Psychology of Aesthetics, Creativity, and the Arts
2015, Vol. 9, No. 3, 235–247

1931-3896/15/$12.00 http://dx.doi.org/10.1037/a0039107

Granularity of Emotional Responses to Music: The Effect of Musical Expertise

Joanna Kantor-Martynuska and Joanna Horabik
Polish Academy of Sciences, Warsaw, Poland

This paper explores the role of musical expertise, rumination, and the analytical versus experiential music focus (as a stable processing tendency or an induced processing mode) for the granularity of emotional responses to music (ERM granularity). A total of 316 musicians and nonmusicians volunteered for 3 studies. In Study 1, ERM granularity measured in a musical emotion discrimination task showed a strong positive relationship with musical expertise but not with rumination. In Study 2, the mode of music focus the participants used while listening revealed a modest effect of analytical versus experiential music focus induction procedures. In Study 3, ERM granularity was found to be independent of the temporary analytical versus experiential music focus, systemizing-empathizing, music systemizing–music empathizing, and amateur musical experience; but it was strongly positively associated with musical expertise. This paper demonstrates that ERM granularity is best explained by musical expertise and cannot be accounted for by any general information processing or music processing bias.

Keywords: emotional responses to music, granularity, musical expertise, rumination

Listeners' perception and experience of the affective aspect of music has been thoroughly investigated for the last two decades (for review, see Juslin & Sloboda, 2010; Juslin & Vastfjäll, 2008). Also, individual differences in many aspects of musical emotion have gained growing interest. Listeners' personality has been shown to affect their emotional involvement in listening to music (Kallinen, Saari, Ravaja, & Laarni, 2005), pleasure felt in response to musical background (Kallinen & Ravaja, 2004a), the intensity of being moved by music (Ter Bogt, Mulder, Raaijmakers, & Gabhainn, 2011), and the enjoyment of negative emotions in music (Garrido & Schubert, 2011). Listeners' musical expertise is associated with their stronger psycho- and neurophysiological responsiveness to musical dissonance (Dellacherie, Roy, Hugueville, Peretz, & Samson, 2011) and to a violation of harmonic expectation, indicating increased emotional response (Steinbeis, Koelsch, & Sloboda, 2005, 2006). Musicians' brainstem response to the complex aspect of sound that carries a large dose of emotional elements also is stronger than nonmusicians' (Strait, Kraus, Skoe, & Ashley, 2009). On the other hand, there have been inconsistent results on the role of musical expertise for the structural organization of the emotional responses to music, that is, the granularity of self-perceived emotional responses to music (ERM granularity; Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005; Kantor-Martynuska & Bigand, 2013). The main aim of this paper is to find out whether ERM are more diverse, that is, granular, in musicians (systematically trained in performing music) than in nonmusicians. On the other hand, we assume that high rumination considered as a tendency to analyze one's negative experiences in order to understand their causes and consequences (Lambie & Marcel, 2002) also may be associated with higher ERM granularity indicated in a task that requires making judgments of similarity between listeners' own emotional responses to music. This paper also strives to test the contribution of the mode of an individual's typical information processing to ERM granularity.

High granularity of the affective responses to music denotes the fine-grained structure of representations of one's experiences, whereas low granularity denotes the more general 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). More emotionally responsive individuals are more likely to attend to emotional stimuli (Halberstadt & Niedenthal, 1997) and to react to stimuli of the slightest emotional load (Strelau, 2008). This should result in a wider range of emotional experience meaning greater diversification.

ERM granularity is a palette of the affective states (see Barrett, 2004) that listeners may consider either as their own response to music or as perceptions of the expressive qualities of music (Gabrielsson, 2002; Kallinen & Ravaja, 2006; Vastfjäll, 2002). ERM granularity may result from the ability to distinguish between the nuances of one's own affective involvement in music and, if one

This article was published Online First May 11, 2015.

Joanna Kantor-Martynuska, Institute of Psychology, Polish Academy of Sciences, Warsaw, Poland; Joanna Horabik, Systems Research Institute, Polish Academy of Sciences, Warsaw, Poland.

The research was supported with the Grant N N106 041134 awarded to Joanna Kantor-Martynuska by the Scientific Research Committee (KBN, Poland). We thank Emmanuel Bigand and the two anonymous reviewers for their helpful comments on the manuscript.

Correspondence concerning this article should be addressed to Joanna Kantor-Martynuska, Institute of Psychology, Polish Academy of Sciences, ul. Jaracza 1, 00-378 Warsaw, Poland. E-mail: jkantor@psych.pan.pl

does not feel involved, from the ability to distinguish between the perceptions of nuances in the expressive qualities of music. Ultimately, ERM granularity may be an interaction effect of both these abilities (Bigand et al., 2005). High ERM granularity denotes a detailed representation of one's feelings, and low ERM granularity stands for a more global representation of the affective responses to music.

Using a free categorization task, Kantor-Martynuska and Bigand (2013) demonstrated that ERM granularity is positively associated with musical expertise and rumination, and with the interaction of these factors moderated by sex. However, this research left unanswered the question of whether the effects found are rooted in the analytical mode of processing information concerning self or music that listeners may have applied in the task. Music processing may reveal the influences of general cognitive styles: A tendency to systemize, that is, the capacity to respond to regularities of objects and events, and a tendency to empathize, that is, the capacity to respond to feeling states of other people (see Baron-Cohen, Knickmeyer, & Belmonte, 2005; Wakabayashi et al., 2006). The cognitive styles promote respective modes of information processing. Such modes of music processing, either as stable tendencies or temporary analytical versus experiential processing biases, may contribute to the ERM granularity. The objective of this paper is to study individual differences in ERM granularity using a new experimental procedure, with consideration to the analytical versus experiential processing bias. Literature in the music perception domain (as presented in the following) shows the importance of the individual characteristics of a listener for the way the emotional aspect of music is processed, perhaps because of a two-sides-of-a-coin relationship between cognition and emotion in which the experience of an emotion is a cognition (Laird & Bresler, 1992).

Individual Differences in Affective Responses to Music

Varied aspects of musical emotion have shown associations with listeners' emotionality (Lewis & Schmidt, 1991), emotional intelligence (Resnicow, Salovey, & Repp, 2004), and musical expertise (Kantor-Martynuska & Bigand, 2013; Scherer & Zentner, 2001). Impulsive sensation-seeking and psychoticism regulated listeners' self-reported emotional involvement in pleasant and unpleasant music (Kallinen et al., 2005; Rawlings & Leow, 2008), and sensitivity of the dispositional behavioral activation system (BAS; one of the primary brain motivational systems underlying behavior and affect; Gray, 1982, 1991; Pickering & Gray, 1999), moderated listeners' ratings of pleasure felt along with startling background music (Kallinen & Ravaja, 2004b). Individual differences in absorption and music empathizing have been found to positively correlate with the enjoyment of negative emotions evoked by music (Garrido & Schubert, 2011).

Rumination and Analytical Information Processing

Considering that the way we process information is related to our experience, Barrett (2005) suggested that the categorical knowledge we have about emotions influences the way we perceived our feelings. A mental process of category formation proceeds through practice with a specific class of objects (Gauthier, Skudlarski, Gore, & Anderson, 2000; Tanaka, Curran, & Sheinberg, 2005), here with musical emotional expressions and the responses they trigger. Categories of perceived emotions may develop through the selective attending to one's emotional responses (Niedenthal & Dalle, 2001), typical of individuals with high levels in rumination (Mor & Winquist, 2002). Rumination as an information processing mode may be pragmatic and adaptive (see Schank, Collins, & Hunter, 1986), allowing for better discrimination between the conditions that induce anxiety, and these that do not suggest any harm or worry. *Rumination*, more intense in women (Nolen-Hoeksema & Jackson, 2001), is a tendency to focus on one's self when in a negative mood (Lambie & Marcel, 2002; Nolen-Hoeksema, Morrow, & Fredrickson, 1993) to understand the causes and meanings of experience (Watkins, 2004). People in a negative mood classify objects into a greater number of less inclusive and less abstract categories as compared to those in positive mood (Isen & Daubman, 1984; Rosch, 1978; Wytykowska, 2012). A recent study brought data consistent with the latter findings, demonstrating a positive association between rumination and ERM granularity using a free categorization task (Kantor-Martynuska & Bigand, 2013). The objective of the present study was to identify the relationship between the ERM granularity, rumination, and musical expertise, using a task that would reduce a contribution of the mode of task performance to the way in which listeners group their affective responses to music.

The affective responses to music are studied here as the subjective experiential feeling element of emotion (see Panksepp, 2005). Feeling, the "private, mental experience of emotion" (Damasio, 1999, p. 42) is their central component. It integrates all the aspects of emotion and forms the grounds for its conscious representation (Scherer, 2004). As did Barrett (2005), we assumed that "emotions are perceptions" (p. 262) in that they consist in assigning objects to meaningful categories based on what we know about emotion from our experience. We adopted this theoretical approach as a basis for studying the relationship of ERM granularity with rumination, musical training, and a tendency to process information analytically (Nettle, 2007). Systematic processing increased by sad mood due to raised attention to details (for review, see Schwarz & Clore, 2003) and local processing produce contrast rather than assimilation (Förster, Liberman, & Kuschel, 2008), which, in addition to the results of the previous research (Kantor-Martynuska & Bigand, 2013), supports our hypothesis.

Positive rumination is a tendency "to respond to positive affective states with recurrent thoughts about positive self-qualities, positive affective experience, and one's favorable life circumstances" (Feldman, Joormann, & Johnson, 2008, p. 509) and inspiration is a motivational state posited to energize the actualization of creative ideas (Thrash, Maruskin, Cassidy, Fryer, & Ryan, 2010). Research has shown that the intensity and frequency of self-focused positive rumination and emotion-focused positive rumination as measured with Responses to Positive Affect questionnaire (Feldman et al., 2008) are positively associated with the score on inspiration scale (Jones, Dodd, & Gruber, 2014). However, the understanding of rumination in this context is different from rumination about negative experience, referred to in the previous study (Kantor-Martynuska & Bigand, 2013; see also Nolen-Hoeksema et al., 1993).

A free categorization task had an undisputable advantage for studying listeners' grouping of their emotional responses to music with reference to the perceived similarity of this affective experience (Bigand et al., 2005; Kantor-Martynuska & Bigand, 2013). It did not require any verbalization of affective experience and suggested no specific strategy of task performance. However, this task only consisted in random comparison of the responses to pieces of music that were available. In the present study, data regarding ERM granularity were collected using a musical emotion discrimination task. This method requires that a participant make systematical comparison of the affective responses to each of two musical excerpts, pointing out whether they are "the same" or "different." Unlike the free categorization task used by Kantor-Martynuska and Bigand (2013), it guides a listener through the pairs of music samples available, minimizing the role of an information processing mode for the organization of the task performance.

Finer granularity of ERM shown in musicians and high rumination scorers (Kantor-Martynuska & Bigand, 2013) may be due to their more analytical categorization of emotional experience, meaning more systematic comparisons between each pair of emotional responses to music. A strong relationship between the analytical self-focus and high rumination (Lambie & Marcel, 2002), as well as musicians' stronger analytical mode of music perception, besides having more eager music empathizing (Brennan & Stevens, 2002; Kreutz, Schubert, & Mitchell, 2008), may interact to contribute to higher ERM granularity. The present study's aim was to find out whether a more structured task, which required more systematic comparisons of ERM and guided by the structure of the experimental task, would show finer ERM granularity in musicians and high rumination listeners as suggested by the results of the previous research (Kantor-Martynuska & Bigand, 2013). Study 1 was devised to verify the results of the past research concerning individual differences in ERM granularity (Kantor-Martynuska & Bigand, 2013) with consideration to rumination and musical expertise.

Study 1

Method

Participants. A total of 73 high-school students (33 musicians, 40 nonmusicians; 32 males, $M_{\text{age}} = 17.1$ years, $SD_{\text{age}} = 0.52$ years) volunteered for the study. Musicians were students of secondary music schools and had an average of 8 years ($SD = 0.7$ years) of systematic musical training. Nonmusicians declared no music education beyond the general elementary school curriculum. In Session 1, they were dismissed from class to individually perform the experimental task. In Session 2, they filled out questionnaires in groups during class.

Procedure.

Musical emotion discrimination task. The participants read and signed an informed consent. None of the participants left the tasks unfinished. In Session 1, the participants individually listened to 20 instrumental musical excerpts with a maximum length of 30 s. The excerpts were combined in pairs, which made a total of 190 pairs of musical excerpts. The music samples were selected from a previously used pool of 27 excerpts (Bigand et al., 2005) as those that were grouped similarly by musicians and nonmusicians and by low and high rumination scorers (Kantor-Martynuska & Bigand, 2013). The number of excerpts was reduced so as to maintain response reliability. The participants' task was to determine, while listening to each pair of excerpts, whether the two pieces of music evoked the affective responses that were *the same* or *different*. This task consisted in making obligatory systematical comparisons between the affective responses to each pair of pieces of music considered. Listeners were instructed to perceive how they felt about the music, which was supposed to form the basis of their judgment making, as in the affect-as-information model (Forgas, 1994). The instruction required focusing on one's own emotional experience and delivering each response as soon as the similarity between the experiences of two musical excerpts had been determined. Participants were allowed to repeat the excerpts, and to stop listening to them any time they wanted. The mean response time in a trial was 9 s ($SD = 2.34$).

Measures of individual characteristics. In Session 2, participants filled out questionnaires measuring rumination. The Emotional Control Questionnaire (ECQ; Roger & Najarian, 1989) is a homogenous questionnaire measure of rumination consisting of 20 items, 10 measuring rumination and 10 measuring inhibition. The Rumination Questionnaire (RQ; Baryła & Wojciszke, 2005) consists of two subscales, 10 items each, measuring negative rumination about the self (e.g., "I wonder why I did not behave in a different way in certain situations") and rumination about the world (e.g., "I think of how unfair the world is").

Results

Correlations between the participants' individual characteristics are presented in Table 1.

Musical emotion discrimination—Data analysis. Data analysis of each participant's responses in the experimental task was aimed at identifying the pairs of musical excerpts perceived as *being the same* or *being different*. To structure the data and facilitate the analysis we refer to the basic concepts of graph theory. Graph theory enables the mathematical investigation of structures consisting of nodes (vertices) and edges (lines) connecting certain nodes (Schvaneveldt, Durso, & Dearholt, 1989). The graphical representation it provides is useful for representing problems in various research disciplines (Bollobás, 1998; Diestel, 2000). Here, each participant's responses were transformed into a labeled graph with vertices (nodes in a graph) representing musical excerpts and edges bridging excerpts that evoked emotional responses considered as *the same*. To produce the graphs from experimental data we developed our own functions in R (R Core Team, 2014). The dedicated Mathematica (Wolfram Research Inc., 2010) procedures were used to calculate the number of graph edges and components. The cluster analysis based on graph dis-

Table 1
Pearson Correlation Coefficients Between Personal Dispositions' Variables in Study 1

Personal disposition	Musical expertise	Rumination	Rumination about self
Musical expertise			
Rumination	−.02		
Rumination about self	.21	.27*	
Rumination about the world	−.17	.10	.16

* $p < .05$.

tance was handled in R (R Core Team, 2014). Selected properties of a graph were later used to quantify patterns of connections (edges) among vertices, which reflected each participant's emotional responses to considered pieces of music. That is, each graph was analyzed in terms of its complexity and distance from all the other participants' graphs.

The indexes of ERM granularity were (a) the number of edges, (b) the number of components, and (c) distance between graphs. The number of graph edges (NE; a negative index of granularity), denotes perceived similarity between pairs of responses to music: the smaller the NE, the finer ERM granularity. The number of graph components (NC; a positive index of granularity) represents the disconnected subparts of the entire graph. The larger the NC, the larger was the granularity of representation of the set of emotional responses to music. The graph distance, a degree of similarity between each of the two individual graphs, was the number of edges that are present in one graph but nonexistent in the other graph in a pair, divided by the sum of edges in both graphs. The distance is 0 for two identical graphs, and 1 for the graphs in which none of the edges line up.

Measures of individual characteristics—Reliability. From the ECQ (Roger & Najarian, 1989) only the Rumination scale was used in the analyses. The reliability of the scores participants obtained on the scale of Rumination (Roger & Najarian, 1989) was very low (Cronbach's $\alpha = .186$). The analysis also comprised the scores on the scales of Rumination About Self (RS; Cronbach's $\alpha = .894$) and Rumination About the World (RW; Cronbach's $\alpha = .81$; reliability of RS and RW: Cronbach's $\alpha = .894$; RQ, Baryła & Wojciszke, 2005), which showed satisfactory reliability.

Graph edges. Considering the normal distribution of the number of graph edges, we ran the analysis of variance (ANOVA) with musical expertise as between-subjects factor. The analysis showed a smaller number of graph edges in musicians ($M = 28.33$, $SD = 16.41$) than in nonmusicians ($M = 49.84$, $SD = 20.89$), $F(1, 71) = 25.33$, $p < .001$, $\eta_p^2 = .24$. Figure 1 provides exemplary graphs by a musician and a nonmusician.

Graph components. Considering the right-skewed distribution of the number of graph components, we used Mann–Whitney U tests to compare the median values of this dependent variable in musicians ($Mdn = 3$) and nonmusicians ($Mdn = 1$). The distributions in the two groups differed significantly (Mann–Whitney $U = 376.5$, $N_{\mathrm{mus}} = 40$, $N_{\mathrm{nmus}} = 33$, $p = .001$).

Distance. To verify the hypotheses concerning the relationship between the distance as a measure of granularity and the two independent variables, we performed a cluster analysis of graphs in R (R Core Team, 2014) with the use of the k-medoid method, which revealed two graph clusters (Kaufman & Rousseeuw, 2005). Such a grouping, as well as participants' musical expertise, ECQ rumination and both RQ rumination scores (considered as separate and in combination) was subject to the chi-square test of independence. The grouping, based on the distance between graphs, was found to be associated with musical training, $\chi^2(df = 1) = 15.57$, $p < .001$. The three indexes of ERM granularity did not show any significant relationship with rumination. Time spent listening was irrespective of the participants' musical expertise, and it showed no significant correlation with any indexes of ERM granularity.

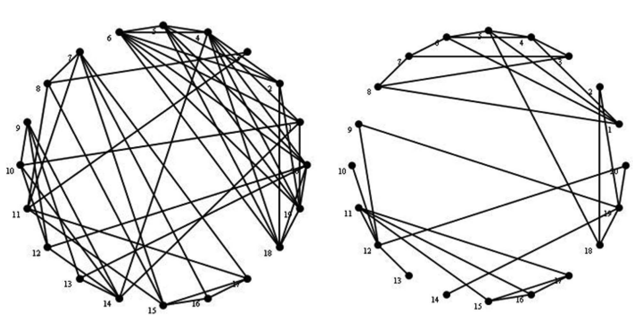

Figure 1. Examples of a nonmusician's (left) and a musician's (right) graphs representing the granularity of their responses to music.

Discussion

Study 1 revealed a positive relationship between the ERM granularity and musical expertise but not between ERM granularity and rumination. The effect of musical expertise may be based on experts' attention to subtler perceptual features in the stimuli within the domain of their expertise as compared to novices (Johnson & Mervis, 1997). Therefore, training in performing music may refine the perception of nuances in the expressive qualities of music or the differentiation of self-perceived emotional experience evoked by music.

Empirical studies show that musical expertise is manifested in multiple aspects of music processing. On the one hand, musical training does not have any effect on responding to subtle musical structure or perceiving music on a basic melodic, harmonic and global structural level (Bigand, 1997; Bigand & Parncutt, 1999; Bigand & Poulin-Charronnat, 2006; Tillmann & Bigand, 1998). On the other hand, musicians are more successful in coding musical information in sensory memory representations (Koelsch, Schröger, & Tervaniemi, 1999) and in processing music on an attentive level (Tervaniemi, Just, Koelsch, Widmann, & Schröger, 2005). They exhibit larger neurophysiological responsiveness to a violation of expectation (Steinbeis et al., 2005, 2006), which indicates their increased emotional response. Consistent with the second group of studies, our data suggest that musicians' self-perceived emotional responses to music are more nuanced and more varied when compared with nonmusicians.

The lack of consistency with the results of the previous study in terms of the relationship between ERM granularity and rumination (Kantor-Martynuska & Bigand, 2013), may be due to the difference in the type of task. The experimental task in the former study (Kantor-Martynuska & Bigand, 2013) allowed for more freedom in grouping one's affective responses to music. Here, the requirement to compare the responses to each of the two pieces of music samples may have reduced the importance of the participants' actual feeling experience, and most probably favored recognition of the expressive features of music. As a consequence, a more structured and systemized task may have reduced the role of the mode of self-focus, erasing the effect of rumination on ERM granularity. In the light of the present data, the effect of rumination on ERM granularity found in the previous study is much less informative than the effect of musical expertise, confirmed here with the use of another research method. It remains to be tested whether musical training, and not just experience in listening, determines the ability to perceive nuances in musical emotion. Another option to consider is the possible contribution of the analytical versus experiential music processing mode to the granularity of ERM.

To identify the role of the analytical versus experiential music focus for ERM granularity, we tested next the possibility of inducing the two aforementioned modes of music focus. Study 2 aimed to reveal whether the mode of listeners' music processing is affected by application of the analytical versus experiential music focus induction procedures. Here, we refer to the analytical and experiential self-focus (Watkins & Teasdale, 2004) considered a disengaged, "think-about" focus on one's self, and experiential self-focus as a global, synthetic representation of what one experiences, involving imagery or metaphorical thinking. Another references are systemizing-empathizing as tendencies in general information processing (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003) and music systemizing-music empathizing as music processing modes (Kreutz et al., 2008). By analogy we assumed that the same differentiation may be relevant to music processing, meaning the analytical and experiential music focus.

Study 2

Method

Participants. A total of 107 participants (M_{age} = 16.6 years, SD_{age} = 0.55 years) performed two parallel music-focus tasks. Of these, 30 musicians (13 males) and 24 nonmusicians (9 males) performed the analytical music-focus induction task (aMFIT). Thirty musicians (17 males) and 23 nonmusicians (10 males) performed the experiential music-focus induction task (eMFIT). In Session 1, they were dismissed from class to individually perform the experimental task. In Session 2, they filled out questionnaires in groups during classes.

Procedure. The analytical and experiential computer-based music-focus tasks were meant to induce the respective mode of music focus in participants. Participants listened to five 50-s long instrumental musical samples of varied style, instrumentation, and emotional expression (see Appendix A). In aMFIT, the participants were instructed to focus on instrumentation and to write down the names of the main and accompanying instruments. In eMFIT, the participants' task was to focus on feelings they experienced when listening to the music. They were asked to find the corresponding images or situations (see Watkins & Teasdale, 2004). In both tasks, the participants wrote down their answers on the sheets provided. When the piece of music was finished, they rated their familiarity with it, and the program moved on to the next music sample.

Analytical and experiential music focus—Manipulation check. The experimental manipulation was followed by a manipulation check in which participants listened to four 30-s long instrumental musical excerpts of a varied style, instrumentation, and emotional expression (not used earlier in the experiment, see Appendix B). After listening to each piece of music, the participants gave the information about whether they were familiar with the music they heard. Once they completed the task, they filled out a 10-item questionnaire to estimate the mode of listening they applied. The questionnaire comprised eight items, constituting the analytical and experiential scales in equal proportions, and two buffer items. One of the analytical scale items (aMFIT) was "When I was listening to the music, I was thinking about its rhythm and internal organization," and of the experiential scale (eMFIT), "The music I was listening to engaged me emotionally." The four response options were *strongly agree*, *rather agree*, *rather disagree*, and *strongly disagree*.

Measures of individual characteristics. In Session 2, given 3 to 4 weeks after the experiment, the participants filled out a measure of a tendency to systemize or empathize in general information processing (Systemizing Quotient; SQ–Short; Empathy Quotient; EQ–Short; Wakabayashi, et al., 2006), and in music processing specifically (Music Systemizing–Music Empathizing; MS–ME; Kreutz et al., 2008), as well as two measures of rumination (ECQ; Roger & Najarian, 1989; RQ, Baryła & Wojciszke, 2005). SQ–Short is a 25-item questionnaire that measures the skill to analyze the rules of a system and to monitor operations of input–output relations that can be used across the range of domains (Wakabayashi et al., 2006). EQ–Short is a 22-item questionnaire measuring the ability to empathize with other people: to imagine oneself in a position of another person; to predict and understand what other people think, feel, or do, and to react (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004).

Results

Measures of individual characteristics—Reliability. In the analysis we entered the scores the participants obtained on the scale of Rumination (but not Inhibition) from the ECQ (Roger & Najarian, 1989). This time, the Reliability scores for the tested sample was higher than in Experiment 1, but still unacceptable (Cronbach's α = .495). The scores on the scales of Rumination About Self, (*RS*; Cronbach's α = .896) and Rumination About the World (both subscales originally in the participants' mother tongue; RW; Cronbach's α = .849; reliability of RS & RW in combination: Cronbach's α = .875; RQ, Baryła & Wojciszke, 2005) showed high reliability.

The participants' scores on SQ–Short and EQ–Short; Wakabayashi, et al., 2006) revealed satisfactory (EQ–Short: Cronbach's α = .79) or high (SQ–Short: Cronbach's α = .83) reliability, whereas their scores on music systemizing (MS) and music empathizing (ME) were nearly satisfactory (MS: α = .749; ME: α = .758).

There were no correlations between the scores on analytical music focus (AMF; (Cronbach's α = .593) or experiential music focus (EMF; Cronbach's α = .521) and rumination measured with ECQ (Roger & Najarian, 1989) but a weak correlation was found between AMF and the score on the scale of Rumination about the World ($r = .25$, $p < .05$; Baryła & Wojciszke, 2005). AMF ratings were correlated with SQ–Short, $r = .43$, $p < .01$; EQ–Short, $r = .25$, $p < .05$, and ME, $r = .34$, $p < .01$, although EMF was correlated with SQ–Short only, $r = -.29$, $p < .05$.

The ANOVA demonstrated that the AMF was higher just after completing the aMFIT than after completing the eMFIT, $F(1, 103) = 9.93$, $p < .005$, $\eta_p^2 = .09$, and the experiential music focus (EMF) was higher under eMFIT than under aMFIT condition, $F(1, 103) = 5.72$, $p < .05$, $\eta_p^2 = .05$. Small effect sizes indicate that the experimental manipulation was successful but low in effectiveness. The analytical mode of music processing was induced more effectively.

Musicians reported higher values of AMF (M = 7.85, SD = 2.16) than nonmusicians (M = 6.27, SD = 2.21), $F(1, 103) = 13.5$, $p < .001$, $\eta_p^2 = .11$, but the estimates of EMF were independent of musical expertise, $p > .05$. Under aMF induction, there was a positive effect of musical expertise on self-reported AMF, $F(1, 103) = 13.5$, $p < .001$, $\eta_p^2 = .13$. There also was a marginally significant interaction effect of the induction of the music processing mode (aMF vs. eMF) and musical expertise on AMF, $F(1, 103) = 3.9$, $p = .05$, $\eta_p^2 = .04$. Post hoc test with Bonferroni correction demonstrated that nonmusicians reported higher AMF under the aMFIT versus the eMFIT conditions ($p = .001$) while in musicians there was no significant difference in AMF between the experimental conditions.

Discussion

The procedure aimed at inducing the analytical versus experiential mode of music focus showed moderate effectiveness. Besides, musicians were more eager to process music analytically than nonmusicians irrespective of the type of music focus required in the induction task, but there was no relationship between musical expertise and self-reported experiential music focus. The results suggest that any differences in the way musicians and nonmusicians grouped their emotional responses to music should be attributed to nonmusicians' higher AMF after aMF induction as compared to eMF induction.

The induction of music processing mode was ineffective in musicians. This finding indicates that the AMF in musicians does not increase due to temporary activation of the analytical music processing mode but it does in nonmusicians. Contrary to prior assumptions, the results of Study 1 and 2 do not provide any promising grounds for further testing of the relationship between ERM granularity and rumination or the analytical self-focus. On the other hand, the results concerning music focus suggest that the mode of music focus may contribute to the ERM granularity.

AMF and eMF induction procedures were only marginally effective in Study 2. However, Sutdy 3 was devised as a test of the possible interaction effects of (a) a stable tendency to apply the analytical or experiential mode of music processing (MS–ME), and of (b) a temporary state-like focus on the analytical versus experiential aspect of music (AMF, EMF). Besides, we assumed that despite the lack of a strong self-reported influence of the manipulation tasks (aMFIT, eMFIT) on the mode of music processing (manipulation check), they may have a direct effect on the type of music processing as measured in the emotion discrimination task.

Study 3

Considering musicians' advantage in ERM granularity, we hypothesized that listeners' higher ERM granularity may be due to the analytical music focus. The analytical music focus is considered here both as a trait-like music systemizing tendency (Kreutz et al., 2008) and as a temporary mode of processing that can be induced in listeners prior to music listening. Study 3 also aimed to verify whether the positive effect of musical expertise on ERM granularity is accounted for exclusively by systematical formal musical training or could be explained with reference to informal musical experience.

Method

Participants. A total of 81 high-school students ($M_{age} = 16.8$ years, $SD_{age} = 0.61$): 44 musicians (25 female, $M_{age} = 16.5$ years, $SD_{age} = 0.63$) and 37 nonmusicians (20 female, $M_{age} = 17.2$ years, $SD_{age} = 0.36$) volunteered for the study and were released from class to participate in the experiment. The average duration of musicians' musical training was $M = 11.14$ years. Nonmusicians, even if musically trained ($M = 1.7$ years), were not playing an instrument anymore. In Session 1, the participants were dismissed from class to individually perform the experimental task, and in Session 2, they filled out questionnaires during classes.

Procedure.

Induction of the music processing mode. The participants read an informed consent and signed it. In Session 1, the participants performed either the analytical (aMFIT) or the experiential music focus (eMFIT) induction task (see Study 2). In Session 2, they performed the alternate task. None of them left the tasks unfinished.

Musical emotion discrimination task and music-focus manipulation check. Next, they performed a musical emotion discrimination task measuring ERM granularity (see Study 1), which was followed by a postexperimental 10-item music-focus manipulation check (see Study 2, Analytical and Experiential Music Focus). The order of the two tasks in Sessions 1 and 2 was counterbalanced across the participants. The two sessions were completed at a 4 to 6 weeks interval.

Measures of individual characteristics. In Session 3, which was timed for 4 to 6 weeks after Session 2, participants filled out a musical training survey, the Polish versions of the SQ–Short, EQ–Short (Nettle, 2007; Wakabayashi et al., 2006); MS–ME (Kreutz et al., 2008); and the Music Experience Questionnaire–short version comprising six scales: Commitment to Music, Affective Reactions, Innovative Musical Aptitude, Social Upheaval, Positive Psychotropic Effects and Reactive Musical Behavior (MEQ; Werner, Swope, & Heide, 2006).

Results

Data analysis. Data were analyzed according to graph theory (Study 1: Results: Musical emotion discrimination—Data analysis). The details of the analysis were the same as in Study 1, except in the third measure of ERM granularity. In this analysis, graph distance was replaced by edge connectivity (EC; the minimum number of edges whose deletion from a graph disconnects it). EC informs about the frequency of the perceptions of a certain pair of items as being the same. EC only characterizes graphs that are connected (Schvaneveldt et al., 1989).

Measures of individual characteristics–Reliability. The participants' scores on the SQ–Short and the EQ–Short (Wakabayashi, et al., 2006) revealed highly satisfactory (EQ–Short: Cronbach's $\alpha = .88$) or satisfactory reliability (SQ–Short: Cronbach's $\alpha = .77$) but reliability of the scores on MS and music empathizing ME was nearly satisfactory (MS: $\alpha = .704$, ME: $\alpha = .792$).

Individual characteristics.

Systemizing–empathizing, sex, and musical expertise. A 2 (musicians, nonmusicians) × 2 (male, female) ANOVA indicated a significant main effect of sex, $F(1, 69) = 7.11$, $p = .01$, and an interaction effect of sex and musical expertise on systemizing, F(1,

69) = 8.88, $p < .005$, $\eta_p^2 = .11$, but no effect of musical expertise, $p > .5$. Post hoc test with Bonferroni correction demonstrated that although male nonmusicians showed a significantly higher level of systemizing ($M = 35.3$) than female nonmusicians ($M = 28.4$), $p < .005$, and female musicians scored higher on systemizing ($M = 32.8$) than female nonmusicians, $p < .05$, there was no difference in systemizing between male ($M = 32.4$) and female musicians, $p > .05$. Scores on empathizing were independent of participants' sex and musical expertise.

MS–ME, musical expertise, and informal musical experience. Musicians reported higher MS, $F(1, 71) = 5.94$, $p = .02$, $\eta_p^2 = .08$, and ME, $F(1, 71) = 26.31$, $p = .001$, $\eta_p^2 = .28$, than nonmusicians, but participants' sex did not moderate this effect. The significant and strong correlations between musical expertise, MS–ME, and the subdimensions of informal musical experience are presented in Table 2.

Music-focus manipulation check.

AMF and EMF. Reliability of the scores on the AMF and EMF is acceptable considering that both measures consisted of merely four items each (see Table 3).

Student's t test demonstrated that participants reported higher EMF as compared with AMF, both after completing aMFIT, $t(74) = -13.27$, $p < .001$, and eMFIT, $t(74) = -12.24$, $p < .001$. There were no within-subject differences in the reported AMF or EMF across the experimental conditions, indicating that the experimental manipulation was generally unsuccessful.

AMF, EMF, and musical expertise. Under eMFIT condition, ratings of AMF and EMF were higher in musicians, $F(1, 67) = 5.47$, $p = .02$, $\eta_p^2 = .09$, and $F(1, 67) = 5.14$, $p = .02$, $\eta_p^2 = .09$, respectively, which may indicate their stronger emotional involvement in listening while prompted to attend to the experiential aspect of music perception.

AMF, EMF, and MS–ME. The correlations between AMF, EMF, MS–ME, and the subdimensions of informal musical experience are presented in Table 4. MS is stronger associated with AMF than ME. Commitment and Innovation have a lot in common with the AMF, whereas Integration with the EMF.

A 2 (high vs. low MS) × 2 (high vs. low ME) multivariate ANOVA revealed the interaction effect of MS and ME on AMF ratings both under aMFIT, $F(1, 67) = 6.07$, $p = .02$, $\eta_p^2 = .09$, and eMFIT condition, $F(1, 67) = 3.76$, $p = .057$, $\eta_p^2 = .06$; however, the effects were of modest significance (see Figure 2).

Table 2
Pearson Correlation Coefficients Between Music Systemizing–Music Empathizing and the Subscales of Music Experience Questionnaire–Short Version

MEQ subscales	Musical expertise	Music systemizing	Music empathizing
Affect	.22	$.36^{**}$	$.34^{**}$
Positive Psychotropic Effects of Music	$.31^{**}$	$.47^{***}$	$.55^{***}$
Commitment to Music	$.53^{***}$	$.56^{***}$	$.71^{***}$
Reactivity to Music	.11	$.29^{*}$	$.34^{**}$
Integration	.22	$.30^{**}$	$.27^{*}$
Innovation	$.37^{**}$	$.45^{***}$	$.52^{***}$

Note. MEQ = Music Experience Questionnaire–Short version.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Participants with high scores on both MS and ME gave the highest ratings of AMF, irrespective of the prior music-focus induction. EMF ratings were generally independent of MS or ME. However, after the EMF induction procedure, they revealed a weak interaction effect of MS and ME, $F(1, 60) = 3.87$, $p = .05$, $\eta_p^2 = .06$ (see Figure 3).

Participants with low scores on both MS and ME rated EMF lower than other participants. This finding suggests that low MS and ME may be associated with a decreased capability to focus on one's own emotional responses to music and to value them. High MS and ME boost the analytical mode of music processing.

Experimental data.

Musical emotion discrimination task and musical expertise. A 2 (aMF vs. eMF music-focus induction) × 2 (musician vs. nonmusician) repeated-measures ANOVA demonstrated the main effect of musical expertise, $F(1, 66) = 17.8$, $p < .001$, $\eta_p^2 = .21$, showing a lower number of edges in musicians, but revealed no effect of the experimental manipulation of the music processing mode. Also, the number of graph components and the edge connectivity brought evidence of musicians' finer ERM granularity. Considering the right-skewed distributions of the number of graph components and edge connectivity, we used Mann–Whitney U test to compare the median numbers of graph components and median edge connectivity across the groups of musicians and nonmusicians, irrespective of the experimental condition. Musicians and nonmusicians differed in their distributions of the number of graph components, $Mdn_{\text{mus}} = 5.0$, $Mdn_{\text{nmus}} = 1.5$, Mann–Whitney $U = 519$, $N_{\text{mus}} = 45$, $N_{\text{nmus}} = 36$, $p = .005$, as well as in their graphs' edge connectivity, $Mdn_{\text{mus}} = 0.5$, $Mdn_{\text{nmus}} = 0.0$, Mann–Whitney $U = 498$, $N_{\text{mus}} = 45$, $N_{\text{nmus}} = 36$, $p = .002$. Thus, musicians showed finer ERM granularity than nonmusicians.

Musical emotion discrimination task and informal musical experience. MEQ Commitment was the only subdimension of the informal musical experience that revealed a significant negative relationship with the number of edges in graphs but the effect was small, $F(1, 54) = 4.73$, $p < .05$, $\eta_p^2 = .08$. Participants' sex, processing styles (systemizing–empathizing, MS–ME) or self-focus did not have any major effect on the ERM granularity.

Musical emotion discrimination task and the type of music focus. As shown in Session 2, if the participants first performed the discrimination task after the eMFIT and then after the aMFIT, we found a larger number of edges, $F(1, 71) = 5.2$, $p = .03$, $\eta_p^2 = .07$, as shown by one-way ANOVA, and a larger number of components ($Mdn_1 = 1$, $Mdn_2 = 4.5$, Mann–Whitney $U = 358.5$, $N_1 = 37$, $N_2 = 36$, $p < .001$) as compared with the performance of the AMF task in Session 1. The latter of these results indicated finer ERM granularity and it was more significant. The reverse order of aMF and eMF induction procedures did not result in a significant difference in ERM granularity. Musical expertise did not moderate this effect. The specific effect of training in performance of the musical affect discrimination task can be explained with the easier analytical, more local listening mode after applying an experiential, more global mode. This finding suggests that attention to detail within one's own emotional responses to music, resulting in fine ERM granularity, is a more advanced listening mode.

Musical emotion discrimination task and MS–ME. There were moderate correlations between MS and AMF ratings on the one hand, under aMF induction, $r(65) = .41$, $p = .001$, under

Table 3
Pearson Correlation Coefficients Between Music Systemizing–Music Empathizing and the Analytical and Experiential Music Focus After Completing Analytical Music Focus and Experiential Music Focus Induction Task

Experimental condition	Music systemizing	Music empathizing	Affect	Positive psychotropic effect of music	Commitment	Reactivity	Integration	Innovation
AMF after aMFIT	.41**	.16	.11	.29*	.38**	.14	.08	.31*
AMF after eMFIT	.42**	.35**	.16	.36**	.46**	.15	.10	.45**
EMF after aMFIT	.21	.03	.16	.26*	.07	.22	.40**	−.02
EMF after eMFIT	.21	.28*	.23	.38**	.27*	.27*	.35**	.20

Note. AMF = analytical music focus; aMFIT = analytical music focus induction task; eMFIT = experiential music focus induction task; EMF = experiential music focus.
* $p < .05$. ** $p < .01$.

eMFIT condition, $r(64) = .42$, $p = .001$, and scarcely any correlations between ME and EMF ratings, under aMFIT condition, $r(65) = .03$, $p > .05$, and under eMF induction, $r(64) = .28$, $p < .05$. However, there were interaction effects of MS and ME on ERM granularity following the aMFIT and eMFIT performance. We found a modest interaction effect of dichotomized MS and ME on the number of edges across the aMFIT and eMFIT conditions, $F(1, 57) = 4.18$, $p = .046$, $\eta_p^2 = .07$. The number of edges was noticeably lower (indicating finer ERM granularity under AMF induction) in participants with lower scores on MS and higher scores on ME (see Figure 4).

A combination of a trait tendency to apply the experiential mode of music processing (ME), substantially higher in musicians, and the temporary state-like focus on the analytical aspect of music (AMF) may contribute to a higher ERM granularity. Figure 4 suggests that those who benefitted from the prior aMFIT performance to produce the lowest number of edges scored low on MS and high on ME. Mann–Whitney *U* did not show any relationship between MS or ME and the number of graph components or edge connectivity, suggesting that these indexes of ERM are independent of the music processing mode considered as a trait.

Discussion

As in Study 1, Study 3 demonstrated a strong positive relationship between ERM granularity and musical expertise. Systemizing and empathizing as general information processing modes were of no importance for ERM granularity, as were neither aMFIT nor eMFIT procedures that may have been too short to have the effect on the mode of the subsequent music processing. This finding suggests that participants followed the instructions they were given for the affect discrimination task, which required that they focus on the experiential aspect of music.

Table 4
Coefficients for the Analytical and Experiential Music Focus After Analytical Music Focus and Experiential Music Focus Inductions in Musicians and Nonmusicians

Experimental condition	Musicians α	Nonmusicians α	Total α
AMF after aMFIT	.66	.34	.55
AMF after eMFIT	.50	.53	.60
EMF after aMFIT	.70	.66	.68
EMF after eMFIT	.41	.64	.51

Note. AMF = analytical music focus; aMFIT = analytical music focus induction task; eMFIT = experiential music focus induction task; EMF = experiential music focus.

Musicians' higher scores on MS, ME, and their higher ratings of AMF and EMF reveal their general engagement with music. We can expect that while high MS and ME listeners were perceiving similarity in affective responses evoked by music; they applied a strong analytical music focus besides high involvement in listening. The aMFIT and eMFIT procedures may have amplified any perceived differences in the musical affect. The fact that listeners with low MS and ME reported the lowest level of EMF under eMFIT condition adds more empirical evidence in favor of this assumption.

Study 3 showed that the degree to which emotional responses to music are nuanced is positively associated with the systematic and versatile musical training (Sloboda, 2005) but not with an amateur experience in listening to music. We infer that musical expertise comprises a unique set of competences including active musical experience, which is crucial for the fine-grained affective responses to music. To better understand the effect of musical expertise on ERM granularity, we may refer to musicians' familiarity with the type of music that was played in the experiment (Marin & Bhattacharya, 2009), considering that empathy with musical expression is positively correlated with familiarity and preference (Egermann & McAdams, 2010). This factor should be controlled for in further studies.

General Discussion

This research, in consistence with the former findings (Kantor-Martynuska & Bigand, 2013), systematically shows finer ERM granularity in musicians than in nonmusicians, and fails to demonstrate associations of ERM granularity with any other listener's characteristics considered. Rumination does not have any effect on granularity of the emotional responses to music measured with a musical emotion discrimination task.

The faculty of fine discrimination of emotional responses to music seems to be positively associated with purposeful listening to the music, both in the form of one-time experience in discrimination of affective responses to music and long-term musical training. Despite the advanced listening strategies found in nonmusicians (Bigand & Poulin-Charronnat, 2006), formal musical training has a unique validity as a predictor of ERM granularity. The effect of musical expertise on ERM granularity cannot be reduced to the role of an analytical tendency in the mode of music

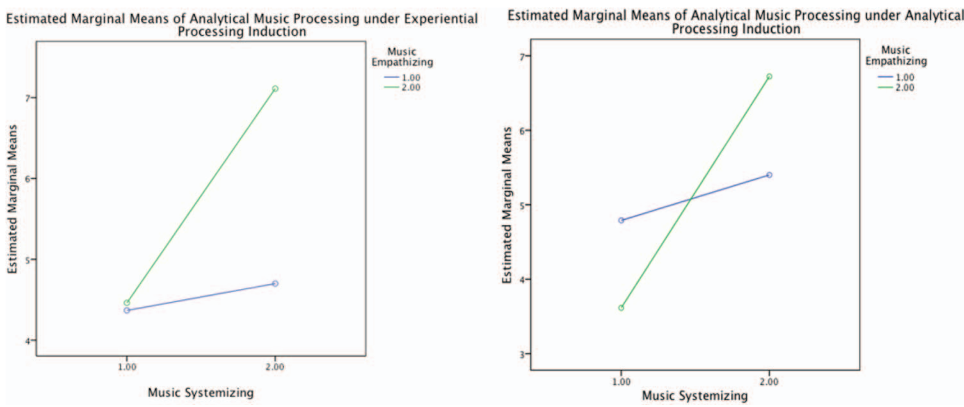

Figure 2. The interaction effect of music systemizing and music empathizing on the self-reported analytical music processing under the analytical and experiential processing mode inductions. See the online article for the color version of this figure.

processing. However, although right-dominant activation in the secondary auditory areas in nonmusicians indicates right hemispheric predominance in musically naïve listeners, musicians show left-dominant temporal cortical activation during music perception (Ohnishi et al., 2001) and left-lateralized representations of music (Bever & Chiarello, 1974; Mazzucchi, Parma, & Cattelani, 1981) or a different strategy of music perception that calls on the left hemispheric function (Mazziotta, Phelps, Carson, & Kuhl, 1982). Such a functional lateralization may be responsible for musicians' better discrimination of musical emotions.

Auditory expertise seems to comprise enhancement and efficiency of subcortical neural responses, connected with the acoustic features important for the communication of emotion (Strait et al., 2009). The capacity to differentiate between one's emotional responses to music may not be limited to music processing (see Kraus & Chandrasekaran, 2010). Research shows that among its many functional advantages (Barrett, Ashley, Strait, & Kraus, 2013), musical expertise enhances, for instance, foreign language acquisition by an ability to more accurately pronounce foreign languages (Milovanov, Pietilä, Tervaniemi, & Esquef, 2010) and to identify expressed emotion in speech prosody (Lima & Castro, 2011). The results of our study are consistent with these findings, indicating the importance of musical expertise for the more detailed structure of the affective responses to music. However, we should keep in mind that music conveys emotions as "perceived qualities of our sensible experience" and such a phenomenon "is not merely a musical phenomenon but a phenomenon of human perceptual experience in general" (Kivy, 2002, p. 33).

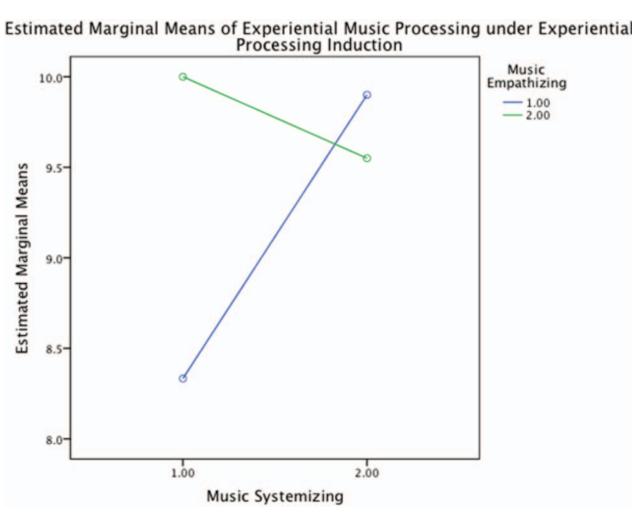

Figure 3. The interaction effect of music systemizing and music empathizing on self-reported experiential music processing under the experiential music focus condition. See the online article for the color version of this figure.

In this study, the effect size of musical expertise on ERM granularity demonstrated in the discrimination task (and measured with the frequency of perceiving the affective experiences of music as "the same") was higher (.21) than the one shown in the free categorization task (.10; Kantor-Martynuska & Bigand, 2013). Although comparing affective responses within a more analytical and systematical methodological frame, musicians showed a higher level of discrimination skills than nonmusicians, as compared with a free categorization task. Although grouping emotional responses to musical samples into pairs on the basis of their similarity, listeners may have more frequently referred to their acoustical resemblance than in a task in which they were asked to give free groupings of emotional responses to the same extracts. This finding suggests a more analytical type of listening in the musical emotion discrimination task, and a more holistic and situated type of listening in a free categorization task (Dibben, 2001). However, the extent to which listeners were emotionally engaged in music listening, and the exact basis of the responses the participants gave in the emotion discrimination task remains hidden in the "black box" (Kivy, 2002) to be opened in further studies on individual differences in the emotional responses to music.

In the process of making judgments about whether one's emotional experiences to two excerpts of music are "the same" or "different," listeners were instructed to refer to the question "how do I feel about it?", as consistent with the affect-as-information model of judgment making (Forgas, 1995). Due to this, an affect infusion model (AIM) assumes that affective information is incorporated in judgmental process, contributing to the judgment outcome (Forgas, 1994). Processing strategy regulates the

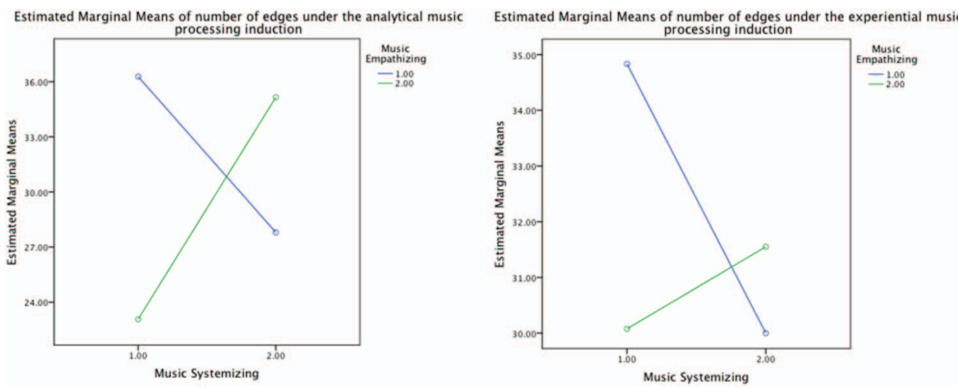

Figure 4. The interaction effect of dichotomized music systemizing and music empathizing on the number of edges across the analytical music focus and experiential music focus conditions in Experiment 3. See the online article for the color version of this figure.

presence and extent of mood effects on social judgment. In this study, as the judgments were not constructive or generative in their nature, we did not expect any affect infusion to occur (see Forgas, 1994). We did not predict the role of a listener's mood for the granularity of the structure of ERM and we did not manipulate it, either. We considered that the type of task comprised a specific goal, which dominated and guided judgments. Such a motivated processing strategy, with highly predetermined information search, should limit the extent to which affect infusion affects a judgment (Forgas, 1994).

To sum up, our studies demonstrate that ERM granularity is based on the exceptionally nuanced perception or experience of the expressive qualities of music comprised in musical expertise, rather than on the listener's fine affective experience of music and their analytical or experiential self-focus. Musical training is associated with a wider range of either the perceived expressive qualities of music, the emotional experience accompanying music processing or both, which may lead to a richer aesthetic pleasure, greater appreciation of music, and a better quality of life.

References

Baron-Cohen, S., Knickmeyer, R. C., & Belmonte, M. K. (2005). Sex differences in the brain: Implications for explaining autism. *Science, 310,* 819–823. http://dx.doi.org/10.1126/science.1115455

Baron-Cohen, S., Richler, J., Bisarya, D., Gurunathan, N., & Wheelwright, S. (2003). The systemizing quotient: An investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences. *Philosophical Transactions of the Royal Society B: Biological Sciences, 358,* 361–374. http://dx.doi.org/10.1098/rstb.2002.1206

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34,* 163–175. http://dx.doi.org/10.1023/B:JADD.0000022607.19833.00

Barrett, K. C., Ashley, R., Strait, D. L., & Kraus, N. (2013). Art and science: How musical training shapes the brain. *Frontiers in Psychology, 4*(713), 1–13. http://dx.doi.org/10.3389/fpsyg.2013.00713

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. http://dx.doi.org/10.1037/0022-3514.87.2.266

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, NY: Guilford Press.

Baryła, W., & Wojciszke, B. (2005). Kwestionariusz ruminacji [Rumination questionnaire]. *Studia Psychologiczne, 43,* 5–22.

Bever, T. G., & Chiarello, R. J. (1974). Cerebral dominance in musicians and nonmusicians. *Science, 185,* 537–539. http://dx.doi.org/10.1126/science.185.4150.537

Bigand, E. (1997). Perceiving musical stability: The effect of tonal structure, rhythm, and musical expertise. *Journal of Experimental Psychology: Human Perception and Performance, 23,* 808–822. http://dx.doi.org/10.1037/0096-1523.23.3.808

Bigand, E., & Parncutt, R. (1999). Perceiving musical tension in long chord sequences. *Psychological Research, 62,* 237–254. http://dx.doi.org/10.1007/s004260050053

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. http://dx.doi.org/10.1016/j.cognition.2005.11.007

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. http://dx.doi.org/10.1080/02699930500204250

Bollobás, B. (1998). *Modern graph theory*. New York, NY: Springer. http://dx.doi.org/10.1007/978-1-4612-0619-4

Brennan, D., & Stevens, C. (2002). Specialist musical training and the octave illusion: Analytical listening and veridical perception by pipe organists. *Acta Psychologica, 109,* 301–314. http://dx.doi.org/10.1016/S0001-6918(01)00063-4

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. Orlando, FL: Harcourt.

Dellacherie, D., Roy, M., Hugueville, L., Peretz, I., & Samson, S. (2011). The effect of musical experience on emotional self-reports and psychophysiological responses to dissonance. *Psychophysiology, 48,* 337–349. http://dx.doi.org/10.1111/j.1469-8986.2010.01075.x

Dibben, N. (2001). What do we hear when we hear music? Music perception and musical material. *Musicae Scientiae, 5,* 161–194.

Diestel, R. (2000). *Graph theory* (2nd ed.). New York, NY: Springer.

Egermann, H., & McAdams, S. (2010, August). 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 eleventh international conference on Music Perception and Cognition*. Seattle, WA. Retrieved from https://www.mendeley.com/profiles/hauke-egermann/publications/conference_proceedings/

Feldman, G. C., Joormann, J., & Johnson, S. L. (2008). Responses to positive affect: A self-report measure of rumination and dampening. *Cognitive Therapy and Research, 32,* 507–525. http://dx.doi.org/10.1007/s10608-006-9083-0

Forgas, J. P. (1994). The role of emotion in social judgments: An introductory review and an affect infusion model (AIM). *European Journal of Social Psychology, 24,* 1–24. http://dx.doi.org/10.1002/ejsp.2420240102

Forgas, J. P. (1995). Mood and judgment: The affect infusion model (AIM). *Psychological Bulletin, 117,* 39–66. http://dx.doi.org/10.1037/0033-2909.117.1.39

Förster, J., Liberman, N., & Kuschel, S. (2008). The effect of global versus local processing styles on assimilation versus contrast in social judgment. *Journal of Personality and Social Psychology, 94,* 579–599. http://dx.doi.org/10.1037/0022-3514.94.4.579

Gabrielsson, A. (2002). Emotion perceived and emotion felt: Same or different? *Musicae Scientiae, 12,* 3–147.

Gardner, R. W. (1953). Cognitive styles in categorizing behavior. *Journal of Personality, 22,* 214–233.

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

Gauthier, I., Skudlarski, P., Gore, J. C., & Anderson, A. W. (2000). Expertise for cars and birds recruits brain areas involved in face recognition. *Nature Neuroscience, 3,* 191–197. http://dx.doi.org/10.1038/72140

Gray, J. A. (1982). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system*. New York, NY: Oxford University Press.

Gray, J. A. (1991). The neuropsychology of temperament. In J. Strelau & A. Angleitner (Eds.), *Explorations in temperament: International perspectives on theory and measurement* (pp. 105–128). New York, NY: Plenum Press. http://dx.doi.org/10.1007/978-1-4899-0643-4_8

Halberstadt, J. B., & Niedenthal, P. M. (1997). Emotional state and the use of stimulus dimensions in judgment. *Journal of Personality and Social Psychology, 72,* 1017–1033. http://dx.doi.org/10.1037/0022-3514.72.5.1017

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology, 47,* 1206–1217. http://dx.doi.org/10.1037/0022-3514.47.6.1206

Johnson, K. E., & Mervis, C. B. (1997). Effects of varying levels of expertise on the basic level of categorization. *Journal of Experimental Psychology: General, 126,* 248–277. http://dx.doi.org/10.1037/0096-3445.126.3.248

Jones, S., Dodd, A., & Gruber, J. (2014). Development and validation of a new multidimensional measure of inspiration: Associations with risk for bipolar disorder. *PLOS One, 9,* e91669. http://dx.doi.org/10.1371/journal.pone.0091669

Juslin, P. N., & Sloboda, J. (2010). *Handbook of music and emotion: Theory, research, applications*. New York, NY: Oxford University Press.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences, 31,* 559–575. http://dx.doi.org/10.1017/S0140525X08005293

Kallinen, K., & Ravaja, N. (2004a). Emotion-related effects of speech rate and rising vs. falling background music melody during audio news: The moderating influence of personality. *Personality and Individual Differences, 37,* 275–288. http://dx.doi.org/10.1016/j.paid.2003.09.002

Kallinen, K., & Ravaja, N. (2004b). The role of personality in emotional responses to music: Verbal, electrocortical, and cardiovascular measures. *Journal of New Music Research, 33,* 399–409. http://dx.doi.org/10.1080/0929821052000343868

Kallinen, K., & Ravaja, N. (2006). Emotion perceived and emotion felt: Same and different. *Musicae Scientiae, 10,* 191–213. http://dx.doi.org/10.1177/102986490601000203

Kallinen, K., Saari, T., Ravaja, N., & Laarni, J. (2005). Mood, music, and involvement: The moderating effects of personality. *Electronic Musicological Review, 9*. Retrived from http://www.rem.ufpr.br/_REM/REMv9-1/kallinen.pdf

Kantor-Martynuska, J., & Bigand, E. (2013). Individual differences in granularity of the affective responses to music. *Polish Psychological Bulletin, 44,* 399–408. http://dx.doi.org/10.2478/ppb-2013-0043

Kaufman, L., & Rousseeuw, P. J. (2005). *Finding groups in data: An introduction to cluster analysis*. New York, NY: Wiley-Interscience.

Kivy, P. (2002). *Introduction to a philosophy of music*. New York, NY: Oxford University Press.

Koelsch, S., Schröger, E., & Tervaniemi, M. (1999). Superior pre-attentive auditory processing in musicians. *NeuroReport, 10,* 1309–1313. http://dx.doi.org/10.1097/00001756-199904260-00029

Kraus, N., & Chandrasekaran, B. (2010). Music training for the development of auditory skills. *Nature Reviews Neuroscience, 11,* 599–605. http://dx.doi.org/10.1038/nrn2882

Kreutz, G., Schubert, E., & Mitchell, L. A. (2008). Cognitive styles of music listening. *Music Perception, 26,* 57–73. http://dx.doi.org/10.1525/mp.2008.26.1.57

Laird, J. D., & Bresler, C. (1992). The process of emotional experience: A self-perception theory. In M. Clark (Ed.), *Emotion: Review of personality and social psychology, No. 13* (pp. 213–234). Thousand Oaks, CA: Sage.

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. http://dx.doi.org/10.2307/3345750

Lima, C. F., & Castro, S. L. (2011). Speaking to the trained ear: Musical expertise enhances the recognition of emotions in speech prosody. *Emotion, 11,* 1021–1031. http://dx.doi.org/10.1037/a0024521

Marin, M. M., & Bhattacharya, J. (2009). Music induced emotions: Some current issues and cross-modal comparisons. In J. Hermida & M. Ferrero (Eds.), *Music education* (pp. 1–38). Hauppauge, NY: Nova Science.

Mazziotta, J. C., Phelps, M. E., Carson, R. E., & Kuhl, D. E. (1982). Tomographic mapping of human cerebral metabolism: Auditory stimulation. *Neurology, 32,* 921–937. http://dx.doi.org/10.1212/WNL.32.9.921

Mazzucchi, A., Parma, M., & Cattelani, R. (1981). Hemispheric dominance in the perception of tonal sequences in relation to sex, musical competence and handedness. *Cortex, 17,* 291–302. http://dx.doi.org/10.1016/S0010-9452(81)80049-4

Milovanov, R., Pietilä, P., Tervaniemi, M., & Esquef, P. A. A. (2010). Foreign language pronunciation skills and musical aptitude: A study of Finnish adults with higher education. *Learning and Individual Differences, 20,* 56–60. http://dx.doi.org/10.1016/j.lindif.2009.11.003

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: A meta-analysis. *Psychological Bulletin, 128,* 638–662. http://dx.doi.org/10.1037/0033-2909.128.4.638

Nettle, D. (2007). Empathizing and systemizing: What are they, and what do they contribute to our understanding of psychological sex differences? *British Journal of Psychology, 98,* 237–255. http://dx.doi.org/10.1348/000712606X117612

Niedenthal, P. M., & Dalle, N. (2001). Le mariage de mon meilleur ami: Emotional response categorization and naturally-induced emotions. *European Journal of Social Psychology, 31,* 737–742. http://dx.doi.org/10.1002/ejsp.66

Nolen-Hoeksema, S., & Jackson, B. (2001). Mediators of the gender difference in rumination. *Psychology of Women Quarterly, 25,* 37–47. http://dx.doi.org/10.1111/1471-6402.00005

Nolen-Hoeksema, S., Morrow, J., & Fredrickson, B. L. (1993). Response styles and the duration of episodes of depressed mood. *Journal of Abnormal Psychology, 102,* 20–28. http://dx.doi.org/10.1037/0021-843X.102.1.20

Ohnishi, T., Matsuda, H., Asada, T., Aruga, M., Hirakata, M., Nishikawa, M., . . . Imabayashi, E. (2001). Functional anatomy of musical perception in musicians. *Cerebral Cortex, 11,* 754–760. http://dx.doi.org/10.1093/cercor/11.8.754

Panksepp, J. (2005). Affective consciousness: Core emotional feelings in animals and humans. *Consciousness and Cognition, 14,* 30–80. http://dx.doi.org/10.1016/j.concog.2004.10.004

Pettigrew, T. F. (1958). The measurement of category width as cognitive variable. *Journal of Personality, 26,* 532–544.

Pickering, A. D., & Gray, J. A. (1999). The neuroscience of personality. In L. A. Pervin & O. P. John (Eds.), *Handbook of personality: Theory and research* (2nd ed., pp. 277–299). New York, NY: Guilford Press.

R Core Team. (2014). *R: A language and environment for statistical computing* [Computer software]. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.R-project.org/

Rawlings, D., & Leow, S. H. (2008). Investigating the role of psychoticism and sensation seeking in predicting the emotional reactions to music. *Psychology of Music, 36,* 267–287. http://dx.doi.org/10.1177/0305735607086042

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. http://dx.doi.org/10.1525/mp.2004.22.1.145

Roger, D., & Najarian, B. (1989). The construction and validation of a new scale for measuring emotional control. *Personality and Individual Differences, 10,* 845–853. http://dx.doi.org/10.1016/0191-8869(89)90020-2

Rosch, E. H. (1978). Principles of categorization. In E. H. Rosch & B. B. Lloyd (Eds.), *Cognition and categorization* (pp. 27–48). Hillsdale, NJ: Erlbaum.

Schank, R., Collins, G., & Hunter, L. (1986). Transcending inductive category formation in learning. *Behavioral and Brain Sciences, 9,* 639–650. http://dx.doi.org/10.1017/S0140525X00051578

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. http://dx.doi.org/10.1080/0929821042000317822

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). New York, NY: Oxford University Press.

Schvaneveldt, R. W., Durso, F. T., & Dearholt, D. W. (1989). Network structures in proximity data. *Psychology of Learning and Motivation, 24,* 249–284. http://dx.doi.org/10.1016/S0079-7421(08)60539-3

Schwarz, N., & Clore, G. L. (2003). Mood as information: 20 years later. *Psychological Inquiry, 14,* 296–303. http://dx.doi.org/10.1080/1047840X.2003.9682896

Sloboda, J. A. (2005). *Exploring the musical mind. Cognition, Emotion, Ability, Function*. Oxford, United Kingdom: Oxford University Press.

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. http://dx.doi.org/10.1196/annals.1360.055

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. http://dx.doi.org/10.1162/jocn.2006.18.8.1380

Strait, D. L., Kraus, N., Skoe, E., & Ashley, R. (2009). Musical experience and neural efficiency: Effects of training on subcortical processing of vocal expressions of emotion. *The European Journal of Neuroscience, 29,* 661–668. http://dx.doi.org/10.1111/j.1460-9568.2009.06617.x

Strelau, J. (2008). *Temperament as a regulator of behavior: After fifty years of research*. Clinton Corners, NY: Eliot Werner Publications.

Tanaka, J. W., Curran, T., & Sheinberg, D. L. (2005). The training and transfer of real-world perceptual expertise. *Psychological Science, 16,* 145–151. http://dx.doi.org/10.1111/j.0956-7976.2005.00795.x

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. http://dx.doi.org/10.1177/0305735610370223

Tervaniemi, M., Just, V., Koelsch, S., Widmann, A., & Schröger, E. (2005). Pitch discrimination accuracy in musicians vs nonmusicians: An event-related potential and behavioral study. *Experimental Brain Research, 161,* 1–10. http://dx.doi.org/10.1007/s00221-004-2044-5

Thrash, T. M., Maruskin, L. A., Cassidy, S. E., Fryer, J. W., & Ryan, R. M. (2010). Mediating between the muse and the masses: Inspiration and the actualization of creative ideas. *Journal of Personality and Social Psychology, 98,* 469–487. http://dx.doi.org/10.1037/a0017907

Tillmann, B., & Bigand, E. (1998). Influence of global structure on musical target detection and recognition. *International Journal of Psychology, 33,* 107–122. http://dx.doi.org/10.1080/002075998400493

Västfjäll, D. (2002). Emotion induction through music: A review of the musical mood induction procedure. *Musicae Scientiae, 6,* 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-Short) and the Systemizing Quotient (SQ-Short). *Personality and Individual Differences, 41,* 929–940. http://dx.doi.org/10.1016/j.paid.2006.03.017

Watkins, E. (2004). Appraisals and strategies associated with rumination and worry. *Personality and Individual Differences, 37,* 679–694. http://dx.doi.org/10.1016/j.paid.2003.10.002

Watkins, E., & Teasdale, J. D. (2004). Adaptive and maladaptive self-focus in depression. *Journal of Affective Disorders, 82,* 1–8. http://dx.doi.org/10.1016/j.jad.2003.10.006

Wegner, D. M., & Giuliano, T. (1980). Arousal-induced attention to self. *Journal of Personality and Social Psychology, 38,* 719–726. http://dx.doi.org/10.1037/0022-3514.38.5.719

Werner, P. D., Swope, A. J., & Heide, F. J. (2006). The Music Experience Questionnaire: Development and correlates. *The Journal of Psychology: Interdisciplinary and Applied, 140,* 329–345. http://dx.doi.org/10.3200/JRLP.140.4.329-345

Wolfram Research, Inc. (2010). Mathematica (Version 8.0) [Computer software]. Champaign, IL: Author.

Wytykowska, A. (2012). The type of temperament, mood, and strategies of categorization. *Journal of Individual Differences, 33,* 227–236. http://dx.doi.org/10.1027/1614-0001/a000073

Appendix A

Experimental Material—Study 2

1. Bach, J. S. (1730–1740). Sonata No. 1 BWV 1027 in G major, Part 2 *Adagio ma non tanto* [Recorded by J. Savall & T. Koopman]. On *The sonatas for viola da gamba* [CD]. EMI Records: Virgin Classics (1978/1989).

2. Anonyme (Afghanistan). Nastaran (Naghma instr.) [Recorded by J. Savall, A. Savall, F. Savall, & P, Estevan]. On *Du temps et de l'instant* [CD]. Sonystrasse, Austria: Alia Vox by Sony DADC Austria AG (2005).

3. Tab Two (1996). Vorfilm. On *Belle affaire* [CD]. Virgin.

4. Garbarek, J. (1996). Pygmy Lullaby [Recorded by J. Garbarek, R. Brüninghaus, E. Weber, M. Mazur, & M. Katché]. On *Visible world* [CD]. ECM Production.

5. Reich, S. (1976). Section 1 [Recorded by S. Reich & Musicians]. On *Music for 18 Musicians* [CD]. New York, NY: Nonesuch Records, a Warner Music Group Company (1997).

Appendix B

Experimental Material: Manipulation Check—Study 2

Shostakovich, D. (1917). Violin concerto no. One in a-minor, Op. 99 [Recoreded by V. Mullova, Royal Philharmonic Orchestra under A. Previn]. On *Shostakovich – Prokofiev – Violin Concertos* [CD]. London, United Kingdom: Philips: Digital Classics. (1988)

part: Scherzo (Allegro), 00:00-00:30.
part: Passacaglia (Andante), 00:00-00:30.

Cesar Camargo Mariano/arr. J. Calandrelli (2003). Cristal [Recorded by Y.-Y. Ma & C. C. Mariano]. On *Obrigado Brazil-Yo-Yo Ma* [CD]. Sony Music Entertainment Inc. Sony Classical (2003).

Heitor Villa-Lobos/arr. S. Assad (2003). A lenda do caboclo [Recoreded by Y.-Y. Ma & Ségio & Odair Assad]. On *Obrigado Brazil - Yo-Yo Ma* [CD]. Sony Music Entertainment Inc. Sony Classical (2003).

Received March 22, 2014
Revision received February 5, 2015
Accepted February 11, 2015 ■