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Factors Influencing Discrimination of Emotional Expression Conveyed Through Music Performance

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ABSTRACT

Previous research has shown that levels of musical training and emotional engagement with music are associated with an individual's ability to decode the intended emotional expression from a music performance (Akkermans & Schapiro, 2016). The present study aims to go further and investigate the contribution of auditory perceptual abilities to decoding performance as measured by a new effective emotion discrimination task (EDT). The first experiment investigated features that influenced the difficulty of the stimulus items (length, melody, instrument, target-/comparison emotion) in order to produce a short calibrated version of the EDT and ensure an optimal level of difficulty. The second experiment then assessed the contribution of individual differences measures of emotional intelligence as well as pitch and duration discrimination abilities. Findings displayed performance on the EDT was correlated with level of emotional intelligence. This research therefore contributes to the understanding of the origins of individual differences in musical emotional abilities.

I. INTRODUCTION

The emotional experience associated with music is widely acknowledged to be one of the main reasons why so many people regularly engage in musical activities (Juslin & Laukka, 2004). Music is often used in a constructive manner, to express emotion through composition and performance, or to evoke or regulate an emotional state through listening; this has proven to be extremely beneficial in the field of therapy and has also been influential in other areas such as film and marketing (Juslin & Sloboda, 2011). Due to the vast range of practical applications, the amount of research contributing to an understanding of emotional processes in relation to music has increased considerably over the last few decades, most of which has focused especially on the expression and induction of musical emotions (Thompson, 2009). Despite this, questions still remain as to how individual differences in emotional, musical and perceptual skills may affect the ability to perceive emotion in music (Taruffi, Allen, Downing & Heaton, 2017).

It been suggested that the perception of musical emotions may vary between individuals, just as recognition of facial and vocal expressions has been found to vary according to individual differences (Taruffi et al., 2017; Palermo, O'Connor, Davis, Irons & McKone, 2013). The current study therefore aims to investigate whether differences in emotional, musical and perceptual abilities may account for variation in perceived musical emotion.

One potential factor that may influence emotion recognition is emotional intelligence (EI): the ability to categorize, express and regulate one's emotions, as well as those of others (Salovey & Mayer, 1990). EI is typically separated into two constructs for the purpose of measurement; ability EI, measured using cognitive ability tests, and trait EI, assessed via self-report methods (Petrides, Frederickson & Furnham, 2004). In keeping with a recent study of emotion decoding in music (Akkermans & Schapiro, 2016), a self-report measure of trait EI was used within the current research. Differences in recognition of emotion within speech prosody have previously been linked to EI (Trimmer & Cuddy, 2008), suggesting its potential importance in terms of musical emotion decoding ability. Furthermore, Resnicow, Salovey and Repp (2004) found a positive correlation between EI and a test of emotion recognition, in which participants' rated basic emotions conveyed through piano pieces. This evidence therefore indicates that differences in EI may explain variation in music-perceived emotion.

Another element of emotional ability that should be taken into account is emotional contagion (EC), which refers to ones' tendency to be influenced by, or unconsciously mimic, others' emotional states (Doherty, 1997). EC has mostly been investigated in relation to facial expressions (Juslin & Västfjäll, 2008), though contagion from vocal expression has also been found to occur (Neumann & Strack, 2000). On the basis of such evidence, as well as the aforementioned notion that music's emotional quality may be derived from its similarities to vocal expression (Juslin & Laukka, 2003), it has been speculated that EC may occur in music listening through the internal mimicking of a perceived expression (Juslin, Liljeström, Västfjäll, & Lundquist, 2009). This is backed up by neuroimaging research conducted by Koelsch, Fritz, Müller & Friederici (2006); activation was found within mirror-neuron systems believed to be involved in vocal production when participants listened to music. It is thought that this could suggest the mimicking of emotions expressed by music (Juslin & Västfjäll, 2008). This implies that EC may play a role in the ability to categorize emotions in music.

Though a high level of emotional ability is likely to result in a consistent level of emotion processing throughout different modalities, it is arguable that emotional ability may vary specifically in relation to music. Therefore, it is necessary to consider an individuals' typical level of emotional engagement with music, alongside more general measures of emotional ability, when investigating factors influencing emotion recognition. Emotional engagement with music can be measured using the Goldsmiths Musical Sophistication Index (GOLD-MSI) (Müllensiefen, Gingras, Musil, & Stewart, 2013), a self-report tool that allows for the assessment of a wide range of musical skills and behaviours.

This subscale was used in a recent study, which found that level of emotional engagement with music predicted level of accuracy when decoding emotions in music (Akkermans & Schapiro, 2016). Level of emotional engagement with music, as measured using the emotions subscale of the GOLD-MSI, may therefore influence recognition of a conveyed expression in music.

Musical ability has also been explored in relation to emotional ability. The idea that musical expertise may enhance emotional skills seems plausible, when taking into account other cognitive advantages found to result from training (Schellenberg, 2005). In accordance with this, it has been suggested that enhanced musical and acoustic processing, acquired through musical training (Kraus & Chandrasekaran, 2010), may lead to superior performance in emotion recognition tasks (Taruffi et al., 2017). Research has provided supportive evidence for this claim; accurate categorisation of musical emotions was found to be associated with the amount of musical training an individual had received (Lima & Castro, 2011). On the other hand, some studies have demonstrated little difference between the emotion decoding abilities of musicians and non-musicians (Trimmer & Cuddy, 2008). Therefore, further investigation is required to establish whether a relationship exists between musical training and recognition of emotion in music (Taruffi et al., 2017).

If we are to assume that superior emotion recognition ability may result from enhanced perceptual processing, it follows that fundamental differences in auditory perception may also influence recognition ability. The pitch and duration of musical events are important cues for interpreting emotional expression in speech and music (Juslin & Laukka, 2003; Lima et al., 2016), meaning that differences in perceptual sensitivity may be predictive of differences in emotion perceived in music.

The current research is based upon a recent replication (Akkermans & Schapiro, 2016) of a study carried out by Gabrielsson and Juslin (1996). The original study investigated expressive cues involved in communication of emotion in music. A production-recognition paradigm was used to accomplish this; firstly, a flutist, violinist and vocalist were recorded performing three melodies in order to convey a certain emotional expression (happy, sad, angry, fearful, tender solemn or without expression). These performances were analysed in terms of musical characteristics that contributed towards the overall expression. Listening experiments were then carried out in which participants were asked to identify the emotions expressed within each performance. Results indicated that expressive intentions were usually identified correctly, and a higher decoding accuracy was displayed for basic emotions, in accordance with Juslin's (1995) hypothesis that basic emotions would be easiest to communicate. In the replication study, emotional and musical skills were assessed in regard to their influence on decoding accuracy (Akkermans & Schapiro, 2016); accuracy was found to be associated with participants' level of musical training and emotional engagement.

The present investigation aimed to further explore what might make one individual better at decoding emotions conveyed through music than another. Thus, the main objectives for the current study were: firstly, to develop a short and effective Emotion Discrimination Task (EDT), which tests an individuals' ability to perceive emotions in music using a simple response format. Secondly, to further examine individual differences in EI, EC, musical training and emotional engagement, in relation to their influence on perceived emotion in music, and finally, to extend previous research by investigating the contribution of low-level auditory ability to emotion decoding performance. In pursuit of achieving these aims, two experiments were carried out. Experiment 1 consisted of a preliminary EDT, in which two excerpts of the same melody were presented that differed only in terms of emotional expression. Excerpts differed between trials in terms of features such as: length, instrument, melody, target emotion and comparison emotion. The effect of these features on the item difficulty was assessed, not only to gain a better understanding of the cognitive processes underlying task performance but also to optimally calibrate overall test difficulty and thus being able to form a shorter test of emotion discrimination. The refined EDT was formed of excerpts that were shortest in length, and featured only one of the two melodies from the preliminary task. This task was then utilized within experiment 2, along with measures of individual differences and perceptual ability.

II. EXPERIMENT 1

METHOD

A. Participants

33 participants were recruited through advertisement on social network platforms and the Goldsmith's research participation scheme. Participants ranged from 18-80 years of age, (M = 37.06, SD = 22.65), and included 21 females, 10 males and 2 individuals who preferred to withhold gender information. The current study was granted ethical approval by Goldsmith's Research Ethics Committee.

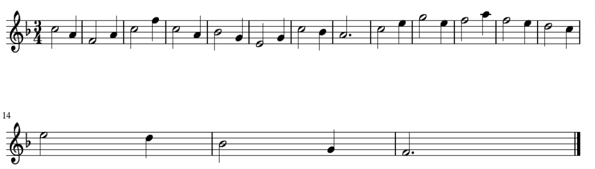
B. Materials & Stimuli

1) Melody recordings. For the EDT, melodies B and C from Gabrielsson and Juslin's (1996) study were employed. Melody B is a Swedish folk melody, while Melody C was composed specifically for use within their research (see Figure 1).

Hereafter, Melody B will be referred to as melody 1, and melody C as melody 2. The musical extracts utilized in the current study were re-recordings of the stimuli used by Gabrielsson and Juslin (1996) and were validated through their comprehensive study. In addition, the replication study carried out by Akkermans and Schapiro (2016) validated the re-recorded versions of the stimuli. In this study, only recordings that conveyed angry, happy, sad and tender expressions on piano, violin or voice were used, as findings indicated these were the most accurately perceived by listeners (Akkermans & Schapiro, 2016).

2) Editing. Recordings were edited in order to establish a greater variation of difficulty between items in the EDT. This was achieved by splitting audio files into musically meaningful phrases using Adobe audition CC. Melody 1 was split into 4, 4 bar phrases, while melody 2 was split into 6, 2 bar phrases; all possible combinations of consecutive sequences of phrases were produced. These excerpts were then paired in terms of their main musical features, but not in terms of emotional expression. Pairs of clips were then merged to create one mp3 file using SoundeXchange software, with a buzzer inserted in-between. Thus, 1116 items were produced that featured two clips with the same melody, instrument and phrases, but differing emotional expressions.

B



C

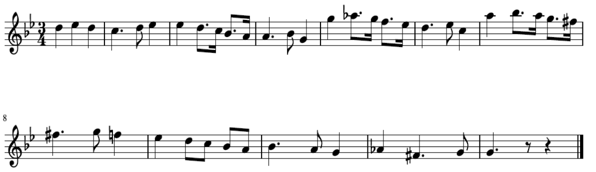


Figure 1. Notation, melodies B & C (1 & 2)

3) Emotion discrimination task. The EDT consisted of 112 items, of which 36 were randomly presented to participants. Responses were collected using a two-alternative forced choice format (2-AFC).

4) Depression screening. The Patient Health Questionnaire (PHQ-9), a short, self-administered survey, was used to assess current depression severity (Kroenke & Spitzer, 2002). This measure consists of 9 items, directly related to the diagnostic criteria within the DSM-IV.

C. Procedure

This experiment was conducted online, thus participants gained access to Qualtrics via a URL; this allowed for automatic administration of the information sheet, consent form, depression screening, EDT, demographics form and debrief. For the EDT, participants were told that they would hear two versions of a melody at a time, which would differ in terms of emotional expression and that they should indicate which version they felt was most representative of the emotion in each question. Participants were exposed to 21 audio clips, and instructed as follows: 'Please listen to the following clips and select which one sounds happier to you. Select 1 for the clip heard before the buzzer, or 2 for the clip heard after the buzzer.' This task took around 15-20 minutes to complete.

RESULTS

From the initial sample of 78 participants, 35 participants were excluded from analysis, as they had not fully completed the experiment. Additionally, 10 participants were excluded as their scores were above the typical cut off point (≥10) in the depression screening (Manea, Gilbody & McMillan, 2012).

A. Musical Features

Correct responses were scored with a value of 1 and incorrect with 0. The total correct response rate was 83.4%.

1) Target emotion. A chi-square test of independence was used to investigate the relationship between target emotion (happy, angry, sad, tender) and performance in the EDT (correct, incorrect response). The relationship between these variables was found to be statistically significant, $\chi^2(3, 693) = 15.12$, $p = .002$, with an effect size of ϕ_c=.15. Findings indicated that questions featuring sad as the target emotion were most likely to be answered correctly, while those with tender as the target emotion were the least likely to elicit a correct response, as shown in Table 1.

Table 1. Cross-Tabulation of Target Emotion and Task Performance.

Target Emotion	Response			
	Correct	Incorrect	χ^2	ϕ_c
Angry	183 (88.4%)	24 (11.6%)	15.12**	.15
Happy	150 (78.1%)	42 (21.9%)		
Sad	147 (88.6%)	19 (11.4%)		
Tender	98 (76.6%)	30 (23.4%)		

Note. ** = $p \leq .01$. χ^2 represents chi-square statistic. ϕ_c represents phi coefficient.
Percentages appear in parentheses below frequencies.

2) Length. A chi-square test of independence was performed to examine the association between length of melody (one phrase, two phrase, three phrase) and EDT performance (correct/incorrect response). The relationship between these variables was significant, $\chi^2(2, 693) = 9.43$, $p = .009$, while the effect size was small, $\phi_c = .12$. Results displayed that extracts of only one phrase in length were least likely to elicit a correct response, as can be seen in Table 2.

Table 2. Cross-Tabulation of Item Length and Task Performance.

Length	Response			
	Correct	Incorrect	χ^2	ϕ_c
One Phrase	154 (76.6%)	47 (23.4%)	9.43**	.12
Two Phrase	251 (86.3%)	40 (13.7%)		
Three phrase	173 (86.1%)	28 (13.9%)		

Note. ** = $p \leq .01$. χ^2 represents chi-square statistic. ϕ_c represents phi coefficient.
Percentages appear in parentheses below frequencies.

Three further chi-square tests of independence were conducted to assess the relationship between task performance (correct, incorrect response), and comparison emotion (angry, happy, sad, tender), instrument (piano, violin, voice) or melody (1,2); none of the findings were statistically significant. Additionally, a logistic regression was performed; musical feature variables were assessed as independent variables with regard to their ability to predict EDT performance. This analysis confirmed the findings of the chi-square tests.

III. EXPERIMENT 2

METHOD

A. Participants

45 participants (26 female) were recruited, partly through advertisement on social media, and partly in exchange for participation in other studies. The majority of participants were students from Goldsmiths, University of London, ranging from 20-50 years of age (M = 24.71, SD = 5.86). This study gained ethical approval from Goldsmiths Research Ethics Committee.

B. Materials & Stimuli

1) Individual difference measures. The Goldsmiths Musical Sophistication Index (GOLD-MSI), was used to assess musical behaviours and skills using a self-report questionnaire (Müllensiefen et al., 2013). This inventory consists of 5 sub-scales, of which 3 were used; these measured musical training, emotional engagement with music and active engagement with music.

The Trait Emotional Intelligence Questionnaire Short Form (TEIQue-SF) was administered, in order to measure EI via self-report (Petrides, 2009).

Emotional contagion was measured using the Emotional Contagion Scale (Doherty, 1997), which consists of 15 self-report items, including hypothetical scenarios such as 'When someone smiles warmly at me, I smile back and feel warm inside.'

2) Emotion discrimination task. The refined EDT was comprised of 28 items, 8-23 seconds in length, which contained only one phrase and featured only melody 1. Responses were collected using a 2-AFC format.

3) Auditory perception tasks. Psychoacoustic tests were also employed to establish participants' ability to discriminate duration and pitch. These were run using two experiments from the Maximum Likelihood Procedure (MLP) toolbox on MATLAB 2013b (Grassi & Soranzo, 2009): namely, pitch discrimination complex tone and duration discrimination complex tone. Experiments were set up so that 2 blocks of 20 trials were completed per test, and responses were collected using a 3-AFC format. Default settings, as specified by the MLP toolbox, were otherwise maintained. Participants carried out both the new EDT and psychoacoustic tests using AKG-K451 headphones and responses were collected using a computer keyboard and mouse.

C. Procedure

For this experiment, both the short EDT and psychoacoustic tests were completed separately to the individual difference measures, in a silent, controlled setting. If participants had not taken part in Experiment 1, they were asked to complete the individual difference measures, either before or after the in-lab tests took place. At the beginning of each part of this study, participants were provided with an information sheet and consent form.

For the short EDT, participants received the same instructions as were provided in the first experiment; this task took approximately 8-10 minutes. Following this, participants took part in two psychoacoustic tests; for each test, they were told that they would hear three tones per trial. For the first, they were asked to distinguish which tone was longer in duration, while for the second they were asked to identify which was higher in pitch. Each test took around 3 minutes to complete. After the online individual differences measures and the in-lab auditory experiments had been completed, participants were thanked and debriefed.

RESULTS

From the initial 60 responses, data from three participant's was excluded from analysis as they had not completed the individual difference test battery, while 12 participants were excluded as a consequence of high scores in the depression screening (≥10).

A. Individual differences

Total correct responses were calculated as a measure of EDT performance, which ranged from 17-25 out of 28 (M = 21.38, SD = 1.81). Active engagement was excluded from analysis, due to the high correlation with emotional engagement found in Experiment 1. For the psychoacoustic measures, an auditory threshold estimate was produced for each block of trials. Out of the two blocks completed within each test, the lower threshold was retained for analysis. For duration tests, thresholds ranged from 258.36 - 330.03 ms (M = 282.28, SD = 14.9), while for pitch discrimination, thresholds ranged from 330.76 - 349.07 Hz (M = 334.34, SD = 4). For a complete outline of the descriptive statistics obtained for each measure, see Table 3.

Correlational analyses were carried out to distinguish whether the individual difference and perceptual measures were associated with EDT scores. Emotional intelligence (M = 4.99, SD = .61) and EDT performance were positively correlated, $r(45) = .27$, $p = .04$, one-tailed (as shown in Figure 2). None of the other personality traits or perceptual ability differences were significantly correlated with performance.

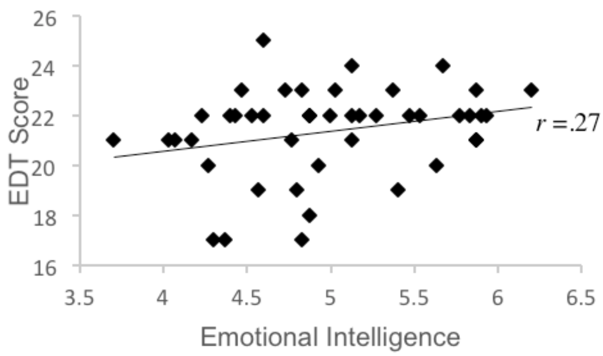


Figure 2. Graph to display correlation between EDT score and emotional intelligence. *r* denotes Pearson's correlation coefficient.

In addition, a multiple regression was performed to establish whether EI, EC, musical training, emotional engagement with music, pitch threshold and duration threshold predicted EDT performance. Backwards elimination was used to discard variables that were not significantly contributing to the model ($p < .05$). The sixth model arrived at through this process indicated that emotional intelligence displayed a trend in the prediction of EDT performance, R^2 = .07, adjusted R^2 = .05, $F(1, 43) = 3.24$, $p = .08$, as outlined in Table 4.

Table 3. Descriptive statistics. Experiment 2.

	M	SD	Range
EDT score	21.38	1.81	17-25
Emotional intelligence	4.99	.61	3.7-6.2
Emotional contagion	50.24	8.63	33-65
Musical training	22.11	5.26	13-39
Emotional engagement	29.09	4.34	16-36
Pitch discrimination	334.38	4.1	330.76-349.07Hz
Duration discrimination	280.53	14.19	258.36-330.03ms

Table 4. Regression Model of Total EDT Score.

	B	*SE*	β	*p*
Constant	21.14	.3		<.001
EI	.48	.3	.27	.08

Note. *B* represents unstandardized regression coefficient. *SE* represents standard error of *B*. β represents standardized regression coefficient. EI=Emotional Intelligence.

IV. DISCUSSION

Primarily, the focus of Experiment 1 was to identify features that contributed to the difficulty of task items; item difficulty was influenced by how many phrases were featured in the musical extract, and which emotion participants were required to identify. Extracts featuring 'tender' as a target emotion or only one phrase of the melody appeared to be the most difficult, when looking at the percentage of correct responses per item (refer to Tables 1 & 2). Therefore, results provide support for the hypothesis that features of musical excerpts may contribute to the overall difficulty of individual task items.

The main aim of Experiment 2 was to determine factors that might influence the ability to discriminate performer-intended expressions of emotion in music. It was expected that those with a high level of emotional, musical and perceptual skills would display superior discrimination ability. While skills such as emotional intelligence were found to be positively associated with discrimination ability, there was no evidence to suggest that musical or perceptual abilities had a significant impact on performance; therefore the original hypothesis was not fully supported.

Nevertheless, the present study presents a first step towards the creation of a short and effective EDT and secondly, has aided the investigation of individual differences in emotional, musical and perceptual abilities that may have contributed to variation in task performance. Experiment 1 results were used to establish a shorter test, which was found to be an effective measure of emotion discrimination ability, on the basis that mean level of task performance in Experiment 2 was at 76% and therefore half way between chance level (50%) and perfect discrimination. The refined EDT was further validated by Experiment 2 results, displaying that discrimination ability was associated with, and to some extent predicted by, level of EI. These findings are also of importance, as they contribute to an understanding of the factors that might influence the ability to recognize emotions conveyed through music performance.

Emotional intelligence typically refers to a capacity to recognize one's own emotions and those of others; thus, it is possible that the ability to perceive emotions in music relies on similar emotional processes. This backs up previous findings that individual differences in EI relate to individual differences in emotion recognition ability in the music domain (Resnicow et al., 2004). Additionally, this experiment extends previous findings, by demonstrating that EI is associated with perception of emotional expression in musical extracts featuring instruments other than piano. Therefore, the results from experiment 2 support and extend previous findings, indicating that the ability to recognize emotional expressions conveyed through music may be an important aspect of EI.

Based on this evidence the claim that emotional ability impacts upon the perception and identification of emotions in music seems to be reasonably justified. Although, in contrast to this conclusion, results indicate that the emotions subscale of the GOLD-MSI and the emotional contagion scale were not associated with EDT performance. The findings from the present experiment appear to be inconsistent with this rationale as well as the findings from previous studies (Akkermans & Schapiro, 2016). This either indicates that typical emotional engagement with music does not impact upon emotion recognition ability or that a larger sample size may be required to establish an effect. The latter would appear the most plausible explanation meaning that further testing is necessary in order to establish the concurrent validity of the EDT.

It was suggested by Juslin & Västfjäll (2008) that emotional responses to music might occur through internal mimicking of emotions expressed in music. The current results do not appear to support this claim, as emotional contagion was not associated with emotion recognition ability, though this could be due to the study of perceived emotional expression as opposed to 'felt' emotions (Gabrielsson, 2001). Conceptually, it is arguable that EC is more involved with emotions evoked by music, than emotions perceived in music, which could account for the discrepancy in results. It may, therefore, be more appropriate to study EC with regard to individual differences in emotions evoked during music listening.

The hypothesis that musical expertise may have a positive influence on the ability to perceive intended expressions in music was not supported by the current experiment; there was no evidence to suggest that musical training influenced EDT performance. These findings are a result of a low level of musical training within the current sample, according to normative data from the GOLD-MSI (Müllensiefen, Gingras, Musil, & Stewart, 2014). Further investigation with a larger proportion of musically trained participants is required to clarify the effect of musical training on the ability to discriminate emotions conveyed by music.

In accordance with findings relating to musical ability, no significant relationship was established between pitch or duration discrimination ability and the recognition of a musically conveyed expression. It could be argued that this is an unexpected result, as pitch and duration are both expressive cues used within the interpretation of musical and vocal emotional expression (Juslin & Laukka, 2003). Although, Filipic, Tillmann and Bigand, (2010) found that emotion judgments were not affected by basic acoustic features; they suggest that perception of musical emotion is based on the interpretation of a complex combination of features, as has also been found in studies of facial expression. This would account for the finding that psychoacoustic abilities did not influence performance on the EDT.

From a broader perspective, the finding that emotional abilities such as EI, previously found to be related to recognition of both facial (Petrides & Furnham, 2003) and vocal (Trimmer & Cuddy, 2008) expression, are involved in musical emotion recognition is of significance. While this is not a novel discovery, results from this study provide further evidence to suggest that recognition of emotion within music is supported by an innate mechanism for emotional processing. Furthermore, this finding is consistent with the predictions put forward in functionalist perspective of music and emotion (Juslin, 1997), suggesting a link between processes involved in recognition of emotions in speech and music (Juslin & Laukka, 2003).

In addition, the fact that listeners were able to distinguish between basic emotions conveyed through music supports the theoretical assumption that basic emotions can be portrayed through music performance (Juslin, 1995), and the applicability of discrete emotional constructs within the study of music and emotion. However, it must be considered that the stimuli used within the current experiment were specifically manipulated in order to portray these particular emotions, and this procedure is distinct from that which is likely to occur within a natural music performance. In a realistic setting, intrinsic structural aspects of the score would typically determine the intended emotional expression, and these emotive intentions would then be reflected by the musicians' performance (Resnicow et al., 2004). Another issue with validity that the current investigation poses is the fact that only three performers were featured. Performers may differ in terms of their technical skill (Gabrielsson & Juslin, 1996) as well as their interpretation of emotional expression (Akkermans & Schapiro, 2016). This could impact upon the ease with which listeners are able to recognize intended expressions. Future studies should, therefore, aim towards including a wider range of stimuli that are more representative of music that one would typically encounter in everyday life, and feature a larger sample of performers.

V. CONCLUSION

While music's appeal lies within the emotive character it conveys, it appears that individuals differ in the extent to which they are able to perceive music-portrayed emotions. This research represents a step towards a short and effective measure of an individuals' capacity to perceive performer-intended emotional expressions using musical stimuli. Furthermore, it contributes to an understanding of the origins of individual differences in music-perceived emotions, backing up previous findings that suggest the ability to identify intended emotional expressions is dependent on emotional intelligence. Further investigation into factors influencing perception of emotions in music is necessary, in order to determine whether music may truly be considered a universal 'language of emotion' (Cooke, 1959).

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