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## Individual differences in granularity of the affective responses to music

**Abstract:** *The main focus of the paper is the role of listeners' emotion-relevant characteristics and musical expertise in the granularity of affective responses to music. Another objective of the study is to test the consistency of the granularity of affect that is perceived in music and/or experienced in response to it. In Experiment 1, 91 musicians and nonmusicians listened to musical excerpts and grouped them according to the similarity of the affects they experienced while listening. Finer grouping granularity was found in musicians and high rumination scorers. Male musicians with above-median scores in rumination produced a larger number of clusters than the other male participants. Experiment 2 that engaged 23 participants demonstrated moderate consistency with which listeners grouped affects that they perceived in music and affects they experienced while listening to music. The study suggests that affective responses to music are subject to individual differences in musical expertise and rumination. Affects perceived in music and felt in response to it seem to be categorized with reference to the common principles. However, the cues that are used in such instances of categorization seem to be different. The paper encourages further research on the importance of listeners' personal characteristics for the affective responses to music.*

**Key words:** *affect, emotion, musical expertise, rumination, music*

### Introduction

One of the most important motivations to listen to music is its ability to generate affective responses of a multifaceted nature (e.g., Saarikallio, 2011; Thayer & Faith, 2001; Zentner, Grandjean, & Scherer, 2008). Music is considered to signify (Damasio, 1999) or provoke emotions (Scherer & Zentner, 2001), and listeners may echo the emotion expressed in the music (Kivy, 1989) or mirror this expression (Davies, 1994). Feelings can also be induced in music listeners by contagion, that is catching the mood of the emotional atmosphere dominant around us (Hatfield, Cacioppo, & Rapson, 1994), or osmosis (Davies, 1994). However, there is little evidence from laboratory studies on emotion induction that music produces physiological response, expressive behavior or feeling in the combination characteristic of basic emotions. Rather, it evokes the states of being moved, aesthetic awe, thrills (Konečni, 2008) or aesthetic emotions, independent of goal-oriented appraisal

of a stimulus typical of emotions experienced in everyday contexts (Scherer, 2004). Looking into the complexity and variability of listeners' representations of these phenomena is a theoretical and methodological challenge. The main aim of this study is to find out whether listeners' emotion-relevant traits (Rusting, 1998) and musical expertise contribute to the granularity of their affective responses to music. This paper also strives to test the consistency between the granularity of emotions perceived in music and emotions felt in response to music.

High granularity of the affective responses to music denotes fine-grained structure of representations of one's experiences, and low granularity denotes their more coarse and global representations (see Barrett, 2004). Fine-grained structure of affective experience suggests narrow and specific representations of feelings (see Barrett, 2004) meaning their lesser conceptual equivalence (Gardner, 1953; Pettigrew, 1958). The consequent variability of emotional experience positively correlates with the importance of

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emotion for an individual (Barrett, 1998; Bieri, 1971), and emotional information processing is modulated by emotion-relevant traits (Rusting, 1998). More emotionally responsive individuals are more likely to attend to emotional information (Halberstadt & Niedenthal, 1997) and to react to slightest emotional stimuli (Strelau, 2009). As emotion concepts are represented by loose collections of situated representations, for instance, in meaningful background situations (Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011), their palette should show finer granularity in individuals who care a lot about their emotional experience.

### Affective Responses to Music

In the context of music listening, affect is considered an umbrella term covering all evaluative states such as emotion, mood, and preference (Juslin & Västfjäll, 2008). Over the past decade, affective responses to music have gained notable interest (for review see Juslin & Sloboda, 2010). To date, research has focused on the experiential (Gabrielsson & Lindström, 1993; Schubert, 2004), behavioral (Trainor & Trehub, 1992), or physiological and neurophysiological aspects of affective responses to music (Khalifa, Peretz, Blondin, & Manon, 2002; Koelsch & Mulder, 2002; Schmidt & Trainor, 2001; Thayer & Faith, 2001).

Affective response to music is the subjective experiential-feeling element of emotion (Panksepp, 2005). Feeling, the mental experience of emotion (Damasio, 1999), is a central component of emotion that consists in perceived experience of the changes of body state and cognition juxtaposed to the simultaneous mental images of what might have evoked these changes (Damasio, 1994; Scherer, 2004). It integrates other aspects of emotion and forms grounds for the conscious representation of emotion (Scherer, 2004), which is a state of feeling made conscious (Damasio, 1999).

Feeling is conceptually close to core affect, a neurophysiological state that results from assessing the predictive value of a stimulus available to be felt (Barrett, 2005). Perceiving one's core affect and identifying it as being about music is when the experience of emotion begins while listening to music. Like Barrett (2005), we assume that emotions are perceptions in that they consist in assigning objects to meaningful categories based on what our experience has taught us about affect. Such a theoretical approach underlies investigation of individual differences in granularity of the affective responses to music.

### Individual Differences in Affective Music Processing

Studies show that listeners vary in a tendency to get emotionally involved in listening (Ter Bogt, Mulder, Raaijmakers, & Gabhainn, 2011) and to empathize with music (Kreutz, Schubert, & Mitchell, 2008). Research demonstrates interindividual consistency in matching the emotional responses to music with linguistic labels (Cunningham & Sterling, 1988) and faces expressing happiness, fear, anger and sadness (Kastner & Crowder,

1990; Terwogt & van Grinsven, 1991). However, the unique personal experience modifies emotional processing (Damasio, 1994), and studies in the music perception domain bring evidence supporting this claim. The structure of emotional responses to music shows systematic association with listeners' emotionality (Lewis & Schmidt, 1991) and musical expertise (Scherer & Zentner, 2001). The sensitivity of the dispositional behavioral activation system moderates listeners' ratings of pleasure felt to the startling background music (Ravaja & Kallinen, 2004), while impulsive sensation seeking regulates listeners' involvement in pleasant and unpleasant music (Kallinen, Saari, Ravaja, & Laarni, 2005). Music increases physiological activation, particularly in listeners with high BIS, neuroticism and anxiety (Kallinen & Ravaja, 2004). Positive relationships were found between rumination and music-induced anxiety (Blagden & Craske, 1996), between emotional intelligence and recognition of emotional expression in music (Resnicow et al., 2004), and between absorption and music empathy on the one hand and the enjoyment of negative emotions evoked by music on the other hand (Garrido & Schubert, 2011). There is also some evidence of the associations between perceived tempo and loudness, contributing to the formation of affective responses to music, and temperamental activity and reactivity (see Kantor-Martynuska, 2009). Eventually, listeners' ability to distinguish between their emotional responses to music seems to show high within- and between-subjects stability, and independence of musical expertise (Bigand, Vieillard, Madurell, Mrozeau, & Dacquet, 2005). However, this finding requires support from more data.

Considering that phenomenology of music listening is still understudied (Clarke, 2011), the above literature encourages further investigation into the contribution of listeners' musical expertise and emotion-relevant personality traits to the perceived variability of their affective responses to music.

### Individual Differences in Emotional Response Categorization

The way we perceive our feelings depends on the categorical knowledge we have about emotion while recognizing our affective state (Barrett, 2005). Category formation proceeds through practice with a specific class of objects (Gauthier, Skudlarski, Gore, & Anderson, 2000; Tanaka, Curran, & Sheinberg, 2005) that is through the selective attending to one's emotional responses (Niedenthal & Dalle, 2001). Such an attitude is characteristic of individuals with high levels in rumination (Mor & Winquist, 2002). While experiencing emotional states, we refer to emotional response categories we have learnt by experience (Innes-Ker & Niedenthal, 2002). Therefore, such categories of affect show experience-based individual differences (Niedenthal, Halberstadt, & Innes-Ker, 1999). We assume that affective responses to music vary as a function of experience with affect underlying emotion-relevant traits.

## Musical Expertise and Emotional Responses to Music

As an exemplification of expert knowledge, musical expertise involves extensive exposure to music and experience in attending to auditory stimuli, perceiving them, and discriminating between them. The structure of expert knowledge, in contrast to non-expert knowledge, is more differentiated and better organized (Boster & Johnson, 1989; Weiser & Shertz, 1983). Experts' and novices' judgments of similarity between the classified objects differ in that less trained participants base their judgments on more superficial features, which may result in lower consistency of novices' judgments (Suzuki, Ohnishi, & Shigemasa, 1992). On the other hand, experts form more subordinate categories of objects associated with their domain of expertise (Chartrand, Peretz, & Belin, 2008; Johnson & Mervis, 1997) in that they identify objects of their expertise more specifically: for instance, birds are not identified as *birds*, but as *sparrows* or *chipping sparrows*. Our experience depends on what we know about the characteristics of an object and how we use this knowledge as we categorize it (Barrett, 2005).

Musical training requires an apprehension of a musical structure-emotion mapping that is developed in middle childhood (Sloboda, 2005). It does not affect responding to subtle musical structure (Bigand, 1997; Bigand & Parncutt, 1999; Tillman & Bigand, 1998) but it contributes to other forms of music processing. Listening to music reveals musicians' superiority in coding musical information in sensory memory representations (Koelsch, Schröger, & Tervaniemi, 1999) and in processing music on an attentive level (Tervaniemi, Just, Koelsch, Widman, & Schröger, 2005). Musicians exhibit larger neurophysiological responsiveness to violation of expectation (Steinbeis, Koelsch, & Sloboda, 2005, 2006), and they show stronger psychophysical and self-reported aversion to dissonance in auditory stimuli (Dellacherie, Roy, Hugueville, Peretz, & Samson, 2010), which indicates their increased emotional response. This body of knowledge forms the basis to assume that listeners' musical expertise should be positively associated with fine granularity of their affective responses to music, that is the ability to discriminate between them, which may result in richer emotional experience of music.

The aim of this study is to explore individual differences in granularity of listeners' affective responses to music. Another objective is to test the consistency between the mental structures of emotions perceived in music and felt in response to music, which may be partly congruent and partly divergent dependent on emotion category (Kallinen & Ravaja, 2006). Each of the two experiments that follow concerns one of the above issues. Listeners' emotion-relevant dimensions of temperament and personality, namely, emotional reactivity (Strelau & Zawadzki, 1993, 1995), neuroticism (Eysenck, 1967), and rumination (Nolen-Hoeksema, 1998; Watkins & Teasdale, 2004), are associated with varied aspects of emotional processing (Eysenck & Eysenck, 1985; Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; Lyubomirsky & Nolen-Hoeksema, 1995; Watkins, Moulds, & Mackintosh, 2005).

Each of these dimensions involve affective experience that should be positively associated with variability of the affective responses to music: Individuals with higher scores on emotional reactivity, neuroticism, and rumination will share ample and intense emotional experience as compared with those who represent lower levels of these traits. We hypothesize that the palette of emotional responses to music (see Niedenthal, Barsalou, Ric, & Krauth-Gruber, 2005) will show finer granularity in more affectively responsive listeners and music experts compared with the participants who are less experienced in the domains of music and emotion.

## Experiment 1

### Method

**Participants.** Ninety-one high school students volunteered for the study. We discarded the results of three participants due to the ambiguous character of the grouping and the resulting difficulty to assess the number of categories. The results of 11 participants were exempt from the analyses due to the incomplete data sets. One musician's outlier response (number of groups = 14) was then truncated to 12, the value within the 3SDs from the mean.

Data of a total of 77 participants – 38 musicians who attended secondary music schools (22 females, 16 males;  $M_{\text{age}} = 18.7$  years,  $SD = 1.25$  years) and 39 nonmusicians (14 females, 25 males;  $M_{\text{age}} = 18.4$  years,  $SD = 0.6$  years) were included in the analysis. Musicians had an average of 10.6 years ( $SD = 1.9$  years) of musical training. Nonmusicians declared no music education beyond the general elementary school curriculum.

**Stimuli.** The musical stimuli, described in detail by Bigand et al. (2005), are listed in the Appendix. They comprised 27 musical excerpts of classical non-vocal music which music theorists and psychologists selected for the intensity and homogeneity of their emotional expression. The average duration of an excerpt was 30 s. We assumed that listeners are capable of affectively responding to the experimental stimuli of this duration considering that distinguishing between 'neutral' and 'moving' was demonstrated for segments of sound of barely 250 ms in length (Filipic, Tillman, & Bigand, 2010) and the affective responses they evoked were grouped similarly to those referring to one second excerpts (Bigand, Filipic, & Lalitte, 2005).

**Apparatus.** All the stimuli were played at medium loudness by a mono file at 16 bits and 44.1 kHz. Participants listened to the music through Sennheiser HD 256 headphones. The sound files were represented with a PowerPoint file as a group of small loudspeaker icons situated in the center of the computer screen. The location of each loudspeaker in the group was set at random. Participants performed the task individually, listening to the musical excerpts after clicking on the loudspeakers.

**Procedure.** Following Bigand et al. (2005), we used a grouping task that formally resembles the Object Sorting Test, a measure of breadth of categorization as a

cognitive style (Gardner, 1953; Pettigrew, 1958). It requires item grouping with no verbalization of grouping categories. The participants were released from class to perform a grouping task. They were presented with a visual pattern of 27 icons and were informed that they represented the 27 musical excerpts. The participant's task was to listen to the excerpts as many times as they needed in order to group them with reference to the similarity of the emotional states that he or she experienced while listening to the music. Grouping required dragging the corresponding loudspeaker icons and visually rearranging them. In the instruction, we used the term "emotional" as more communicative for the participants as compared with "affective", meaning a broad class of affective responses that listeners perceived in themselves. There was no limit to the number of items in a separate group. The criterion for a group was the relative distance between the icons located on the screen. The duration of the experimental session was ca. 40 minutes. Finally, in another session, participants filled out the questionnaires and the follow-up survey that included basic demographic information such as age, gender, and duration of music education.

**Psychometric measures.** Emotional reactivity, neuroticism, and rumination were estimated with the respective questionnaires: *Formal Characteristics of Behavior – Temperament Inventory (FCB-TI)*; (Strelau & Zawadzki, 1993), *Eysenck Personality Questionnaire-Revised (EPQ-R)*; (Eysenck, Eysenck, & Barrett, 1985), and *Emotional Control Questionnaire (ECQ)*; (Roger & Najarian,

1989). *FCB-TI* consists of 120 items in six scales to measure briskness, perseveration, activity, endurance, emotional reactivity, and sensory sensitivity. *EPQ-R* consists of 100 items in four scales to measure extraversion, neuroticism, psychoticism, and lie. *ECQ* is composed of 20 items to measure emotional rumination and inhibition. Participants filled out the questionnaires in groups during classes.

## Results

Three independent judges decoded the number of groups that each participant produced, based on the visual inspection of the response screens. The inter-analyst agreement regarding the number of groups was close to perfect (analysts 1 vs. 3,  $r = .99$ ; analysts 1 & 3 vs. 2,  $r = .98$ ). The average number of groups of emotional responses was 5.97 (range: 3-12,  $SD = 2.16$ ). As rumination level is considered higher in women (Nolen-Hoeksema & Jackson, 2001), we included gender in the statistical analyses as a control variable. The correlation matrix including the number of groups and all the predictors is presented in Table 1.

The emotion-relevant variables, dichotomized after a median split, together with musical expertise and gender were entered as factors into ANOVA in SPSS. The descriptive statistics are presented in Table 2. Larger standard deviations in the number of groups can be seen in female as compared to male participants (Table 2).

**Table 1. Pearson correlation matrix with the dependent variable and all the predictors.**

	Number of groups	Musical expertise	Neuroticism	Emotional reactivity	Rumination	Gender
number of groups	---	-.29 *	.10	.11	.10	.12
musical expertise		---	-.06	-.06	-.03	-.22
neuroticism			---	.70 **	.63 **	.38 **
emotional reactivity				---	.56 **	.31 **
rumination					---	.23

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

**Table 2. Descriptive statistics in Experiment 1.**

Musical expertise	Rumination	Gender	M	SD	N
musicians	low	male	5.20	1.13	10
		female	5.80	2.49	5
	high	male	10.00	0.82	4
		female	7.00	2.17	15
			6.65	2.31	34
nonmusicians	low	male	4.61	0.87	13
		female	5.12	2.47	8
	high	male	5.75	1.91	12
		female	6.50	2.43	6
			5.36	1.91	39

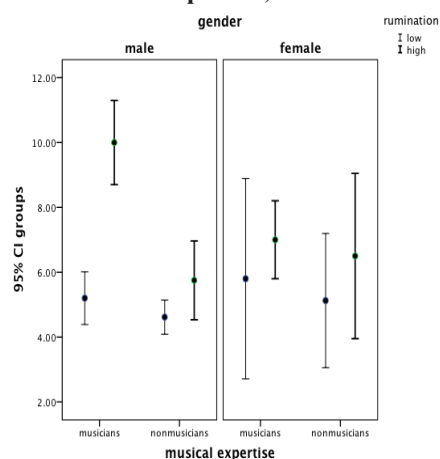
Emotional reactivity and neuroticism did not show any relationship with the number of groups,  $F(1, 72) = .59$ , ns, and  $F(1, 72) = .02$ , ns, respectively, whereas rumination revealed a positive effect on the number of groups: Participants with higher scores in rumination produced more groups than those with lower rumination scores (see Table 2). Musical expertise showed a significant main effect on grouping granularity: Musicians produced slightly more groups than nonmusicians (see Table 2). Next, interaction analyses were conducted using the three-way option of the univariate analysis of variance within General Linear Model in SPSS, with Musical Expertise (2), Rumination (2) and Gender (2) as factors. There was no significant relationship between the number of groups and participants' gender (see Table 3). The interaction effects of musical expertise and dichotomized rumination on one hand, and musical expertise and gender on the other hand, on the number of groups were marginally significant. The analysis revealed a weak three-way interaction effect of musical expertise, rumination, and gender on the number of groups of emotional responses to music (see Table 3).

**Table 3. Tests for the between-subjects effects in ANOVA**

	F	p	$\eta^2_p$
Musical Expertise (ME)	6.88	.01	.08
Rumination	14.34	.0001	.17
Gender	1.10	.29	.01
ME x Rumination	3.28	.07	.05
ME x Gender	3.60	.06	.05
Rumination x Gender	3.04	.09	.04
ME x Rumination x Gender	3.97	.05	.06

Tukey's post-hoc test, revealed that emotional granularity was comparable in female participants, regardless of their musical training and rumination, and in male nonmusicians. However, male musicians with high rumination scores produced many more groups than did male musicians with low rumination scores,  $p = .001$ , male nonmusicians with high rumination scores,  $p = .005$ , and the other groups of participants (ps from  $p < .001$  to  $p < .05$ ), except of female participants with high scores on rumination (Figure 1).

**Figure 1. The mean number of categories with respect to participants' musical expertise, rumination and gender.**



We found no correlation between rumination and gender but there was a marginally significant interaction effect of musical expertise and gender on rumination,  $F(1, 72) = 3.7$ ,  $p = .06$ ,  $\eta^2_p = 0.05$ . Male and female nonmusicians had comparable levels in rumination, but female musicians had higher scores on rumination ( $M = 42$ ,  $SD = 9.57$ ) than male musicians ( $M = 32$ ,  $SD = 8.39$ ). The interaction effect of musical expertise, gender, and rumination on the number of groups was found in the process of exploratory data analysis resulting in a small number of participants in particular cells.

## Discussion

The experiment indicated that the structure of affective responses to music is subject to individual differences in rumination (large effect) and musical expertise (medium size effect; Cohen, 1988). Rumination was the only emotion-relevant variable that revealed a significant relationship with granularity of the emotional responses to music. This finding suggests that it is not emotional sensitivity per se but the analytical self-focused attention inherent in high rumination (Lyubomirsky & Nolen-Hoeksema, 1995) that may be responsible for the observed effect.

A three-way interaction effect of rumination, musical expertise and gender on the number of groups demonstrated exceptional granularity of emotional responses to music in male musicians who scored high on rumination. They represented the analytical focus of high rumination individuals (Lambie & Marcel, 2002), the analytical mode of information processing and a general tendency to systemize that are more typical of males (Wakabayashi et al., 2006), a systemizing mode of music processing characteristic of male listeners (Kreutz et al., 2008), and musicians' sensitivity to auditory expressiveness (Sloboda, 2005). These features may have made them exhibit finest response granularity.

In this study, rumination was considered as one of several emotion-relevant variables. Thus, particular groups of participants (musicians-nonmusicians, low rumination-high rumination scorers) were not balanced with respect to gender. The lack of correlation between rumination and gender might have been due to the unequal proportions of male and female low and high rumination participants. Such characteristics of the sample can partly be explained with the higher rumination level in female musicians, mediated by the combination of beliefs about control of emotions, responsibility for the emotional tone of relationships, and mastery over negative events (Nolen-Hoeksema & Jackson, 2001). A small number of participants in the compared cells, especially in the high rumination male musicians, precludes forming conclusions concerning wider population. However, the results may be considered a cue for further research on individual differences in emotional responses to music. Further exploration of the relationship between the granularity of emotional responses to music and rumination should provide more balance in the number of participants in the compared cells.

Regarding the character of the responses that were grouped in the experiment, in the laboratory setting participants' detachment from what they experienced may have made their responses vary from those that occur while listening to the music at one's own discretion (Aiello, 1994). Laboratory listening favors affective response as perceived expressive meaning conveyed by the respective musical pattern (Scherer, 2004). In a laboratory, emotional engagement in music is "weak more often than not" (Damasio, 1999, p. 58), unless the pieces heard happen to be highly meaningful to a listener. However, a focus on the perceived expressive tone should not undermine the assumption that listeners, while asked to group their emotions, refer to what they experience and that the emotional response is there nonetheless (Damasio, 1999). In the music that makes the listeners empathize with the musicians, emotions felt and perceived are consistent. In the instance of the pieces with low empathy ratings, emotions felt are opposite of emotions perceived (Egermann & McAdams, 2010). This finding suggests that not only the experimental situation but also music itself and the empathizing tendency of a listener (here uncontrolled) may moderate the extent of such emotional involvement and the predominance of the affective or cognitive aspect of music perception. In order to shed light on the bases for the subjects' grouping of the affective responses, we should estimate the consistency between the granularity of perceived expressive features of music and the granularity of listeners' affective experience evoked by music. This problem is investigated in Experiment 2.

Studying the relationship between emotion perceived in music and emotion felt while listening to it, researchers have so far juxtaposed tasks that require the focus on either musical expression or affective experience while listening to the music (Kallinen & Ravaja, 2006; Schubert, 2007; Västfjäll, 2002). We adopted this approach in Experiment 2 devised to verify whether the ways in which listeners group their affective responses and the emotional expression of music are indeed nearly identical, as shown by Bigand et al. (2005). Grouping tasks will be carried out under the two alternate instructions – with the focus on the musical expression or on the listener's affective experience of music. Additionally, the relationship between both types of grouping and the familiarity and liking for the experimental stimuli will be measured.

## Experiment 2

### Method

**Participants.** Twenty-three high-school and university students ( $M_{\text{age}} = 21$  years,  $SD = 3.6$ , range 17-29 years; 13 males), nonmusicians ( $N = 18$ ) and musicians ( $N = 5$ ), volunteered for the study.

**Procedure.** The musical samples and apparatus were the same as those used in Experiment 1. Each participant completed the task twice under alternate instructions. In task A, the instruction required grouping based on the similarity of the emotional expression that a listener perceived in music. In task B, the instruction was identical to the one

from Experiment 1, and it required grouping based on the similarity of the participant's affective states that he or she experienced while listening to the music. All the other details of the procedure were kept constant and the order of the two task options was counterbalanced. As the participant finished grouping in each task, he or she gave each cluster a verbal label for easier identification of the number of clusters. Consequently, participants reported familiarity with each excerpt (question: „Are you familiar with the piece of music?” optional responses: „familiar” or „unfamiliar”) and liking for the stimuli (question: „Do you like the piece of music?” optional responses „like”, „neutral”, „don't like”). After 1-2 weeks, participants performed the task with an alternate instruction.

### Results

In tasks A and B, listeners produced an average of 6.1,  $SD = 1.8$ , and 6.2,  $SD = 2.04$  groups, respectively. The grouping responses were moderately correlated,  $r(19) = .66$ ,  $p < .005$ . The analysis of variance with repeated measures within General Linear Model (GLM) in PASW Statistics did not show any effect of experimental instruction,  $F(1,18) = .17$ ,  $p > .05$ . The number of groups produced was independent of task order, familiarity with the music samples (Task A: 38% of music samples; Task B: 39% of music samples) or liking for them (Task A: 46% of music samples; Task B: 44% of music samples). The qualitative analysis of group labels is beyond the scope of this paper.

### Discussion

Experiment 2 demonstrated that the number of groups the participants produced under each condition did not vary significantly but the correlation between the groupings performed under the two alternate instructions was much lower than the one that was found by Bigand et al. (2005). Our study suggests that the participants differentiated between the two task instructions and/or that the grouping shows moderate intraindividual stability. These results do not form a sufficient basis to infer about the proportion of cool cognition and warm affect in the experiences that were grouped. The representations of the affective expression of music and listeners' emotional responses to it seem to interlock, but all the same, these categories entail specific elements and cannot be regarded as identical (see Barrett, 2004; Damasio, 1994). Keeping in mind that emotion is perception (Barrett, 2005), what the participants considered to be their affective responses to music must have been related both to the perceived expressive features of music and to the affective experience they might have triggered.

### General Discussion

Music seems to include distinct cues that convey specific emotional qualities (Sloboda, 2005). However, the capacity to decode more subtle differences between them and respond to them affectively seems to vary across individuals. This study demonstrates that the structure of

representation of affect experienced in response to music in a laboratory is associated with rumination and musical expertise, and is partly determined by the interaction effect of rumination, musical expertise, and gender.

### **Granularity of Affective Responses to Music and Rumination**

The positive relationship between granularity of affective responses to music and rumination, as the only emotion-relevant trait from among those considered in the study, suggests the importance of the recurrent, analytical mode of emotional information processing for the “grade of resolution” of the structure of affective responses to music. It is likely that individuals with high rumination have access to a wider range of emotion concepts that, according to the Conceptual Act Theory of Emotion (Wilson-Mendenhall et al., 2011), plays a central role in the construction of emotional episodes and might have been revealed in Experiment 1.

Rumination as an information processing mode may be pragmatic and adaptive (see Schank, Collins, & Hunter, 1986), allowing for better differentiation of the situations that induce anxiety and those that do not indicate any harm or worry. Unlike other emotion-relevant traits, such as neuroticism or emotional reactivity (Eysenck et al., 1985; Strelau & Zawadzki, 1993, 1995), rumination consists in a tendency to focus on oneself when being in a negative mood and to process information more analytically (Sedikides, 1992) in order to understand the causes and meanings of experience (Watkins, 2004). Another implication of the negative mood is the smaller inclusiveness of categories (Isen & Daubman, 1984; Rosch, 1978), in other words, a tendency to classify objects into more subordinate categories of a lower level of abstraction. This inclination results from loading the information processing system with ruminations and worries (Neveh-Benjamin, McKeachie, & Lin, 1987), which makes it harder to compare objects using more abstract criteria. The results of our study seem to exemplify such a bias, even though the musical excerpts in our study were not exclusively negative. Fine granularity of grouping in high rumination listeners may have been due to the open and unlimited nature of the task that gave the participants freedom in organizing their responses to auditory samples. A general tendency to emphasize differences or similarities (Gardner, 1953; Pettigrew, 1958) might have confounded the results and should be controlled in future research. Another option would be to use a more structured task, where breadth of categorization, as one of the basic cognitive styles (Gardner, 1953; Pettigrew, 1958; see Kozhevnikov, 2007), would have less opportunity to influence the outcome of a categorization task.

The lack of effect of emotional reactivity on grouping granularity is consistent with the nature of temperament that reveals its influence on simple cognitive processes under ongoing stress (Strelau, 2009) rather than on more complex ones (such as categorization) occurring in the relatively relaxed conditions of a laboratory based task. In the experimental context that comprised no

pressure or competition, participants were not subject to high tension and thus their results did not vary as a function of neuroticism. Analogous results showed no effect of neuroticism on evaluation of job satisfaction under low state anxiety conditions in the workplace (Zalewska, 2011).

### **Granularity of Affective Responses to Music and Musical Expertise**

The positive relationship between granularity of affective responses to music and musical expertise demonstrates that the structure of affective responses to music in musicians consists of a slightly higher number of colorations of being-moved (Konečni, 2008) as compared with nonmusicians. Similarly, the findings concerning other types of expertise show that experts form more subordinate categories of objects associated with their domain of expertise as they attend to subtler perceptual features than novices (Johnson & Mervis, 1997). Such a consistency suggests that the effects we observed resulted from training in processing emotion and music, with particular attention to nuances of the affective palette.

Young musicians are encouraged to attend to music and to memorize it (Schellenberg, 2004). Learning to map the structure and emotion of music, to appreciate and to apply expressive cues while performing, as part of musical training (Sloboda, 2005), involves both raising the awareness of musical structure and strengthening the focus on producing the emotional expression that is inherent in music performance. Extensive development of these skills may contribute to finer granularity of musicians’ affective responses to music.

A positive relationship between grouping granularity and musical expertise demonstrated here is inconsistent with the results of the previous study conducted with university students (Bigand et al., 2005). This discrepancy may be due to a difference in sample size to the advantage of the present study but also to a bit younger age of our sample. Considering that younger age is associated with a lower level of familiarity and preference for classical music (Baumann, 1960; Egermann & McAdams, 2010), in our study, there may have been a larger gap between teenage musicians’ and nonmusicians’ familiarity with the style of the musical samples. Younger age has also been shown to slow down the speed and accuracy of recognition of the emotional facial expressions (Elfenbein & Ambady, 2003). The participants of our study may have been less skillful in emotion recognition as compared with university student participants (Bigand et al., 2005), which could diversify the results of the two studies.

### **Perception and Experience of Emotion in Music**

It is arguable whether perception and experience of emotion in music should be conceptually detached from one another (Krumhansl, 1997). So far, studies on the relationship between emotions perceived in music and felt in response to it have been inconclusive. In some study reports it is impossible to determine whether participants

referred to the emotional expressiveness of music or to their own affective state (Krumhansl, 1997; Sloboda & Lehmann, 2001). They support the notion that cognition and emotion are intertwined so tightly that there is no meaningful way to separate them (Barrett, Niedenthal, & Winkielman, 2005). Affect is inherent in reasoning (Damasio, 1999) as people embody the expressive character of stimuli they perceive by experiencing body states, and such embodied emotion mediates cognitive responses (Niedenthal et al., 2005). The present study supports the previous evidence that the granularity of affects perceived in music is highly consistent with the granularity of affects experienced while listening to music (Bigand et al., 2005; Thayer, 1986 after Nykliček, Thayer, & van Doornen, 1997). However, the qualitative organization of the affective representation varies considerably across the two conditions. Such results encourage an integrative approach to studying cognitive and affective aspects of listeners' responses to music. Disentangling emotion and cognition enhances the risk of forming an incomplete and inaccurate view of both emotional and cognitive processes (Niedenthal et al., 2005; Phelps, 2005).

Reports of people's beliefs about what they feel are often considered as reports of their experience (Dennett, 1991), and in order to learn whether people feel these emotions we have to ask them (Barrett, 2004; Thayer, 1986). There is no basis to doubt that the participants of Experiment 1 at least to some extent followed the instructions to focus on their own affective response, and actually grouped their responses according to what they experienced while listening to music. Arousal is rated higher in emotions perceived in music than emotions felt, and there is evidence for positive correlations between empathy with musical expression on one hand, and familiarity with music and preference for it on the other hand (Egermann & McAdams, 2010). Our study shows that familiarity and preference do not contribute to the differentiation between the emotions perceived in music and those felt in response to it.

Philosophical concern on the relationship between the experience (e.g., feeling response) and the experienced (e.g., the object of the affective response) also concludes that to describe experience is to describe the experienced world (for review see Noë, 2000). Such an approach suggests both transparency of experience and its function as a representation of the world. In empirical studies, where experience itself is an object of investigation, the issue of its transparency is no less vital. Experience may reflect the environment and thus it is a kind of active engagement in the world (Noë, 2000). Affective responses to music are represented with reference to the emotional appraisal of what is heard (Juslin, 2006) or to what is consequently felt (Russell, 2003; Russell & Barrett, 1999). As demonstrated here, the qualities of such affective experience are subject to individual differences in rumination and musical expertise. Further research should aim to explain the processes and mechanisms involved in these effects.

## Conclusion

This paper shows the importance of listeners' rumination and musical expertise for the granularity of affective responses to music. It suggests that perceiving the expressive features of music and experiencing the response it triggers are moderately consistent and certainly nonidentical. Further research on individual differences in the granularity of emotional responses to music should give attention to individual predispositions to focus on cold cognition of musical expressiveness and warmer genuine experience of emotion provoked while listening to music. It is a challenge for further research to estimate the contributions of the listener's focus on self, inherent in rumination, and the listener's focus on music, inherent in musical expertise, to the granularity of the affective responses to music.

## References

- Aiello, R. (1994). Can listening to music be experimentally studied? In R. Aiello & J. Sloboda (Eds.), *Musical perceptions* (pp. 273-282). New York: Oxford University Press.
- Barrett, L. F. (1998). Discrete emotions or dimensions? The role of valence focus and arousal focus. *Cognition and Emotion*, *12*, 579-599.
- Barrett, L. F. (2004). Feelings or words? Understanding the content in self-report ratings of experienced emotion. *Journal of Personality and Social Psychology*, *87*, 266-281.
- Barrett, L. F. (2005). Feeling is perceiving: Core affect and conceptualization in the experience of emotion. In L. F. Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotion and Consciousness* (pp. 255-286). New York: Guilford Publications, Inc.
- Barrett, L. F., Niedenthal, P. M., & Winkielman, P. (Eds.). *Emotion and Consciousness*. New York: Guilford Publications, Inc.
- Baumann, V. H. (1960). Teen-age music preferences. *Journal of Research in Music Education*, *8*, 75-84.
- Bieri, J. (1971). Cognitive structures in personality. In M. Schroeder & P. Suedfeld (Eds.), *Personality theory and information processing*. New York: Ronald.
- Bigand, E. (1997). Perceiving musical stability: the effect of tonal structure, rhythm and musical expertise. *Journal of Experimental Psychology: Human Perception and Performance*, *23*, 808-812.
- Bigand, E., Filipic, S., & Lalitte, P. (2005). The time course of emotional responses to music. *Annals of the New York Academy of Sciences*, *1060*, 429-437.
- Bigand, E., & Parncutt, R. (1999). Perception of musical tension in long chord sequences. *Psychological Research*, *62*, 237-254.
- Bigand, E., Vieillard, S., Madurell, F., Marozeau, J., & Dacquet, A. (2005). Multidimensional scaling of emotional responses to music: The effect of musical expertise and of the duration of the excerpts. *Cognition and Emotion*, *19*, 1113-1139.
- Blagden, C., & Craske, M. G. (1996). Active and passive distraction and rumination: A replication in anxious mood. *Journal of Anxiety Disorders*, *10*, 243-252.
- Boster, J. S., & Johnson, J. C. (1989). Form or function: A comparison of expert and novice judgments of similarity among fish. *American Anthropologist*, *88*, 866-889.
- Chartrand, J.-P., Peretz, I., & Belin, P. (2008). Auditory recognition expertise and domain specificity. *Brain Research*, *1220*, 191-198.
- Clarke, E. (2011). Music perception and musical consciousness. In D. Clarke & E. Clarke (Eds.), *Music and consciousness: Philosophical, psychological and cultural perspectives* (p.197). New York: Oxford University Press.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.
- Cunningham, J. G., & Sterling, R. S. (1988). Developmental change in the understanding of affective meaning in music. *Motivation and Emotion*, *12*, 399-413.
- Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Avon Books.



- Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. Orlando, Florida: Harcourt.
- Davies, S. (1994). *Musical meaning and expression*. Ithaca, NY: Cornell University Press.
- Dellacherie, D., Roy, M., Hugueville, L., Peretz, I., & Samson, S. (2010). The effect of musical experience on emotional self-reports and psychophysiological responses to dissonance. *Psychophysiology*, *48*, 337-349.
- Dennett, D. (1991). *Consciousness explained*. Boston: Little, Brown.
- Egermann, H., & McAdams, S. (2010). Recognition is different from feeling: Experimental evidence for two different types of emotional processes in music using a between-subjects design in a web experiment. In S. M. Demorest, S. J. Morrison, & P. S. Campbell (Eds.), *Proceedings of the 11th International Conference on Music Perception and Cognition*. Seattle, Washington, USA.
- Elfenbein, H. A., & Ambady, N. (2003). When familiarity breeds accuracy: cultural exposure and facial emotion recognition. *Journal of Personality and Social Psychology*, *85*, 276-290.
- Eysenck, H. J. (1967). *The biological basis of personality*. Springfield, IL: Thomas.
- Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum.
- Eysenck, H. J., Eysenck, M. W., & Barrett, P. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum.
- Filipic, S., Tillman, B., & Bigand, E. (2010). Judging familiarity and emotion from very brief musical excerpts. *Psychonomic Bulletin and Review*, *17*, 335-341.
- Fresco, D. M., Frankel, A. N., Mennin, D. S., Turk, C. L., & Heimberg, R. G. (2002). Distinct and overlapping features of rumination and worry: The relationship of cognitive production to negative affective states. *Cognitive Therapy and Research*, *26*, 179-188.
- Gabrielson, A., & Lindström, L. (1993). On strong experiences of music. *Music Psychologie: Jahrbuch der Deutschen Gesellschaft für Musikpsychologie*, *10*, 118-139.
- Gardner, R. W. (1953). Cognitive styles in categorizing behavior. *Journal of Personality*, *22*, 214-233.
- 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.
- Gauthier, I., Skudlarski, P., Gore, J., & Anderson, A. (2000). Expertise for cars and birds recruits brain areas involved in face recognition. *Nature Neuroscience*, *3*, 191-197.
- Halberstadt, J. B., & Niedenthal, P. M. (1997). Emotional state and the use of dimensions in judgment. *Journal of Personality and Social Psychology*, *72*, 1017-1033.
- Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1994). *Emotional contagion*. New York: Cambridge University Press.
- Innes-Ker, A., & Niedenthal, P. M. (2002). Emotion concepts and emotional states in social judgment and categorization. *Journal of Personality and Social Psychology*, *83*, 804-816.
- Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology*, *47*, 1206-1217.
- Johnson, K. E., & Mervis, C. B. (1997). Effects of varying levels of expertise on the basic level of categorization. *Journal of Experimental Psychology: General*, *3*, 248-277.
- Juslin, P. N. (2006). From mimesis to catharsis: expression, perception, and induction of emotion in music. In D. Miell, R. MacDonald, & D. J. Hargreaves (Eds.), *Musical Communication* (pp. 85-116). New York: Oxford University Press.
- Juslin, P. N., & Sloboda, J. (2010). *Handbook of Music and Emotion: Theory, Research, and Applications*. Oxford: Oxford University Press.
- Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider the underlying mechanisms. *Behavioral and Brain Sciences*, *31*, 559-621.
- Kallinen, K., & Ravaja, N. (2004). The role of personality in emotional responses to music: Verbal, electrocortical, and cardiovascular measures. *Journal of New Music Research*, *3*, 399-409.
- Kallinen, K., & Ravaja, N. (2006). Emotion perceived and emotion felt: Same and different. *Musicae Scientiae*, *10*, 191-213.
- Kallinen, K., Saari, T., Ravaja, N., & Laarni, J. (2005). Mood, music, and involvement: The moderating effects of personality. *Electronic Musicologica Review*, *9*. Retrieved from [http://www.rem.ufpr.br/\\_REM/REMv9-1/kallinen.pdf](http://www.rem.ufpr.br/_REM/REMv9-1/kallinen.pdf).
- Kantor-Martyuska, J. (2009). The listeners' temperament and perceived magnitude of tempo and loudness of music. *European Journal of Personality*, *23*, 655-673.
- Kastner, M. P., & Crowder, R. G. (1990). Perception of the major/minor distinction: Emotional communication in young children. *Music Perception*, *8*, 189-202.
- Khalifa, S., Peretz, I., Blondin, J-P., & Robert, M. (2002). Event-related skin conductance responses to musical emotions in humans. *Neuroscience Letters*, *328*, 145-149.
- Kivy, P. (1989). *Sound sentiment: An essay on musical emotions*. Temple University Press.
- Koelsch, S., & Mulder, J. (2002). Electric brain responses to inappropriate harmonies during listening to expressive music. *Clinical Neurophysiology*, *113*, 862-869.
- Koelsch, S., Schröger, E., & Tervaniemi, M. (1999). Superior preattentive auditory processing in musicians. *Neuroreport*, *10*, 1309-1313.
- Konečni, V. J. (2008). Does music induce emotion? A theoretical and methodological analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *2*, 115-129.
- Kozhevnikov, M. (2007). Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style. *Psychological Bulletin*, *133*, 464-481.
- Kreutz, G., Schubert, E., Mitchell, L. A. (2008). Cognitive styles of music listening. *Music Perception*, *26*, 57-73.
- Krumhansl, C. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology*, *51*, 336-352.
- Lambie, J. A., & Marcel, A. J. (2002). Consciousness and the varieties of emotion experience: A theoretical framework. *Psychological Review*, *109*, 219-259.
- Lewis, B. E., & Schmidt, C. P. (1991). Listeners' response to music as a function of personality type. *Journal of Research in Music Education*, *39*, 311-321.
- Lyubomirsky, S., & Nolen-Hoeksema, S. (1995). Effects of self-focused rumination on negative thinking and interpersonal problem-solving. *Journal of Personality and Social Psychology*, *69*, 176-190.
- Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect. *Psychological Bulletin*, *128*, 638-662.
- Neveh-Benjamin, M., McKeachie, W. J., & Lin, Y. G. (1987). Two types of test-anxious students: Support for an information processing model. *Journal of Educational Psychology*, *9*, 353-383.
- Niedenthal, P. M., Barsalou, L. W., Ric, F., & Krauth-Gruber, S. (2005). Embodiment and use of emotion knowledge (pp. 21-50). In L. F. Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotion and Consciousness* (pp. 21-50). New York: Guilford Publications, Inc.
- Niedenthal, P. M., & Dalle, N. (2001). Le mariage de mon meilleur ami: Emotional response categorization during naturally-induced emotional states. *European Journal of Social Psychology*, *31*, 737-742.
- Niedenthal, P. M., Halberstadt, J. B., & Innes-Ker, A. H. (1999). Emotional response categorization. *Psychological Review*, *106*, 337-361.
- Noë, A. (2000). Experience and experiment in art. *Journal of Consciousness Studies*, *7*, 123-136.
- Nolen-Hoeksema, S. (1998). The other end of continuum: the cost of rumination. *Psychological Inquiry*, *9*, 216-219.
- Nolen-Hoeksema, S., Jackson, B. (2001). Mediators of the gender difference in rumination. *Psychology of Women Quarterly*, *25*, 37-47.
- Nykliček, I., Thayer, J. F., & Van Doornen, L. J. O. (1997). Cardiorespiratory differentiation of musically-induced emotions. *Journal of Psychophysiology*, *11*, 304-321.
- Panksepp, J. (2005). Affective consciousness: Core emotional feelings in animals and humans. *Consciousness and Cognition*, *1*, 30-80.
- Pettigrew, T. F. (1958). The measurement of category width as cognitive variable. *Journal of Personality*, *26*, 532-544.
- Phelps, E. (2005). The interaction of emotion and cognition: Insights from studies on the human amygdala. In L. F. Barrett, P. M. Niedenthal, & P. Winkielman (Eds.), *Emotion and Consciousness* (pp. 51-66). New York: Guilford Publications, Inc.
- Ravaja, N., & Kallinen, K. (2004). Emotional effects of startling background music during reading news reports: The moderating influence of dispositional BIS and BAS sensitivities. *Scandinavian*

- Journal of Psychology*, 45, 231-238.
- Resnicow, J. E., Salovey, P., & Repp, B. H. (2004). Is recognition of emotion in music performance an aspect of emotional intelligence? *Music Perception*, 22, 145-158.
- Roger, D., & Najarian, B. (1989). The construction and validation of a new scale for measuring emotional control. *Personality and Individual Differences*, 10, 845-853.
- Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, 110, 145-172.
- Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, 76, 805-819.
- Rusting, C. L. (1998). Personality, mood, and cognitive processing of emotional information: Three conceptual frameworks. *Psychological Bulletin*, 124, 165-196.
- Saarikallio, S. (2011). Music as emotional self-regulation throughout adulthood. *Psychology of Music*, 39, 307-327.
- Schank, R. C., Collins, G. C., & Hunter, L. E. (1986). Transcending inductive category formation in learning. *Behavioral and Brain Sciences*, 9, 639-686.
- Schellenberg, G. (2004). Music lessons enhance IQ. *Psychological Science*, 15, 511-514.
- Scherer, K. R. (2004). Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research*, 33, 239-251.
- Scherer, K. R., & Zentner, M. R. (2001). Emotional effects of music: production rules. In P. Juslin & J. A. Sloboda (Eds.), *Music and emotion. Theory and research* (pp. 361-392). Oxford University Press.
- Schmidt, L. A., & Trainor, L. J. (2001). Frontal brain electrical activity (EEG) distinguishes valence and intensity of music emotions. *Cognition and Emotion*, 15, 487-500.
- Schubert, E. (2004). Modeling perceived emotion with continuous musical features. *Music Perception*, 21, 561-585.
- Schubert, E. (2007). The influence of emotion, locus of emotion and familiarity upon preference for music. *Psychology of Music*, 35, 499-515.
- Sedikides, C. (1992). Mood as a determinant of attentional focus. *Cognition and Emotion*, 6, 129-148.
- Sloboda, J. A. (2005). *Exploring the musical mind. Cognition, Emotion, Ability, Function*. Oxford: Oxford University Press.
- Sloboda, J. A., & Lehman, A. C. (2001). Tracking performance correlates of changes in perceived intensity of emotion during different interpretations of a Chopin piano prelude. *Music Perception*, 19, 87-120.
- Steinbeis, N., Koelsch, S., & Sloboda, J. A. (2005). Emotional processing of harmonic expectancy violations. *Annals of the New York Academy of Sciences*, 1060, 457-461.
- Steinbeis, N., Koelsch, S., & Sloboda, J. A. (2006). The role of harmonic expectancy violations in musical emotions: Evidence from subjective, physiological, and neural responses. *Journal of Cognitive Neuroscience*, 18, 1380-1393.
- Strelau, J. (2009). *Psychologia temperamentu* [Psychology of temperament]. Warszawa: Wydawnictwo Naukowe PWN.
- Strelau, J., & Zawadzki, B. (1993). The Formal-Characteristics of Behavior-Temperament Inventory (FCB-TI): Theoretical assumption and scale construction. *European Journal of Personality*, 7, 313-336.
- Strelau, J., & Zawadzki, B. (1995). The Formal-Characteristics of Behavior-Temperament Inventory (FCB-TI): Validity studies. *European Journal of Personality*, 9, 207-229.
- Suzuki, H., Ohnishi, H., & Shigemasa, K. (1992). Goal-directed processes in similarity judgment. *Proceedings of the Fourteenth Annual Conference of the Cognitive Science Society* (pp. 343-348). Hillsdale, NJ: Erlbaum.
- Tanaka, J. W., Curran, T., & Sheinberg, D.L. (2005). The training and transfer of real-world perceptual expertise. *Psychological Science*, 16, 145-151.
- Ter Bogt, T. F. M., Mulder, J., Raaijmakers, Q. A. W., & Gabhainn, S. N. (2011). Moved by music: A typology of music listeners. *Psychology of Music*, 39, 147-163.
- Tervaniemi, M., Just, V., Koelsch, S., Widman, A., & Schröger, E. (2005). Pitch-discrimination accuracy in musicians vs. nonmusicians: an event-related brain potential and behavioral study. *Experimental Brain Research*, 161, 1-10.
- Terwogt, M. M., & Van Grinsven, F. (1991). Musical expression of moodstates. *Psychology of Music*, 19, 99-109.
- Thayer, J. F. (1986). Multiple indicators of affective response to music. *Dissertation Abstracts International*, 47, 12.
- Thayer, J. F., & Faith, M. L. (2001). A dynamic systems model of musically induced emotions. Physiological and self-report evidence. *Annals of the New York Academy of Sciences*, 930, 153-165.
- Tillmann, B., & Bigand, E. (1998). Influence of global structure on musical target detection and recognition. *International Journal of Psychology*, 33, 107-122.
- Trainor, L. J., & Trehub, S. E. (1992). The development of referential meaning in music. *Music Perception*, 9, 455-470.
- Västfjäll, D. (2002). Emotion induction through music: A review of the musical mood induction procedure. *Musicae Scientiae*, 6, Special Issue 2001/2002, 171-203.
- Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., Goldenfeld, N., Delaney, J., Fine, D., ... & Weil, L. (2006). Development of short forms of the Empathy Quotient (EQ) and the Systemizing Quotient (SQ). *Personality and Individual Differences*, 41, 929-940.
- Watkins, E. (2004). Appraisals and strategies associated with rumination and worry. *Personality and Individual Differences*, 37, 679-694.
- Watkins, E., Moulds, M., & Mackintosh, B. (2005). Comparisons between rumination and worry in a non-clinical population. *Behaviour Research and Therapy*, 43, 1577-1585.
- Watkins, E., & Teasdale, J. D. (2004). Adaptive and maladaptive self-focus in depression. *Journal of Affective Disorders*, 82, 1-8.
- Weiser, M., & Shertz, J. (1983). Programming problem representation in expert and novice programmers. *Instructional Journal of Man-Machine Studies*, 14, 391-396.
- Wilson-Mendenhall, C. D., Barrett, L. F., Simmons, W. K., & Barsalou, L. W. (2011). Grounding emotion in situated conceptualization. *Neuropsychologia*, 49, 1105-1127.
- Zaleska, A. (2011). Relationships between anxiety and job satisfaction – Three approaches: ‘Bottom-up’, ‘top-down’, and ‘transactional’. *Personality and Individual Differences*, 50, 977-986. doi: 10.1016/j.paid.2010.10.13
- Zentner, M., Grandjean, D., & Scherer, K. (2008). Emotions evoked by the sound of music: Characterization, classification, and measurement. *Emotion*, 8, 494-521.

## APPENDIX

Experimental material (for details see Bigand et al., 2005)

1. R. Strauss, *Thus Spoke Zarathustra*
2. J. S. Bach, *Violin Sonata no. 1*, Adagio
3. W. A. Mozart, *Piano Concerto, K 488*, Adagio
4. J. Brahms, *Violin Concerto*, Adagio
5. D. Scarlatti, *Sonata A for Harpsichord*, K 208-209
6. R. Schumann, *Dreaming*
7. D. Shostakovich, *Symphony 15*, Adagio
8. D. Shostakovich, *Trio no.2 for piano, violin and cello*, Largo
9. R. Wagner, *Tristan*, Act 4
10. J. Brahms, *Trio for piano, violin and horn*, mvt2
11. F. Liszt, *Symphonic poem*
12. S. Prokofiev, *Piano Sonata no.3*
13. L. v. Beethoven, *Symphony no. 7*, Vivace
14. L. v. Beethoven, *Piano Sonata no.32*, mvt2
15. F. Mendelssohn, *Italian Symphony*, Allegro Vivace
16. F. Chopin, *Prelude no. 22*
17. F. Liszt, *Tasso Lamento & Triumfo*
18. R. Strauss, *Death and Transfiguration*, 7'-7'30
19. J. S. Bach, *Violin Sonata no.3*, Fuga
20. W-F Bach, *Duet for two flutes in F*, Lamentabile
21. J. Haydn, *Symphony in B, Hob I 105*, Andante
22. W-F Bach, *Duet for two flutes in G*, Allegro
23. F. Schubert, *Piano Sonata no.3 in G*
24. I. Stravinsky, *Petrouchka*, The Shrovetide Fair
25. A. Schönberg, *Erwartung*
26. D. Shostakovich, *Trio no.2 for violin, cello & piano*, Moderato
27. F. Liszt, *Totentanz*