Title: Semitone Tuning in Vocal Performance

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Semitone Tuning in Vocal Performance

In earlier work, we studied six professional and six non-professional singers' performances of Schubert's "Ave Maria", both *a cappella* and with accompaniment. We observed a significant effect in both groups for intervallic direction of semitones; on average the singers' descending intervals were 7–8 cents smaller than their ascending intervals. In the non-professional group, we also observed significant effects for the presence of accompaniment and for leading-tone motion. In this group, the singers' semitones in their accompanied performances were 3 cents larger on average than in their *a cappella* performances and their semitones between leading-tone and tonic were 10 cents smaller on average than their other semitones.

In this follow-up experiment, we consider the effect of accompaniment, de-tuning, and harmonic context on singing of semitones in a set of simple two-part exercises, shown in Figure 1. As with the earlier experiment, our subject pool includes both professional and non-professional singers. The subjects are asked to sing the upper line, which is the same simple semitone pattern for all of the exercises, against a recorded version of the lower line. The lower line was retuned using pitch correction software to two different starting pitches (a major second above and below the original pitch) and three different tuning conditions. The three tuning conditions are equal temperament, Just Intonation, and a modified version of Just Intonation tuning with certain notes raised or lowered by one or two syntonic commas (22.5 or 45 cents, respectively). In the modified Just Intonation version, melodic intervals are inflected in a counter-intuitive direction to provoke the subjects into making a choice between acceptable melodic intervals or acceptable vertical intervals. The deviations from equal temperament in the Just Intonation and modified Just Intonation versions are shown Table 1. Overall, there are 6 versions of each of the 15 exercises presented to each subject, resulting in 90 measure-long exercises in total. The subjects are given a score of both parts, so that they can see the notes in the lower line.

Preliminary analysis of a pilot singer's performance of the exercises shows a significant effect for direction, similar to our earlier experiment. This singer's descending intervals were 11 cents smaller on average than the ascending intervals. There were no significant differences between the means of the semitone sizes in different tuning conditions. There was, however, a greater amount of variation in semitone size when the subject sang against the modified Just Intonation version of the exercise than for the equal tempered or Just Intonation conditions.

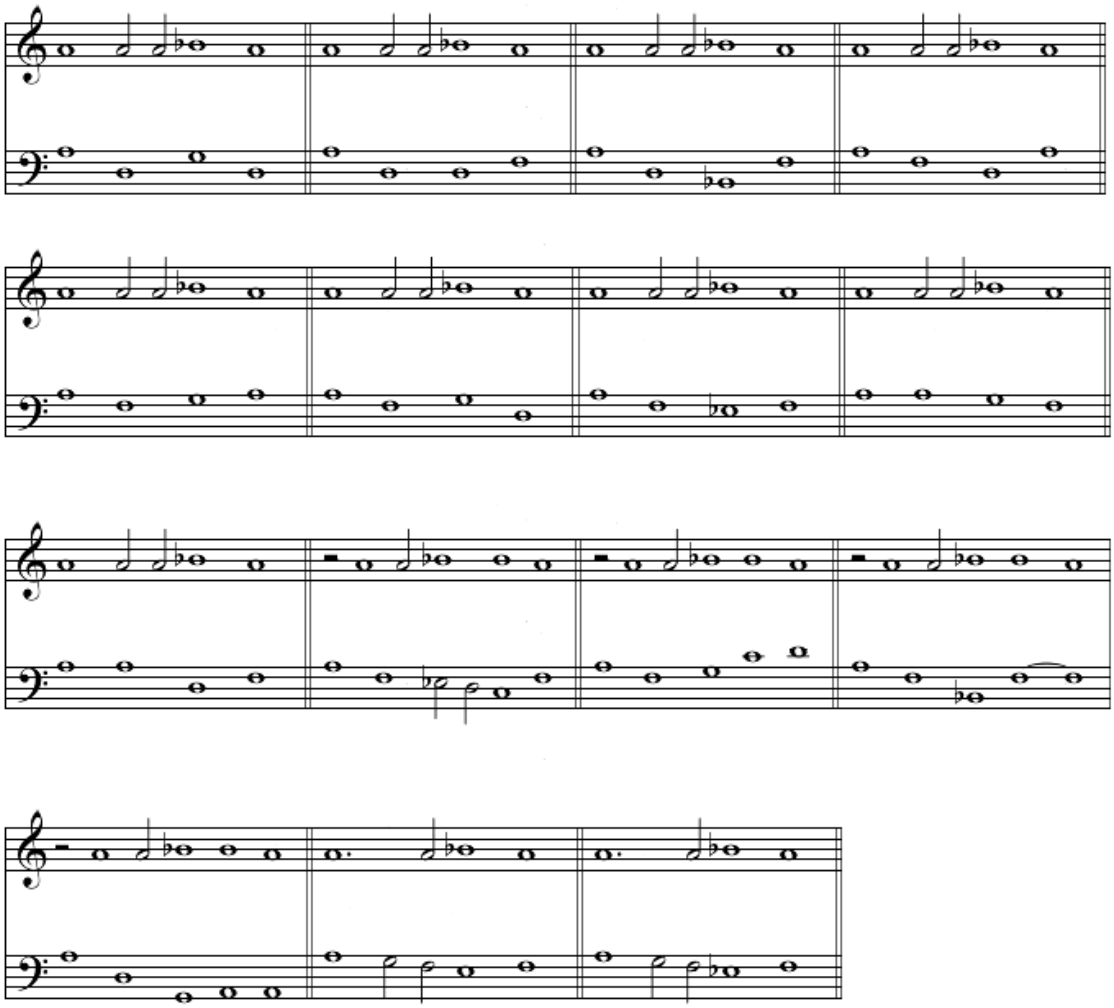

Figure 1: Two-part exercises used in the experiment.

	Just Intonation					Modified Just Intonation				
1	**D**	**G**	**D**			**D**	**G**	**D**		
	-2	-4	-2			-2	18	20		
2	**D**	**D**	**F**			**D**	**D**	**F**		
	-2	-2	14			-2	-25	-8		
3	**D**	**Bb**	**F**			**D**	**Bb**	**F**		
	-2	12	14			-2	-10	-8		
4	**F**	**D**	**A**			**F**	**D**	**A**		
	14	-2	0			14	20	22		
5	**F**	**G**	**A**			**F**	**G**	**A**		
	14	18	0			-8	-4	-23		
6	**F**	**G**	**D**			**F**	**G**	**D**		
	14	18	20			-8	-27	-25		
7	**F**	**Eb**	**F**			**F**	**Eb**	**F**		
	-8	-12	-8			14	33	14		
8	**A**	**G**	**F**			**A**	**G**	**F**		
	0	-4	-8			0	18	37		
9	**A**	**D**	**F**			**A**	**D**	**F**		
	0	-2	-8			22	20	14		
10	**F**	**Eb**	**D**	**C**	**F**	**F**	**Eb**	**D**	**C**	**F**
	14	10	-2	16	14	-8	-12	-2	-6	-8
11	**F**	**G**	**C**	**D**		**F**	**G**	**C**	**D**	
	-8	-4	-6	-2		14	18	16	20	
12	**F**	**Bb**	**F**			**F**	**Bb**	**F**		
	-8	-10	-8			14	12	14		
13	**D**	**G**	**A**	**A**		**D**	**G**	**A**	**A**	
	20	18	22	22			-27	-23	-23	
14	**G**	**F**	**E**	**F**		**G**	**F**	**E**	**F**	
	-4	-8	2	-8		18	14	2	14	
15	**G**	**F**	**Eb**	**F**		**G**	**F**	**Eb**	**F**	
	-4	-8	-12	-8		18	14	10	14	

Table 1: Tuning deviations in cents from equal temperament for the standard Just Intonation tuning (left) and the Just Intonation tuning with syntonic comma inflections (right).