



The Role of Vibrato in Violin Tone Quality and Historic Performance

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Gough, Colin

School of Physics and Astronomy, University of Birmingham, B15 2TT, UK; profgough@aol.com

ABSTRACT

The sound of the violin is strongly characterised by the player's use of vibrato resulting in cyclic variations in pitch, amplitude and timbre within a single note, with amplitudes dependent on the player, the dynamic response of the instrument and the performance acoustic. To separate the influence of the player and instrument, and as an aid to those researching the development of historical performance, software has been developed to measure, display and analyse the temporal fluctuations in playing pitch of violin vibrato sounds. The software has been used to analyse changing vibrato styles in six historic and modern performances of the 1st Brahms Hungarian Dance, and in early recordings of Kreisler and Heifetz, which illustrate the emergence of the modern, almost continuous, vibrato.

INTRODUCTION

The appropriate use of violin vibrato in the performance of baroque, classical, romantic and even early 20th century music remains a highly debated and contentious issue. There have recently been a number of detailed studies of vibrato by musicologists investigating the development of late nineteenth and twentieth century performance styles - notably by Philip [1], Katz [2] and Milsom [3]. These authors have largely used aural evidence based on early acoustic recordings of distinguished performers whose careers spanned the latter half of the 19th and early part of the 20th centuries. Milsom [3] extrapolates information on the use of vibrato still further by citing detailed guidance given on vibrato by influential teachers, such as Spohr in his *Violinschule* (1832), Bériot in *Méthode de Violin* (1858) and, somewhat later, Joachim and Moser's in *Violinschule* (1902-5). However, most such evidence is qualitative and lacks the quantitative evidence on which their conclusions could be more confidently established.

In contrast, there have been a number of quantitative measurements of vibrato tones by, for example, Mellody and Wakefield [4], who were mostly concerned with the methods for quantifying the use of vibrato and the perception and synthesis of vibrato tones, rather than aspects of musical style. In addition, there have been a number of detailed studies of violin vibrato in terms of the acoustical properties of the instrument and performance space by, for example, Fletcher and Sanders [5], Matthews and Kohut [6], Meyer [7] and the present author [8]. Wakayama et al [9] have also recently measured and compared the use of violin vibrato for selected notes played by four modern virtuosi.

In this paper, after a brief introduction to the importance of vibrato in characterising violin sounds, we describe software developed to extract quantitative information on the variations in vibrato pitch and amplitude from historic recordings. As an illustrative example, we quantify the vibrato used by six famous violinists spanning the whole of the 20th century, using the often-recorded 1st Hungarian Dance by Brahms (arranged by Joachim). In addition, we compare the use of vibrato in the same section of 1912 and 1926 recordings of Leibesleid ("Loves Sorrow") played by the violinist/composer Kreisler. The measurements are presented graphically, which allows easy visual comparison of the performance styles of different artists and how such styles have changed over time.

ROLE OF VIBRATO IN VIOLIN TONE QUALITY

In a recent paper [8] we reviewed previous studies of the complexity of violin vibrato tones arising from the closely spaced narrow resonances of the violin body. This leads to large-scale fluctuations in the amplitudes of the individual partials and hence timbre of violin vibrato sounds, in addition to the pitch fluctuations. Meyer [6] had previously shown that the time delays introduced by reflections from the walls of any performance space greatly increase the complexity and hence the projection of violin vibrato tones, as does the highly frequency dependent directional-radiativity of violin sounds above ~ 1 kHz (Weinreich [10]). One potential advantage of acoustic recordings is that the latter two effects are largely absent, as the sound had to be projected directly into the nearby recording horn. In reference [8], we showed that the dynamic response of the violin itself adds to the complexity. This is important to the player and in early recordings, as the sound close to the player's ear and at mouth of the recording horn is dominated by the sound of the violin, without enhancement from the reverberant acoustics experienced by the distant listener – or introduced by the recording engineer in later electric recordings.

The importance of vibrato on perceived violin tone quality is easily demonstrated by listening to the sound of a continuously repeated single-period extracted from a sampled violin vibrato tone, which is indistinguishable from that of a crude electronic synthesiser [8]. Other features of the violin sound, such as the nature of the initial transient and bow noise (McIntyre et al [11]) are almost certainly important – as, for example, when playing an open-string. Interestingly, the sound of a violin remains instantly recognisable, even when the first 50 ms transient of a long note is removed. Fluctuations of amplitude, timbre and pitch within a note must therefore be just as important in defining the violin sound, which emphasises the importance of vibrato and the need to quantify its use in any attempt to measure perceived violin quality.

Typical violin vibrato involves a sinusoidal pitch modulation, with a width (total swing) that ranges from zero to around a quarter-tone (50 cents) and occasionally more, at a typical rate in the range from 5 to 8 cycles per second. Within a given note, a good player has the facility to control both the amplitude and rate of the vibrato used as a function of time. Because of this flexibility and varied use of vibrato, it makes little sense to refer to vibrato rates and amplitudes for single selected notes alone, as has often been attempted in the past. It only makes musical sense to quantify the use of vibrato over extended musical examples. Even then, one must recognise that any such analysis only provides a snap-shot of the player's style for the specific musical example chosen, which may fail to take into account changes in a player's use of vibrato with respect to both emotional context and historical context (i.e. Bach or Brahms).

ANALYSIS OF VIBRATO RATES AND WIDTHS.

The accurate analysis of pitch variations from acoustic recordings presents a number of experimental difficulties arising from the large amount of surface noise and the restricted frequency range only extending up to ~ 3 kHz. In addition, recordings often have piano accompaniments, which “interfere” with the sound and pitch identification of the solo instrument. To minimise such problems, we first use CoolEdit to filter out wide-band surface noise and to remove almost all the largely transient “clutter” associated with the piano accompaniment by removing all frequencies below 1200 Hz. The filtered sound is then analysed using Praat software [12], which uses autocorrelation methods to follow the pitch fluctuations cycle by cycle. The pitch data file is then manually “corrected” for the small number of missing or mistaken values, which arise from the presence of noise and the very large changes in amplitude, shape and spectral content of the vibrato waveform within each vibrato cycle. A MathCAD software programme is then used to extract the notes being played, assuming each note is centred on a note of an equally tempered chromatic scale. A continuous trace can then be plotted of the deviations in pitch within each note played.

Figure 1 illustrates the pitch profile, identified notes and fluctuations in pitch for the first 12 bars of Brahms' Hungarian Dance No 1 recorded by Joachim in 1903.

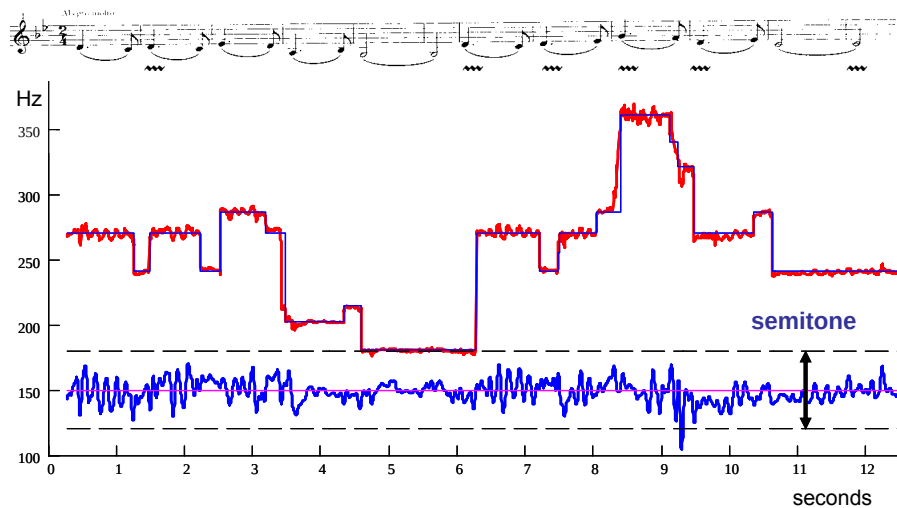


Fig. 1 Pitch variations of the first 12 bars of Brahms Hungarian No 1 in G-minor recorded by Joachim in 1903, with automated note identification and deviations in tuning from the equal temperament scale indicated on an expanded scale, with the dashed lines indicating the extent of a total pitch swing of a semitone.

The curly lines under specific notes of the music illustrate the use of vibrato, as identified by Katz [2] from listening tests. Despite the rather large random fluctuations in pitch - even on the open G-string - which largely arise from surface noise, such measurements provide much more detailed information than could ever be deduced from listening tests alone. Indeed, Katz failed to detect the relatively large vibrato of almost a quarter-tone swing on the very first note.

Sections of such traces can be fitted to a sinusoidal variation of pitch within a note, allowing for slowly varying background variations, to provide quantitative information on both vibrato rates and amplitudes and vibrato onset and termination times within a note. Computer fits to sinusoidal pitch fluctuations are illustrated in Figure 2 for the first note of the Hungarian Dance, once vibrato was established, played by four violinists. Note the significant amount of vibrato used by Joachim and the apparent increase in both vibrato amplitude and vibrato rate with time. However, it would be dangerous to use an isolated note, recorded in a selected piece of music, by four carefully selected players, to deduce that this was a general feature of changing styles of violin playing over the first half of the 20th century. To address such issues, it is important to analyse longer musical examples and to analyse many more players and musical examples. The Brahms Hungarian Dance example is important because it has been recorded by a very large number of individual players over the last century.

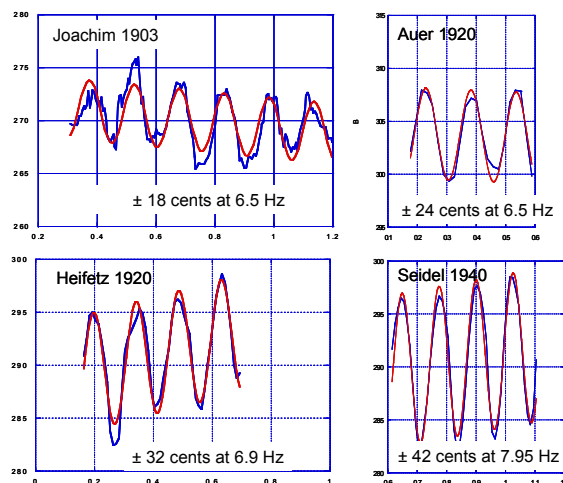


Fig.2 Computer fits of sinusoidal pitch fluctuations to vibrato-established sections of the first note of the Brahms Hungarian Dance No 1 played by 4 violinists.

COMPARISON OF PERFORMANCE STYLES

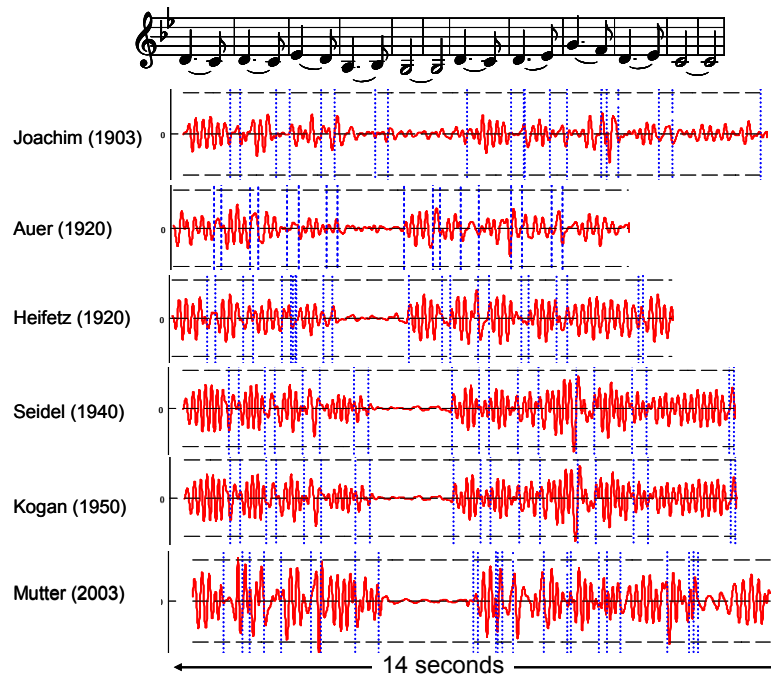


Fig. 3 Fluctuations in pitch from equal temperament tuning in the first 12 bars of Hungarian Dance No. 1 by Brahms recorded by six leading violinists. The horizontal dashed lines correspond to a total width of a semitone (100 cents) and the dotted vertical lines are software generated indicating the times at which the pitch changes by a semitone or more.

Figure 3 illustrates the vibrato induced pitch deviations from an equal temperament scale for six distinguished violinists spanning a hundred years of violin playing. Such plots highlight the general increase in vibrato width over the last century, with both Joachim and Auer using only a third to half to a third of the vibrato widths of modern players, though accurate measurement of smaller amplitudes is difficult because of the large amount of surface noise. Contrary to what has often been claimed, the measurements reveal only a slight increase in vibrato rate, though the finger movements are indeed faster because of the larger amplitudes involved. A faster finger movement as opposed to a faster vibrato may well have been a point of confusion to musicologists commenting on the evolution of vibrato in the nineteenth and early twentieth centuries. In this example, the note lengths are relatively short, so that vibrato is generally only used on the longer notes, as indeed advocated in many nineteenth century teaching texts (see Milsom [3]).

Figure 4 uses the same data to derive the spectrum of vibrato induced-pitch fluctuations. The measurements indicate overall vibrato rates for Joachim and Auer that are very similar, in the range $5\frac{1}{2}$ - $7\frac{1}{2}$ Hz, with Heifetz about $\frac{1}{2}$ Hz faster. Seidel uses a still faster and wider vibrato in the range 6-8 Hz, while Kogan's is typically $\sim \frac{1}{2}$ Hz slower and similar to that used by Heifetz. Anne-Sophie Mutter's use of vibrato is highly individual – at least in this example – often starting extremely slowly, with an overall range from ~ 5 -7 Hz. The absence of any significant increase in spectral weight at two (or three) times the main peak indicates that, to a rather good approximation, the vibrato in all examples is closely sinusoidal in character.

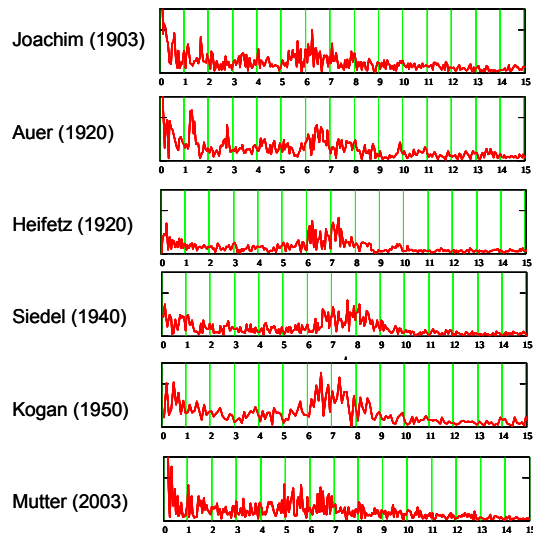


Fig. 4 Fourier spectrum of pitch fluctuations about equal temperament tuning for the first 12-bars of the Brahms Hungarian dance No 1.

EMERGENCE OF THE MODERN “CONTINUOUS” VIBRATO

Acoustic recordings at the turn of the century show that violinists used vibrato more sparingly than is common today, with vibrato generally restricted to longer notes that allowed the completion of several vibrato cycles. This follows the guidance on vibrato given in several influential tutorial texts, such as those by Spohr (1832), Bériot (1858) and Joachim-Moser (1902-5), as cited by Milsom [3], who provides several examples of the recommended use of vibrato from the original texts. Such advice is consistent with modern psycho-acoustic observations (summarised by Brown and Vaughn [13]), which show that for vibrato rates of greater than ~ 5 Hz, the ear cannot follow pitch changes, so that for vibrato tones with at least one or more vibrato cycles, vibrato is perceived as a change in timbre of the note at the time-averaged pitch, while for shorter vibrato tones, the perceived pitch is weighted towards the last pitch sounded. However, as early as 1900, music critics were already commenting on the increased use of vibrato – even on short notes and “technical passages”.

Fig.5 illustrates the vibrato used by the 16-year old Heifetz, in a 1917 recording of a transcription of Schubert’s Ave Maria, and by Kreisler in 1912 and 1926 recording of his composition Leibesleid. Kreisler is often cited as the originator of the modern “continuous” vibrato, though he was clearly not alone in using it in the early years of the 20th century. The illustrated computer fit to a sinusoidal pitch variation, for the 3s-long note ~ 4 s after start of the illustrated section of the Kreisler’s 1912 recording, demonstrates a remarkable constancy within the note of both vibrato amplitude ($\pm 20 \pm 1$ cents) and rate (7.05 ± 0.05 Hz), after the initial single “start-up” vibrato cycle. Interestingly, there is some evidence for the vibrato starting from the central pitch with an initial downward vibrato half-cycle, as advocated by modern teachers such as Galamian [14], though the player is also recommended to vibrato under the pitch of the note, which would make it sound flat. The use of vibrato by Kreisler in the later 1926 recording is almost identical to that of the earlier recording, though somewhat less regular. The longest note is played with the same vibrato width ($\pm 20 \pm 1$ cents), but at a slightly faster rate of 7.5 Hz for the first half of the note slowing to ~ 6.95 Hz for the second part. Fig.5 also illustrates the way that Kreisler starts and stops the vibrato at the start and end of each note - and at each time the bow direction is changed as the same note is repeated, indicated by the vertical arrows. In this sense, the vibrato is continuously used on all the note played, rather than being continuous (i.e. without stopping). Indeed, the way that a player starts, stops and shapes vibrato within a note is a very important characteristic of a player’s individual style. To paraphrase Flesch - *without vibrato it is impossible to recognise individual players, but using vibrato each player is easily and surely distinguished* - cited in full by Milsom [3, page 122]. Note also the use of portamento (continuous pitch changes between notes) in both the Heifetz and Kreisler examples.

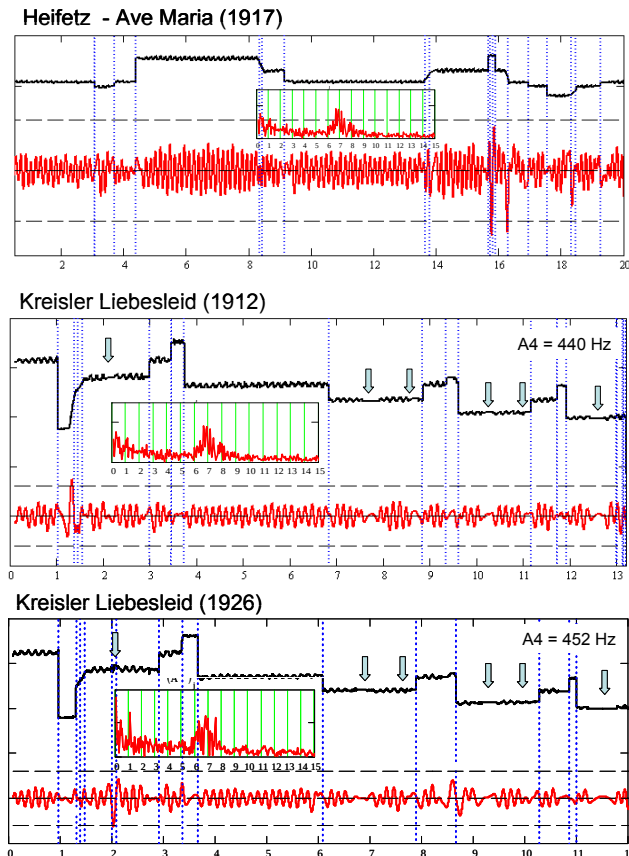


Fig.5 Examples of “continuous” vibrato used by Heifetz and Kreisler, with insets showing the spectrum of vibrato rates. Vertical arrows indicate bow changes on the same note.

CONCLUSIONS

We have developed software and graphical outputs that allow a critical comparative analysis of the use of vibrato in historic and modern recordings of the violin - and any other instrument. Comparison is made of the use of vibrato by six famous violinists playing the same section of Brahms Hungarian Dance No.1, and also of Kreisler and Heifetz playing sections of more melodic music. The measurements quantify the increased use of vibrato over the 20th century and illustrate the emergence of the modern form of “continuous” vibrato. In addition, the software allows the automated analysis of note lengths and the use of portamento (sliding in pitch) between notes, which are other important factors involved in the development of violin playing styles over the last century.

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