A study of intonation tendencies in a professional SATB ensemble.

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Background in Music Technology
The use of a MIDI-audio alignment algorithm to identify notes onsets and offsets and a fundamental frequency estimation algorithm to extract frequency information allows for intonation-related information to be extracted automatically from recordings of the singing voice. This expedites the extraction of performance data from the recordings compared to manual methods, allowing for a larger number of performances to be analysed.

Background in Music Theory
Most of the earlier work on intonation has focused on the overall adherence to, or deviation from, fixed intonation systems, such as equal temperament, Just Intonation, or Pythagorean tuning (Howard 2007a, 2007b; Jers and Ternström 2004). The exercises designed for this experiment and the analysis of “Es ist ein Ros’ entsprungen” by Praetorius allow for an exploration of how musical context may influence intonation.

Aims
The aim of this study is to evaluate a professional SATB quartet’s intonation across several renditions of two sets of musical exercises and a well known musical piece. The analysis focuses on whether the context in which the intervals occur influences the way in which they are tuned.
Main contribution

Method: A professional SATB quartet from the Montreal area performed a set of exercises, where both semitones and whole tones occur in different harmonic contexts, three times. They also performed the first verse of Praetorius’ “Es ist ein Ros’ entsprungen” seven times, four times with the German text, and three times to the syllable “mi”. The singers were recorded with individual directional microphones to facilitate fundamental frequency estimation. Intonation data were calculated by first annotating the onset and offset of each note with a MIDI-audio alignment algorithm (Devaney et al. 2009) and fundamental frequency estimates were made with the YIN algorithm (de Cheveigné and Kawahara 2002). Perceived pitch was calculated by taking a weighted mean across the frame-wise fundamental frequency estimates returned by YIN. Linear regression analysis was used to explore the influence of musical context on melodic and vertical intervals.

Results: For the melodic intervals, we found that the chromatic semitones were significantly smaller than the diatonic semitones and that the descending whole tones were significantly larger than the ascending ones. For the vertical intervals, we observed that their tunings were, on average, closer to the Just Intonation tuning in certain musical contexts. We also found a significant effect for the syllable on which the notes were sung, with the average size of both the ascending and descending melodic intervals and the vertical intervals being larger when sung in German.

Conclusions: Overall our results confirm earlier findings that singers’ tunings have some degree of variability and that they do not strictly adhere to a prescribed tuning system, be it equal temperament, Just Intonation, or Pythagorean tuning. The results do suggest the influence of music context can explain some of the variation in the intonation data.

Implications

Empirical study of singers’ intonation practices provides data for developing expressive performance models of singers’ intonation practices. Such expressive performance models have potential pedagogical applications for training vocalists and could be correlated with the results of psychological experiments on musical expression and emotion. They could also be useful for generating “natural” sounding digital re-creations.
References


Biography of Contributor A

Johanna Devaney research is focused on studying and modeling performance practice. She is currently working on her PhD in Music at McGill University. Johanna holds an MPhil degree in Music from Columbia University, an MA and BFA in Music from York University in Toronto, where also she taught also courses in Digital Music.

Biography of Contributor B

Jonathan Wild is Assistant Professor at McGill University’s Schulich School of Music in Montreal, where he teaches Theory and Composition. He holds a Ph.D from Harvard University. He is an active composer, sought after for vocal music especially, and his compositions are widely performed. His scholarly interests include the analysis of nineteenth- and twentieth-century music; mathematical modelling and computational investigation of musical relationships; and alternative tuning systems.

Additional Biographies

Peter Schubert is Associate Professor at the Schulich School of Music, McGill University, where he teaches counterpoint and early music analysis, and chairs the Department of Music Research. He directs the professional vocal ensemble VivaVoce and has published two counterpoint texts, Baroque Counterpoint, with Christoph Neidhöfer and Modal Counterpoint, Renaissance Style.

Ichiro Fujinaga is an Associate Professor and the Chair of the Music Technology Area at the Schulich School of Music at McGill University. He has a Ph.D. in Music Technology from McGill University. Research interests include music theory, machine learning, music perception, digital signal processing, genetic algorithms, and music information acquisition, preservation, and retrieval.