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Expressivity and emotion: the importance of performer controlled cues.

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Abstract

The communication of emotion through music is shaped by a complex collaboration between composers and performers. Although compositional structure alone can reliably convey emotions (Thompson & Robitaille, 1992), they are more clearly conveyed when both expressive and structural cues are available (Quinto, Thompson, Taylor, 2014). Here we begin an exploratory investigation into the relative influence of composer (structure) vs performer (expressive) controlled cues on listener's judgement of perceived emotion. Thirty non-musician participants rated the perceived emotion of expressionless renditions of 48 excerpts from Bach's *Well-Tempered Clavier* (WTC). After each excerpt played, participants evaluated two aspects of perceived emotion, using scales for valence and arousal adapted from Russell's 2D circumplex model of affect (Russell, 1980). Using regression and commonality analyses, we examined how attack rate (timing), modality (major or minor) and pitch height contribute to listener ratings in expressionless MIDI renditions of a renowned musical work. Results indicated all three cues significantly predicted valence ratings, with modality as the strongest predictor. For arousal ratings, our timing cue of attack rate appeared as the only significant predictor. Our three-cue model for predicted ratings of expressionless stimulus, had R^2 values of 0.83 for valence ratings and R^2=0.59 for arousal ratings. This detailed breakdown of cue use and predictability extends on previous work showing how composer and performer controlled cues affect perceived valence and arousal differently. Future work comparing these results with actual performances of the same piece will clarify the relationship between performer and composer controlled cues for emotion.

Introduction

The process of conveying emotion in music involves a complex communicative relationship connecting composers, performers and listeners. Composers' emotional intentions are encoded through the notation of structural cues—pitches, rhythms, notated tempi, etc. Performers then study, interpret, and ultimately perform these notes and rhythms, adding nuance to the compositional structure. For example, performers use expressive variations in timing and intensity in order to create musical phrases, "giving life" to the raw material supplied by composers. Listeners decode the acoustic information presented, recognizing the emotions conveyed jointly by composer and performer. As such, the listener's emotional and musical experience is shaped by crucial contributions from both the performer's interpretation and composer's interpretative decisions (Gabrielsson, 1988).

Contribution of Performer vs Composer Cues

A performer's emotional intention manifests itself through the manipulation of expressive cues. The importance of these manipulations in conveyed emotion can be seen in research modelling listener responses, suggesting performer controlled cues can explain up to 70% of emotion ratings (Juslin, 2000). In that study, professional musicians encoded four emotions (happy, sad, anger and fear) within three short, well-known melodies ("When the Saints", "Nobody Knows", and "Greensleeves'). Regression modelling of five performer controlled cues (tempo, sound level, frequency spectrum, articulation and articulation variability) assessed the relationship between performers' intended expression and listeners' emotional judgements. The analyses indicated a linear combination of cues accounted for a large amount of variance in judgements, leaving only 30% left unexplained. This remained relatively consistent across regression models analyzed for each emotion investigated—emphasizing the importance of performance expression on emotional perception. This suggests that in some circumstances performers can use interpretive cues to convey emotion independent of structural cues.

Expressive cues remain important even in performances varying both structural and interpretive cues. For example, a more recent study from Juslin and Lindström (2010) found 75-80% of variance associated with listener ratings of emotion could be explained from a linear combination of both performer and composer cues. Using synthesized musical stimuli composed for experimental purposes, the authors varied eight features (pitch, mode, melodic progression, rhythm, tempo, sound level, articulation and timbre) according to a factorial design. Musically trained participants rated musical stimuli along five affective adjective scales ('Happy', 'Sad', 'Angry', 'Fearful' and 'Tender'). Regression analyses indicated composer controlled cues contributed to perceived emotion, however these cues may be less influential than performer controlled cues. In other words, the model combining performer and composer cues did not predict much more variance than Juslin (2000)'s model including only performer cues.

Unfortunately, it is difficult to make direct comparisons between these experiments as the 2000 study used recordings of well-known pieces on guitar whereas the latter presented synthesized stimuli with manipulated features. Moreover, Juslin and Lindström (2010) emphasize the importance of investigating the impact of cues using overlapping stimulus materials (in contrast to monophonic stimuli), given excerpts within their study are simpler than most music experienced in the real world. Understanding how performer and composer cues function in more complex, polyphonic (i.e., multi-voiced) musical stimuli as they suggested, provides valuable complementary insight into the complex process of communicating musical emotions.

Comparisons between performer and composer controlled cues are complicated by differential findings regarding the two common dimensions assessed—valence vs. arousal

(Quinto & Thompson, 2013). In a series of studies, listeners rated emotional valence and arousal for musician-composed excerpts either performed with a specific intended emotion or rendered neutral and expressionless through MIDI software. In order to quantify composer and performer controlled cues, musical excerpts were subject to acoustic analysis using Praat (Boersma & Weenink, 2018) and MIRToolbox (Lartillot, Toivianinen, & Eerola, 2008) software. Overall, regression analyses on listener ratings indicated cues predicted 58-59% of valence and arousal variance. The model included compositional cues such as mode, mean fundamental frequency, range (number of semitones between the lowest and highest frequencies), mean interval size, as well as performance cues of articulation, mean intensity level, intensity variability, high-frequency energy and tempo. Intriguingly, compositional cues such as mode had a greater influence on valence ratings whereas performance cues more strongly influenced arousal ratings. In addition, regardless of the intended emotion, expressive interpretation enhanced ratings of emotional valence and arousal. As such, it appears a performer's interpretative decisions strongly influence emotional communication, particularly with respect to arousal.

Structural (composer-controlled) cues for emotion

Listeners are able to decode a wide range of cues to perceive musical emotion. These cues range from low-level psychoacoustic features such as tempo (Balkwill & Thompson, 1999; Gagnon & Peretz, 2003), articulation and dynamics (Eerola, Friberg, & Bresin, 2013) to features specific to music, such as modality (Costa, Fine, Enrico, & Bitti, 2004; Dalla Bella, Peretz, Rousseau, & Gosselin, 2001; Hevner, 1937). A large body of experimental evidence shows that tempo, modality and pitch are effective in communicating emotions to an audience (Gabrielsson & Juslin, 1996; Hevner, 1937).

Faster timing information like high tempos is strongly associated with affective terms higher in emotional arousal, whereas slower tempos are related to affective terms lower in emotional arousal (Gagnon & Peretz, 2003; Juslin, 1997). In addition, listeners rate higher pitches and major modalities as expressing more positively valenced emotions than lower pitches and minor modes (Costa et al., 2004; Crowder, 1985; Hevner, 1937). Furthermore, work examining the relative contributions of cues to expressed emotion have indicated timing information and modality cues are important for listener ratings.

Our previous investigation explored the influence of attack rate (note attacks per second and a function of tempo), modality and pitch height cues within the polyphonic work of Bach's *Well-Tempered Clavier (WTC).* Regression analyses determined a linear combination of these three cues predicted for 75-79% of variance associated with valence ratings and 48-51% of variance associated arousal ratings. These results suggest attack rate, modality and pitch height are central cues for listener perception within naturalistic polyphonic music that is reflective of the musical complexity experienced in everyday listening.

Current Experiment

The current study is the first in a series aiming to exploring the influences of composer vs. performer controlled cues for emotion in in Bach's *The Well-Tempered Clavier (WTC)* Book 1. The *WTC* is frequently used as a teaching tool for musicians, and mastery of the *WTC* are required for Royal Conservatory of Music standards. Consequently it is a useful set of pieces for a naturalistic study as it is widely revered—both for its theoretical structure and as a set of teaching pieces (Royal Conservatory of Music, 2015). Furthermore, its "balance" with respect to modality (with equal numbers of pieces in all 24 keys) makes it useful for studying issues of emotion, given the well-known importance of modality in its communication.

Our experiment aims to explore the importance of cues in conveyed emotion in an expressionless context, where composer controlled cues are 'isolated' from performer cues. Further work will compare these findings to responses of the same pieces as performed with expression, in order to compare how composer vs performer cues impact the perception of emotion in music. Specifically, we examined the effect of expressionless musical stimuli, on listeners' use of cues to perceive emotion.

Method

Participants

Thirty participants (22 female, 8 male) ranging in age from 18- 51 years (M = 20.45, SD = 5.81) recruited from the McMaster University undergraduate psychology pools and word of mouth participated in this study. Participants reported normal hearing and normal or corrected-to-normal. Each participant received course credit in return for participation.

Musical Stimuli

Our stimuli included MIDI rendered excerpts of J.S Bach's *WTC's Book 1* (n=48*)*. Excerpts contained the first eight measures of each piece, and included a two-second fade out starting at the ninth measure. In order to use the most normative timing information possible, we set the tempo for each piece according to the median tempo of values of 13 prominent performances analysed by Willard Palmer (Palmer, 1994) and calculated attack rate information from these values. Stimuli durations ranged 6 – 104 seconds (M=26.7 seconds, SD=16.8). We used Amadeus Pro to cut and prep the stimuli for experimental use.

Procedure

Table 1. Regression model for attack rate, modality, pitch height on ratings of valence and arousal for MIDI recordings. Unstandardized beta values indicate strength and direction of relationship between each predictor variable and valence and arousal ratings. Major mode serves as reference for the cue of modality.

	Valence				Arousal			
Predictor Coefficients	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*
Attack Rate	0.245	0.036	6.817	p<0.001	4.443	0.597	7.444	p<0.001
Modality	-1.315	0.158	-8.322	p<0.001	2.093	2.624	0.798	p=0.429
Pitch Height	0.047	0.018	2.664	p<0.05	0.180	0. 295	0.611	p=0.545

Before each experiment, participants completed a consent form and musical experience survey. The experiments took place in a sound-attenuating booth, where the research assistant gave verbal instructions for the emotion rating task. Four practice trials preceded the experimental trials, using alternate recordings as performed by Rosalyn Tureck (Bach, 1953). After each excerpt, participants rated perceived emotion on scales of valence from 1 (negative) to 7 (positive), and arousal from 1 (low) to 100 (high). Each participant listened to an individually randomized order of the 48 excerpts.

We conducted the experiment using PsychoPy (Peirce, 2007), a Python-based program. Participants heard stimuli at a consistent and comfortable listening level through Sennheiser HAD-300 headphones. They viewed rating scales on a DELL monitor and provided responses via an Apple mouse connected to a 13-inch MacBook Pro located outside the booth.

Results

We first examined the relationship between attack rate, modality and pitch and emotion ratings to provide a useful comparison to previous studies of emotion. This involved assessing the relationship between acoustic cues (attack rate, mode, pitch) and listener responses, as captured by a two-dimensional model of valence and arousal, using a least squares standard multiple linear regression. Next, we used a novel approach not frequently used in music research—commonality analyse—to determine partitioned variance within the regression models.

Regression analysis

A standard multiple linear regression conducted on the ratings of valence revealed all three acoustic cues—attack rate, modality, and pitch height–significantly predicted ratings of valence (Table 1). Our three-cue model for valence had a significant regression equation of ($F(3.44)= 74.07$, $p<0.001$), with an R^2 of 0.83. Participants' predicted valence ratings are equal to 0.245(attack rate) + 1.315 (mode) + 0.047 (pitch height), where mode is coded as 0=minor, 1=Major. Valence ratings increased by 0.245 per unit increase in note attacks per second, and 0.047 per unit increase in pitch height. Listeners rated Major modes as 1.315 times higher in valence.

Regression results for arousal ratings indicated only the cue of attack rate significantly predicted for listener responses (Table 1). The model for arousal ratings had a significant regression equation of ($F(3,44)= 21.53$, $p<0.001$, with an R^2 of 0.59. Participants' arousal responses are predicted by the relationship with attack rate, where arousal ratings increased by 4.443 per unit increase in note attacks per second.

Commonality Analysis

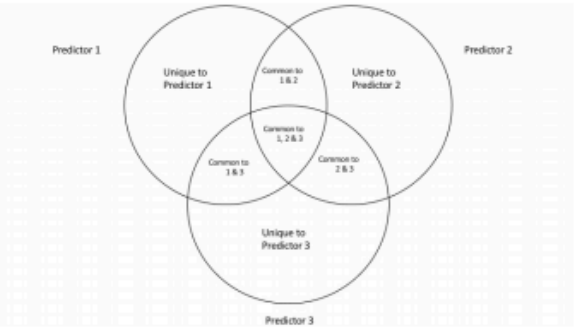

Figure 1. Visual representation of regression predictor relationships using commonality analysis adapted from Capraro & Capraro (2001).

To further explore the relative strengths of each cue, we examined their unique and shared contributions to predictions of participant response (Figure 1) using commonality analysis to decompose the R^2 of each model. Here, 'shared' variance

between predictors (overlapping regions in Figure 1) represent the variance those variables have in common with the dependent variable (Ray-Mukherjee et al., 2014). For the interest of our study and in line with Capraro & Capraro (2001) we interpret negative commonalities as zero, given the small negative values calculated in addition to the negative contribution of attack rate, modality and pitch height combined.

Valence. Uniquely, modality accounted for the largest amount of variance for ratings of valence (26%), followed by attack rate (17%) and pitch height (3%). Modality's shared variance with attack rate accounted for the most variance overall (37%), suggesting a relationship between the two cues and predicting more than shared variance predicted by modality and pitch height (6%).

Arousal. Commonality analysis revealed attack rate as the most important predictor for the prediction of arousal rating variance (51%). Modality (0.6%) and pitch height (0.3%) contributed minimally to the model, in accordance with the non-significant regression findings. Again, the relationship between attack rate and modality accounted for a portion of shared variance (7.5%) larger than the portion accounted for by modality and pitch height uniquely or shared between attack rate and pitch height (0.7%).

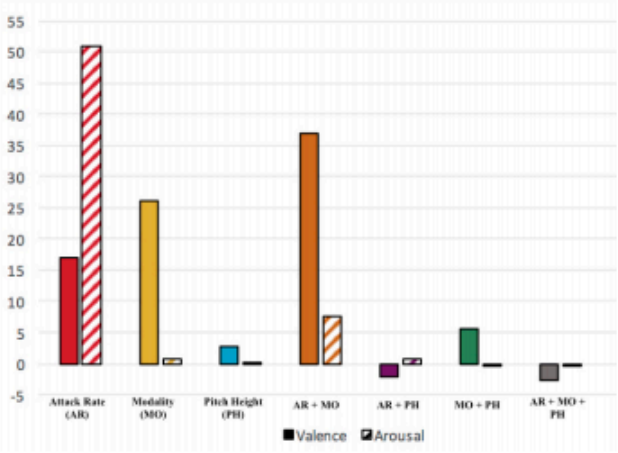

Figure 2. Unique and shared variance of Valence and Arousal ratings by musical cue. Attack rate's unique and shared contribution with modality explained the majority of variance across perceived ratings of arousal. The two bars for each cue depict ratings made of both (1) valence and (2) arousal ratings of emotion.

Discussion

The current exploratory investigation examined the use of composer selected (structural) cues on listener perception of emotion in expressionless music. The experiment is the first in a set that comparing the importance of composer vs performer controlled cues on expressed emotion. Here we build upon previous corpus analysis of Bach's timing and pitch cues (Poon & Schutz, 2015) along with modality, by empirically assessing their perceptual consequences. Using three cues of attack rate (timing), modality and pitch height, we examine the influence of each cue on listener ratings of emotional valence and arousal. Overall, the results suggest the importance of composer controlled cues in conveyed emotion, varying according to the component of emotion measured.

According to our model for valence, attack rate, modality and pitch height significantly predicted listener ratings of emotional valence. Listeners attended to all three cues to perceive the positive or negative nature of the emotion conveyed. The relationships found between structural cues and perceived emotion aligned with previous explorations of communicated emotion in speech and music, where higher pitch height (Bachorowski, 1999) and faster timings (Breitenstein, van Lancker, & Daum, 2001) are linked with positively valenced emotions. In addition, Western listeners often use major and minor modalities to distinguish between emotions with positive or negative valence (Gagnon & Peretz, 2003; Hevner, 1935). In contrast, the regression model for ratings of arousal revealed attack rate as the only significant predictor for arousal (although it contributed significantly to valence). Here, even in music without performance expression, timing information is crucial to the perception of emotional arousal. In addition, the consistent significance of attack rate across both dimensions of emotion is consistent with research suggesting timing as the most salient cue for emotion recognition and perception in music (Gagnon & Peretz, 2003).

Our linear model built using only three cues – attack rate, modality and pitch height- accounted for 83% and 59% of variance in participants' ratings across valence and arousal respectively. These differences are reflective of the limited number of features included in the models, specifically additional features that may be important for ratings of emotional arousal. This may also suggest composer selected cues have greater influence on valence ratings than arousal ratings, in alignment with previous work showing compositional cues such as mode impacted listener rating of valence more than performer cues like articulation (Quinto & Thompson, 2013).

The results also indicate our models could predict for large amounts of variance with only composer selected cues. In addition, these results suggest the selected cues are central to listener perception within naturalistic polyphonic music—reflecting a type of musical complexity experienced by listeners in everyday life. Previous work analyzing models of both performer and composer controlled cues from Juslin and Lindström (2010), demonstrated that 75-80% of variance associated with listener ratings of emotion could be explained from a linear combination of both performer and composer cues. Here we show 59-83% of variance from listener ratings can be predicted with just three composer cues in polyphonic music. Again, the low predictability of our arousal model in contrast to Juslin and Lindström (2010) and similar level of predictability in valence rating variance may reflect the influence of our composer cues on each dimension.

Relative Cue Strengths

The unique component of explained variance represents variance accounted for independently by each predictor. In contrast, shared variance refers to the 'common' variance predicted by two variables in the model (Seibold & Roper, 1979). Commonality analysis affords detailed information breaking down the complex cue relationships associated with listener perception within multi-voiced stimuli. Variance partitioning of attack rate (timing), modality and pitch height ultimately allow us to statistically compare how much each cue contributes, gives us a sense of their musical importance in this experimental context.

The breakdown of cue contribution for valence ratings demonstrated that modality predicted the most variance (26%), followed by attack rate (17%), with pitch height contributing a small amount (3%). This suggests modality is pivotal to conveying emotional valence, over cues of timing and pitch. These findings are further supported from research arguing modality is an important cue for the perception of emotional valence (Hunter, Schellenberg, & Schimmack, 2008; Pallesen et al., 2005). The shared contribution of modality and attack rate predicted the largest amount of shared variance. This points to the compositional relationship between modality and attack rate found in Baroque and Classical Western music, where major modalities are often faster in timing cues and minor modalities are consistently slower (Post & Huron, 2009).

Attack rate accounted for the largest amount of variance of arousal ratings uniquely (51%) and commonly (7%) with modality. Modality and pitch height played a smaller role for ratings of arousal uniquely (Figure 2) with pitch height contributing minimally (<1% uniquely). This is surprising given research indicating modality as the cue of highest importance, followed by features such as tempo and dynamics (Eerola et al., 2013). Our results may vary from these findings however, due to differences in stimuli – our experiment uses performances of baroque era repertoire to explore cue relationships with perceived emotion, in contrast to experimentally composed excerpts with specific intended emotions. Additionally, we used polyphonic (i.e., multi-voice) stimuli, in contrast to the single melodic line stimuli often used in previous research. This suggests that when presented with more ambiguous, complex music participants may rely more on timing cues like attack rate than of the cue modality or pitch.

Furthermore, our results demonstrate a similar finding to the work Quinto & Thompson (2013), where performer controlled (expressive) cues are most important for the dimension of emotional arousal. Although our use of MIDI performances minimized expressive interpretations, listeners used timing information, usually manipulated by the performer for expressive purposes, to decode the conveyed emotion. In this study, the composer alone determined attack rate, as the pieces featured no expressive timing variation. Our valence model found modality the most important cue, with attack rate more important than pitch height. Again, here we made the timing information expressionless, indicating compositional cues influence valence ratings more than cues under the performer's control, as found in previous work (Quinto & Thompson, 2013). However, if the inclusion of expressive timing improves this model, it points to the significance of expressive cues over compositional cues like pitch height for listener ratings of valence.

Future Directions

As the first step in an exploratory investigation on the influence of composer versus performer cues on perceived emotion in music, future work will expand on these findings by exploring the role of performer interpretation through comparison of different performances of this same set of pieces. Specifically focusing on the influence of expressive timing information (in the form of attack rate), we will look to explore how performers' expressive decisions on timing influence how listeners rely on cues to rate conveyed emotion.

Previous work has touched on expressive timing and conveyed emotion, indicating its impact on listener perception of emotion (Bhatara, Tirovolas, Duan, Levy, & Levitin, 2011; Juslin & Madison, 1999). Future research will extend on these findings, to consider timing decisions of multiple notable performers and compare the impact of these decisions in comparison to composer chosen cues. For this, the current experiment serves as a useful baseline of emotion ratings to contrast with future explorations of expressive choices of performers. The MIDI rendered stimuli allows us to vary attack rate in a controlled way, while other cues remain constant. This will allow us to return to more ecological assessment with future research, as global timing information can be set to match with the timing selections of notable performers. Furthermore, given the *WTC's prominence* in musical training, continued investigation using the MIDI rendered excerpts will provide a foundation to compare against performer recorded versions, for an in-depth understanding on how listeners use cues to discern emotion in musical performances.

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References

Bach, J. S. (1953). *Bach: The Well-Tempered Clavier Book I [Recorded by R. Tureck]*. [DC]. RFA-Neef, Wittingen, Germay : Deutsche Grammonphon(1953).

Bachorowski, J.-A. (1999). Vocal Expression and Perception of Emotion. *Current Directions in Psychological Science*, *8*(2), 53–57. http://doi.org/10.1111/1467-8721.00013

Balkwill, L.-L., & Thompson, W. F. (1999). A cross-cultural investigation of the perception of emotion in music: Psychophysical and cultural cues. *Music Perception: An Interdisciplinary Journal*, *17*(1), 43–64.

Bhatara, A., Tirovolas, A. K., Duan, L. M., Levy, B., & Levitin, D. J. (2011). Perception of emotional expression in musical

performance. *Journal of Experimental Psychology: Human Perception and Performance*, *37*(3), 921–934. http://doi.org/10.1037/a0021922

Boersma, P., & Weenink, D. (2018). Praat: doing phonetics by computer [Computer program].

Breitenstein, C., van Lancker, D., & Daum, I. (2001). The contribution of speech rate and pitch variation to the perception of vocal emotions in a German and an American sample. *Cognition and Emotion*, *15*(1), 57–79. http://doi.org/10.1080/0269993004200114

Capraro, R. M., & Capraro, M. M. (2001). Commonality analysis: Understanding variance contributions to overall canonical correlation effects of attitude toward mathematics on geometry achievement. *Multiple Linear Regression Viewpoints*, *27*(2), 16–23. Retrieved from http://mlrv.ua.edu/2001/VOL_27_2/vol27_n2_a3.pdf

Costa, M., Fine, P., Enrico, P., & Bitti, P. E. R. (2004). Interval distributions, mode, and tonal strength of melodies as predictors of perceived emotion. *Music Perception: An Interdisciplinary Journal*, *22*(1), 1–14.

Dalla Bella, S., Peretz, I., Rousseau, L., & Gosselin, N. (2001). A developmental study of the affective value of tempo and mode in music. *Cognition*, *80*(3), B1–B10.

Eerola, T., Friberg, A., & Bresin, R. (2013). Emotional expression in music: Contribution, linearity, and additivity of primary musical cues. *Frontiers in Psychology*, *4*, 1–12. http://doi.org/10.3389/fpsyg.2013.00487

Gabrielsson, A. (1988). Timing in music performance and its relations to music experience. In J. A. Sloboda (Ed.), *Generative processes in music: The psychology of performance, improvisation, and composition* (pp. 27–51). New York, NY: Clarendon Press/Oxford University Press.

Gabrielsson, A., & Juslin, P. N. (1996). Emotional expression in music performance: Between the performer's intention and the listener's experience. *Psychology of Music*, *24*(1), 68–91. Retrieved from http://pom.sagepub.com/content/24/1/68.short

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to" happy-sad" judgements in equitone melodies. *Cognition and Emotion*, *17*(1), 25–40.

Hevner, K. (1935). The affective character of the major and minor modes in music. *The American Journal of Psychology*, *47*, 103–118. Retrieved from http://www.jstor.org/stable/1416710

Hevner, K. (1937). The affective value of pitch and tempo in music. *The American Journal of Psychology*, *49*(4), 621–630.

Juslin, P. N. (1997). Emotional communication in music performance: A functionalist perspective and some data. *Music Perception*, 383–418.

Juslin, P. N. (2000). Cue utilization in communication of emotion in music performance: Relating performance to perception. *Journal of Experimental Psychology: Human Perception and Performance*, *26*(6), 1797–1813. http://doi.org/10.1037//0096-1523.26.6.1797

Juslin, P. N., & Lindström, E. (2010). Musical expression of emotions: Modelling listeners' judgements of composed and performed features. *Music Analysis*, *29*(1–3), 334–364. http://doi.org/10.1111/j.1468-2249.2011.00323.x

Juslin, P. N., & Madison, G. (1999). The role of timing patterns in recognition of emotional expression from musical performance. *Music Perception: An Interdisciplinary Journal*, *17*(2), 197–221.

Palmer, W. A. (1994). *J.S. Bach: The Well-Tempered Clavier* (Third). USA: Alfred Music Publishing.

Peirce, J. W. (2007). PsychoPy-Psychophysics software in Python. *Journal of Neuroscience Methods*, *162*(1–2), 8–13. http://doi.org/10.1016/j.jneumeth.2006.11.017

Post, O., & Huron, D. (2009). Western Classical music in the minor mode is slower (Except in the Romantic period). *Empirical Musicology Review*, *4*(1), 2–10.

Quinto, L., & Thompson, W. F. (2013). Composers and Performers Have Different Capacities to Manipulate Arousal and Valence. *Psychomusicology: Music, Mind, and Brain*, *23*(3), 137–150. http://doi.org/10.1037/a0034775

Ray-Mukherjee, J., Nimon, K., Mukherjee, S., Morris, D. W., Slotow, R., & Hamer, M. (2014). Using commonality analysis in multiple regressions: A tool to decompose regression effects in the face of multicollinearity. *Methods in Ecology and Evolution*, *5*(4), 320–328. http://doi.org/10.1111/2041-210X.12166

Royal Conservatory of Music. (2015). Piano Syllabus. Toronto, ON: Frederick Harris Music Co., Ltd.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178.

Seibold, D. R., & Roper, R. E. (1979). Psychosocial determinants of health care intentions: Test of the Triandis and Fishbein models. *Communication Yearbook*, *3*, 625–643.