AN ANALYSIS OF AGREEMENT IN CLASSICAL MUSIC PERCEPTION AND ITS RELATIONSHIP TO LISTENER CHARACTERISTICS

Markus Schedl, Hamid Eghbal-Zadeh
Johannes Kepler University
Linz, Austria
`firstname.lastname@jku.at`

Emilia Gómez
Universitat Pompeu Fabra
Barcelona, Spain
`emilia.gomez@upf.edu`

Marko Tkalčič
Free University of Bozen–Bolzano
Italy
`marko.tkalcic@unibz.it`

ABSTRACT

We present a study, carried out on 241 participants, which investigates on classical music material the agreement of listeners on perceptual music aspects (related to emotion, tempo, complexity, and instrumentation) and the relationship between listener characteristics and these aspects. For the currently popular task of music emotion recognition, the former question is particularly important when defining a ground truth of emotions perceived in a given music collection. We characterize listeners via a range of factors, including demographics, musical inclination, experience, and education, and personality traits. Participants rate the music material under investigation, i.e., 15 expert-defined segments of Beethoven's 3rd symphony, "Eroica", in terms of 10 emotions, perceived tempo, complexity, and number of instrument groups. Our study indicates only slight agreement on most perceptual aspects, but significant correlations between several listener characteristics and perceptual qualities.

1. INTRODUCTION

Music has always been closely related to human emotion. It can express emotions and humans can perceive and experience emotions when listening to music, e.g., [10, 22, 29]. In a uses and gratification analysis of why people listen to music [20], Lonsdale and North even identify emotion regulation as the main reason why people actively listen to music.

However, little is known about the influence of individual listener characteristics on music perception (emotion and other aspects) and whether listeners agree on such aspects at all. The aim of this paper is therefore to gain a better understanding of the *agreement on perceptual music aspects* and the *relationship between perceptual music aspects and personal characteristics*. To approach these two questions, we present and analyze results of a web-based user study involving 241 participants. We characterize lis-

teners by demographics, music knowledge and experience, and personality. For our study, we focus on classical music, the repertoire under investigation being Beethoven's 3rd symphony, "Eroica". Responses of the listeners to the music are recorded via ratings of perceived emotions, tempo, complexity, and instrumentation.

In Section 2, we position our contribution within existing literature. Details on data acquisition and setup of the user study are provided in Section 3. Subsequently, we present and discuss the findings of our analysis on the agreement on perceptual aspects (Section 4) and on the relationship between these aspects and listener characteristics (Section 5). We round off by concluding remarks and a brief outlook to future research directions in Section 6.

2. RELATED WORK

This work connects to other investigations of music perception, to studies on personality in music, and to music emotion recognition.

Previous analyses on *music perception* have suggested that certain musical parameters especially influence the content of emotional responses, notably timbre, orchestration, acoustics, rhythm, melody, harmony, and structure [14]. For instance, Laurier created mappings between musical descriptors and emotion categories [19], but these emotion categories are limited to the five emotions happiness, sadness, anger, fear, and tenderness [3]. Rentfrow et al. identified five genre-free latent factors that reflect the affective response of listeners to music [25]. They named them "mellow", "urban", "sophisticated", "intense", and "campestral" music preference factors, yielding the acronym *MUSIC*. Not much research has been devoted to how listeners of different demographic, personality, and musical background experience different perceptual aspects of the same music. While there do exist several cross-cultural studies on music and perceived emotion [1, 8, 12, 15, 28], these studies tend to focus on greatly different cultures, rather than on more subtle differences such as age, gender, and musical experience or exposure.

Personality has been related to music preferences in a number of studies. Rentfrow and Gosling showed that personality traits are related to four preference dimensions: reflective and complex, intense and rebellious, upbeat and conventional, and energetic and rhythmic [26]. Furthermore, they found that personality-based stereotypes are

strongly correlated with music genre preferences [24]. Perhaps the most commonly used model of personality is the five factor model (FFM), which is composed of the factors openness, conscientiousness, extraversion, agreeableness, and neuroticism [21]. Employing this model in their study, Chamorro-Premuzic and Furnham found that people who score high on openness tend to consume music in a more rational way, while people who score high on neuroticism and those who score low on extraversion and conscientiousness tend to consume music to regulate their emotions [2]. Similarly, Ferwerda et al. showed that personality accounts for individual differences in mood regulation [6]. Personality has also been linked to how users tend to perceive and organize music [7].

Our work also connects to *music emotion recognition* (MER) at large, which has lately become a hot research topic [4, 11, 13, 18, 27, 30, 32]. It aims at automatically learning relationships between music audio or web features and emotion terms. However, common MER approaches assume that such a relationship exists, irrespective of a particular listener. In the study at hand, we take one step back and approach the question of whether listeners at all agree on certain emotions and other perceptive aspects when listening to classical music.

3. MATERIALS AND USER STUDY

3.1 Music Material

In our study, we focused on classical music and selected one particular piece, namely *Beethoven's 3rd symphony, "Eroica"*, from which we extracted 15 coherent excerpts [31]. This symphony is a well-known piece, also to many who are not much into classical music. We had to make this restriction to one piece to compare results between participants and keep them engaged throughout the questionnaire. Furthermore, this symphony was selected because of its focus in the PHENICX project, [1] the work at hand emerged from. Beethoven's "Eroica" is generally agreed on as a key composition of the symphonic repertoire, constituting a paradigm of formal complexity, as evidenced by the vast literature analyzing the symphony. We considered a performance by the Royal Concertgebouw Orchestra, Amsterdam. The 15 excerpts we used in the study were carefully selected by the authors, some of which are trained in music theory and performance, then reviewed by a musicologist. To this end, every section was first labeled with one of the nine emotions according to the Geneva Emotional Music Scale (GEMS) [33], judged based on musical elements. Then, the six emotions that appeared most frequently among the labels were identified. Three excerpts each for peacefulness, power, and tension, and two excerpts each for transcendence, joyful activation, and sadness, were finally selected. In this final selection step, we ensured that the segments covered a variety of musical characteristics, lasted the duration of a complete musical phrase, and strongly represented one of the above six emotions.

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[1] http://phenicx.upf.edu

For the sake of reproducibility, interested readers can download the excerpts from http://mtg.upf.edu/download/datasets/phenicx-emotion.

3.2 Study Design

The study was conducted as online survey, accessible via a web interface. Participants were recruited by mass mail to all students of the Johannes Kepler University Linz and by posting to several research mailing lists. Announcements were also made on various social media platforms the authors are active on. In the survey, we first asked participants a range of questions, related to demographics, music education and experience, inclination to music and to classical music in particular, and familiarity with Beethoven's "Eroica". Subsequently, participants had to fill in a personality questionnaire, i.e., the standardized Ten Item Personality Instrument (TIPI) [9]. After having provided this personal information, we asked participants to listen to each of the 15 excerpts and provide ratings of perceptual qualities (emotions, tempo, complexity, and instrumentation). We ensured that participants actually listened to the excerpts by measuring the time they played each piece in the web browser. To describe emotions, we used the six emotions of the GEMS model most dominant in the music material (see above) and added five basic human emotions identified in psychological literature [5,23]: transcendence, peacefulness, power, joyful activation, tension, sadness; anger, disgust, fear, surprise, tenderness. We added these additional emotions to complement the GEMS model with basic emotions not specifically targeted at music perception. The options available to participants for each answer, as well as their numeric coding for the following analysis, are provided in Table 1. Note that we are interested in *perceived* music qualities. Therefore, the questions were formulated according to the scheme "I perceive the music as ...".

3.3 Statistics of Participants

The survey was completed by 241 participants, taking them around 40 minutes on average. We had 123 male and 118 female participants. The vast majority of 217 participants were Austrians; other participants were Germans, Italians, Russians, Englishmen, and Spaniards. A limitation of the study is that participation was biased towards younger people, the median age of participants being 25 years. This can be explained by the large number of students among participants. However, the youngest participants were only 16, while the eldest one was 67. As for participants' music taste and listening frequency, on average subjects listen to classical music 2.6 hours per week, and to other genres 11 hours per week. Interestingly, the median for listening to classical music (1 hour per week) is much lower than the median of listening to other genres (8 hours per week). It thus seems that participants either love classical music and devote a lot of time to it, or do not listen to it at all. Less than half of the participants play an instrument (median of 0 hours per week), but most had some form of musical education, on average 6.8

Aspect	Options	Numeric encoding
Age	free form	years
Gender	male or female	—
Country	list selection from 193 countries	—
Listening classical	free form	hours per week
Listening non-classical	free form	hours per week
Playing instrument	free form	hours per week
Musical education	free form	years
Concerts classical	free form	attendances per year
Concerts non-classical	free form	attendances per year
Familiar with "Eroica"	unfamiliar, somewhat familiar, very familiar	0–2
All personality traits	strongly disagree–strongly agree	1–7
All emotions	strongly disagree, disagree, neither agree nor disagree, agree, strongly agree, don't know	0–4, -1
Perceived tempo	slow, fast, don't know	0, 1, -1
Perceived complexity	very low–very high, don't know	0–4, -1
Kinds of instruments	1, 2, 3, 4, more, don't know	1, 2, 3, 4, 5, -1
Description of the excerpt	free form	—

Table 1. Options available to participants and numerical encoding of the answers using for analysis.

Aspect	μ	σ	med	min	max
Age	27.35	8.47	25	16	67
Listening classical (hrs/week)	2.56	5.20	1	0	40
Listening non-classical	11.16	11.86	8	0	70
Playing instrument	1.93	4.23	0	0	40
Musical education	6.77	6.39	5	0	33
Concerts classical	2.43	5.28	1	0	40
Concerts non-classical	3.93	6.70	2	0	70
Familiar with "Eroica"	0.83	0.64	1	0	2

Table 2. Basic statistics of the participants. μ = mean, σ = standard deviation, med = median

Personality trait	μ	σ	med	min	max
Extraverted	4.27	1.88	5	1	7
Critical	4.54	1.68	5	1	7
Dependable	5.27	1.43	6	1	7
Anxious	3.17	1.64	3	1	7
Open to new experiences	5.59	1.27	6	2	7
Reserved	4.41	1.81	5	1	7
Sympathetic	5.39	1.32	6	1	7
Disorganized	2.83	1.69	2	1	7
Calm	5.01	1.56	6	1	7
Conventional	2.84	1.63	2	1	7

Table 3. Personality statistics of participants. μ = mean, σ = standard deviation, med = median

years. Participants attend on average 2 classical and 4 non-classical concerts per year, but the median values are again smaller (1 and 2 concerts, respectively). Many participants do not attend concerts at all: 39% do not attend a single classical concert, 22% do not attend a single concert of another genre per year. Most participants were not (72 or 30%) or somewhat (137 or 57%) familiar with Beethoven's "Eroica". Only 32 (14%) indicated to be very familiar with the piece. Analyzing the personality traits, shown in Table 3, we observe that subjects tend to regard themselves as open to new experiences, sympathetic, calm, but also dependable (average and median ratings are at least "agree a little"). On the other hand, they negate being disorganized, conventional, and anxious (average and median ratings are at most "disagree a little").

4. LISTENER AGREEMENT

We compute the agreement on all perceptive aspects under investigation. To this end, we use *Krippendorff's α* score for inter-rater agreement [16], computed on the ratings given by participants for each segment separately and

subsequently averaged. We excluded from the calculations "don't know" answers, i.e., treated them as missing values.

Table 4 shows the overall mean ratings, standard deviations, and agreement scores among participants for each investigated aspect, macro-averaged over all segments. We observe that participants give highest average ratings (column μ in Table 4) to the aspects of power and tension, followed by transcendence and joyful activation. Lowest ratings are given to fear, sadness, anger, and — much below — disgust. Overall, it seems that the aspects ranging in the lower arousal range (sadness, peacefulness, etc.) are perceived to a smaller degree in the music material under consideration. Tempo is, on average, neither perceived as particularly low nor high. So is complexity. As for instrumentation, overall, most participants could distinguish 4 kinds of instruments.

As for agreement, the study evidences a low to moderate agreement for most aspects, according to Krippendorff's α. Participants do not (0.00–0.20) or at most slightly (0.21–0.40) agree on most perceptual aspects.

Aspect	Scale	μ	σ	α
Transcendence	0–4	2.215	1.095	0.010
Peacefulness	0–4	1.812	0.986	**0.450**
Power	0–4	2.477	0.937	**0.450**
Joyful activation	0–4	2.048	1.059	*0.320*
Tension	0–4	2.318	1.121	*0.222*
Sadness	0–4	1.233	0.979	*0.298*
Anger	0–4	1.204	1.008	*0.300*
Disgust	0–4	0.808	0.941	0.128
Fear	0–4	1.292	1.084	*0.276*
Surprise	0–4	1.790	1.162	0.054
Tenderness	0–4	1.687	1.046	*0.366*
Tempo	0–1	0.460	0.337	**0.513**
Complexity	0–4	2.240	0.864	0.116
Instrument kinds	1–5	3.899	0.980	0.077

Table 4. Mean μ, standard deviation σ, and agreement score (Krippendorff's α) for investigated aspects of music perception. Italic font is used to indicate slight agreement. Bold face is used to denote moderate agreement.

The values indicating moderate agreement (0.41–0.60) according to [17] are printed in bold in Table 4, whereas slight agreement is indicated by italics. Highest agreement among the emotion aspects is found for peacefulness and power, while tempo shows the highest agreement among all investigated aspects. Slight agreement can be observed for joyful activation, tension, sadness, anger, fear, and tenderness. No relevant agreement is observed for transcendence, disgust, surprise, as well as perceived complexity and number of instrument groups. Perceived complexity is presumably a highly subjective aspect. Furthermore, it seems that there is a discrepancy between listeners with regard to their ability to distinguish different instrumentations, which is presumably due to different music knowledge and expertise levels.

5. LISTENER CHARACTERISTICS AND PERCEPTUAL ASPECTS

We investigate whether there exists a significant relationship between listener characteristics and the perceptual aspects under investigation. To this end, we calculate Pearson's correlation coefficient between the respective numerically encoded factors, according to Table 1, treating each user–segment pair as one observation. Table 5 shows the correlation values for all listener characteristics (rows) and perceptual aspects (columns). While most correlations are not very pronounced, several are significant (at $p < 0.05$), where p values are the probability of observing by chance a correlation as large as the observed one, when the true correlation is 0.

Reviewing the results, a remarkable observation is the significant correlations between factors of musical background and knowledge (listening to classical music, playing an instrument, musical education, concert attendances, familiarity with the piece) and perceived number of instrument groups. Participants with a stronger musical back-

ground therefore seem to be able to distinguish more instruments. While participants scoring high on conventionalism show negative correlation with the perceived number of instrument groups, the opposite it true for people who are open to new experiences. As for participants' age, older people tend to perceive the music as more joyful and less fearsome. Frequent listeners of classical music tend to perceive the piece as more powerful, transcendent, and tender, but less fearsome. On the other hand, listeners of other genres perceive more anger and surprise. Playing an instrument, extensive musical education, and frequent classical concert attendances show a positive correlation with perceived power and tension, while attending non-classical concerts seem to have no influence on emotion perception. Participants who are familiar with the "Eroica" overall tend to perceive it as more transcendent, powerful, joyful, and tender.

Among the personality traits, most show little correlation with the perceptual aspects. However, openness to new experiences is significantly correlated with the emotion categories transcendence, peacefulness, joyful activation, and tenderness, as well as tempo and instrumentation. Disorganized people tend to rate the piece higher on sadness, anger, disgust, but also on tenderness. Sympathetic subjects on average give higher ratings to aspects of peacefulness, tenderness, tempo, and number of instrument groups. Calm participants perceive the music as more peaceful, joyful, and tender than others, while conventionalists perceive it as less transcendent and tense.

6. CONCLUSIONS AND FUTURE DIRECTIONS

In the presented study, we addressed two research questions. First, we investigated whether listeners agree on a range of perceptual aspects (emotions, tempo, complexity, and instrumentation) in classical music material, represented by excerpts from Beethoven's 3rd symphony, "Eroica". Only for the perceived emotions peacefulness and power as well as for the perceived tempo, moderate agreement was found. On other aspects, participants agreed only slightly or not at all. The second question we approached in the study is the relationship between listener characteristics (demographics, musical background, and personality traits) and ratings given to the perceptual aspects. Among others, we found significant correlations between musical knowledge and perceived number of instrument groups, which might not be too surprising. We further identified slight, but significant positive correlations between aspects of musical inclination or knowledge and perceived power and tension. Several correlations were also found for the personality traits open to new experiences, sympathetic, disorganized, calm, and conventional.

As part of future work, we plan to assess to which extent the investigated perceptual aspects can be related to music audio descriptors. We would further like to analyze the impact of listener characteristics on the agreement scores of perceptual aspects. Furthermore, a cross-correlation analysis between ratings of the perceived qualities could reveal which emotions (or other investigated aspects) are

	Trans.	Peace.	Power	Joyful.	Tension	Sadness	Anger	Disgust	Fear	Surprise	Tender	Tempo	Compl.	Instr.
Age	**0.155**	0.040	0.102	**0.261**	0.075	-0.081	-0.110	-0.002	**-0.186**	-0.015	0.104	-0.031	-0.019	-0.026
Listening classical	**0.203**	0.112	**0.212**	0.078	0.019	-0.082	-0.090	-0.105	**-0.190**	-0.029	**0.148**	0.028	0.123	**0.192**
Listening non-classical	0.085	0.092	0.121	0.007	0.033	0.028	**0.139**	0.042	0.078	**0.149**	0.054	0.122	0.064	-0.036
Playing instrument	0.085	-0.016	**0.133**	0.010	**0.190**	0.077	0.113	0.073	0.050	0.042	0.014	0.061	0.012	**0.259**
Musical education	**0.140**	-0.073	**0.143**	0.007	**0.170**	0.029	0.101	0.085	0.008	-0.064	0.007	0.077	0.076	**0.418**
Concerts classical	**0.170**	0.065	**0.175**	0.108	**0.192**	-0.015	-0.033	-0.028	-0.065	-0.046	0.076	0.017	0.086	**0.243**
Concerts non-classical	0.114	-0.004	0.048	-0.008	0.099	0.080	0.079	0.061	0.091	0.069	-0.003	0.106	0.045	**0.153**
Familiar with "Eroica"	**0.141**	0.118	**0.211**	**0.184**	0.116	-0.045	0.057	0.026	-0.018	0.004	**0.149**	0.056	0.096	**0.242**
Extraverted	0.045	0.024	0.120	0.065	0.022	0.031	-0.014	-0.027	0.007	0.041	**0.166**	0.112	0.059	0.066
Critical	0.010	0.031	0.094	0.081	0.049	0.037	-0.035	-0.041	-0.011	**-0.141**	0.043	0.066	0.075	0.049
Dependable	0.054	-0.098	-0.074	-0.098	0.009	-0.049	-0.065	-0.035	0.011	-0.018	0.007	-0.023	-0.075	0.033
Anxious	-0.084	-0.054	-0.108	-0.114	-0.108	-0.003	0.017	0.064	0.055	0.023	-0.089	-0.072	-0.054	-0.087
Open to new exp.	**0.159**	**0.139**	0.108	**0.181**	0.054	0.053	0.010	0.005	-0.003	0.009	**0.222**	**0.173**	0.006	**0.201**
Reserved	-0.049	0.033	-0.112	-0.057	-0.095	-0.038	-0.033	-0.014	-0.045	-0.042	-0.084	-0.026	-0.054	-0.061
Sympathetic	0.077	**0.147**	0.098	0.107	0.059	-0.031	-0.012	0.020	0.026	0.078	**0.166**	**0.148**	0.015	**0.134**
Disorganized	0.076	0.120	0.032	0.083	0.114	**0.167**	**0.157**	**0.146**	0.116	0.111	**0.129**	**0.130**	-0.014	-0.069
Calm	0.076	**0.142**	-0.002	**0.153**	-0.032	-0.023	-0.044	-0.060	0.031	-0.063	**0.132**	0.069	**0.153**	**0.135**
Conventional	**-0.145**	0.099	-0.048	0.012	**-0.135**	0.050	0.087	0.070	0.102	0.008	-0.058	-0.040	-0.002	**-0.129**

Table 5. Correlation between demographics, music expertise, and personality traits on the one hand, and aspects of music perception on the other. Significant results ($p < 0.05$) are depicted in bold face.

frequently perceived together. Finally, we would like to perform a larger study, involving on the one hand a larger genre repertoire and on the other an audience more diverse in terms of cultural background.

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