae, 15,* 229–249. doi:10.1177/1029864911403368

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Liljestrom, S., Juslin, P. N., & Vastfjall, D. (2013). Experimental evidence of the roles of music choice, social context, and listener personality in emotional reactions to music. *Psychology of Music, 41,* 579–599. doi:10.1177/0305735612440615

Marks, D. F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology, 64,* 17–24. doi:10.1111/j.2044-8295.1973.tb01322.x

McAdams, S., Vines, B. W., Veillard, S., Smith, B. K., & Reynolds, R. (2004). Influences of large-scale form on continuous ratings in response to a contemporary piece in a live concert setting. *Music Perception, 22,* 297–350. doi:10.1525/mp.2004.22.2.297

McKinney, C. H., Antoni, M. H., Kumar, M., Tims, F. C., & McCabe, P. M. (1997). Effects of guided imagery and music (GIM) therapy on mood and cortisol in healthy adults. *Health Psychology, 16,* 390–400. doi:10.1037/0278-6133.16.4.390

Miu, A. C., & Balteş, F. R. (2012). Empathy manipulation impacts music-induced emotions: A psychophysiological study on opera. *PLoS One, 7,* e30618. doi:10.1371/journal.pone.0030618

North, A. C., Hargreaves, D. J., & Hargreaves, J. J. (2004). Use of music in everyday life. *Music Perception, 22,* 41–77. doi:10.1525/mp.2004.22.1.41

Scherer, K. R., & Coutinho, E. (2013). How music creates emotion: A multifactorial process approach. In T. Cochrane, B. Fantini, & K. R. Scherer (Eds.), *The emotional power of music: Multidisciplinary perspectives on musical arousal, expression, and social control* (pp. 121–145). New York: Oxford University Press. doi:10.1093/acprof:oso/9780199654888.003.0010

Scherer, K. R., & Zentner, M. (2001). Emotional effects of music: Production rules. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 361–392). New York: Oxford University Press.

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology, 48,* 813–838. doi:10.1037/0022-3514.48.4.813

Spreng, R. N., McKinnon, M. C., Mar, R. A., & Levine, B. (2009). The Toronto Empathy Questionnaire: Scale development and initial validation of a factor-analytic solution to multiple empathy measures. *Journal of Personality Assessment, 91,* 62–71. doi:10.1080/00223890802484381

Sutherland, M. E., Grewe, O., Egermann, H., Nagel, F., Kopiez, R., & Altenmuller, E. (2009). The influence of social situations on music listening. *Annals of the New York Academy of Sciences, 1169,* 363–367. doi:10.1111/j.1749-6632.2009.04764.x

Trost, W., Ethofer, T., Zentner, M., & Vuilleumier, P. (2012). Mapping aesthetic musical emotions in the brain. *Cerebral Cortex, 22,* 2769–2783. doi:10.1093/cercor/bhr353

Vaitl, D., Vehrs, W., & Sternagel, S. (1993). Prompts-leitmotif-emotion: Play it again, Richard Wagner. In N. Birbaumer & A. Ohman (Eds.), *The structure of emotion: Psychophysiological, cognitive, and clinical aspects* (pp. 169–189). Seattle: Hogrefe & Huber.

Vuoskoski, J. K., & Eerola, T. (2011a). Measuring music-induced emotion: A comparison of emotion models, personality biases, and intensity of experiences. *Musicae Scientiae, 15,* 159–173. doi:10.1177/1029864911403367

Vuoskoski, J. K., & Eerola, T. (2011b). The role of mood and personality in the perception of emotions represented by music. *Cortex, 47,* 1099–1106. doi:10.1016/j.cortex.2011.04.011

Vuoskoski, J. K., & Eerola, T. (2012). Can sad music really make you sad? Indirect measures of affective states induced by music and autobiographical memories. *Psychology of Aesthetics, Creativity, and the Arts, 6,* 204–213. doi:10.1037/a0026937

Vuoskoski, J. K., Thompson, W. F., McIlwain, D., & Eerola, T. (2012). Who enjoys listening to sad music and why? *Music Perception, 29,* 311–317. doi:10.1525/mp.2012.29.3.311

Walton, K. L. (1999). Projectivism, empathy and musical tension. *Philosophical Topics, 26,* 407–439.

Watson, D., & Clark, L. A. (1994). *The PANAS-X: Manual for the Positive and Negative Affect Schedule - Expanded Form.* Iowa: The University of Iowa.

Wöllner, C. (2012). Is empathy related to the perception of emotional expression in music? A multimodal time-series analysis. *Psychology of Aesthetics, Creativity, and the Arts, 6,* 214–223. doi:10.1037/a0027392

Zentner, M., & Eerola, T. (2010). Self-report measures and models of musical emotions. In P. N. Juslin & J. A. Sloboda (Eds.), *Handbook of music and emotion: Theory, research, applications* (pp. 187–223). New York: Oxford University Press.

Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion, 8,* 494–521. doi:10.1037/1528-3542.8.4.494

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