# Effective and expressive movements in a French-Canadian fiddler's performance

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## ABSTRACT

We report on a performance study of a French-Canadian fiddler. The fiddling tradition forms an interesting contrast to classical violin performance in several ways. Distinguishing features include special elements in the bowing technique and the presence of an accompanying foot clogging pattern. These two characteristics are described, visualized and analyzed using video and motion capture recordings as source material.

## Keywords

fiddler, violin, French-Canadian, bowing, feet, clogging, motion capture, video, motiongram, kinematics, sonification

## 1. INTRODUCTION

Recent developments of motion capture technologies have spurred the interest in movement analysis of music performances. Measurement of instrumentalists' movements have been used for the study of effective movements related to the production of sound [2, 3, 5], as well as the study of ancillary movements related to expression [2, 12]. Motion capture measurements have proven particularly useful for the study of bowed-string instrument performance, as the sound in these instruments is entirely produced by means of overt movements [1, 4, 7, 10, 14].

The violin is known as a highly versatile instrument being played in a wide range of musical styles and traditions. Yet, there is a strong bias of performance research focusing on classically trained, expert performers. Despite the large variety of individual strategies among classical performers, this might constrain our scope on the wide range of possibilities offered by the instrument in terms of playing technique and expressivity.

In this paper we present a case study of a fiddler's performance, stemming from the French-Canadian tradition. The fiddling tradition largely contrasts the classical: a) Performances mostly take place in informal settings, for example a jam session in a pub. b) The playing technique is typically less "polished," as the sound should be audible under varied acoustic conditions, including noisy environments, outside, etc. c) The repertoire mainly consists of traditional tunes learned by ear. d) The performances have an improvised character and are often combined with dance. e) Fiddlers often accompany their playing with clogging patterns produced with their feet, in the French-Canadian tradition typically a heel-heel-toe-toe pattern in sixteenth notes.

The aim of this paper is twofold. First, we want to illustrate the violin's versatility as a musical instrument by focusing on a non-classical violin performance. Second, we want to provide a showcase for alternative analysis methods and representations of movement data. We will present motion-based analyses of a variety of aspects of the performance, illuminating particular bowing techniques and clogging patterns. Motiongrams extracted from the video will be used to illustrate global features of the performance, while analysis of motion capture data will provide insights at a higher level of detail.

## 2. RECORDINGS

Performances of an expert fiddler of the French-Canadian tradition were recorded.[1] The fiddler is an experienced performer, playing and recording on a regular basis, and he is also active as a teacher. For the analyses in this paper a complete performance was selected of the reel *Le bedeau de l'enfer* (transl. *The deacon from hell*). The reel consists of two parts (A and B), and was performed with the following repetition scheme in the recording: A-A-B-B-A-A-B-B. The average tempo of the performance was ∼103 BPM.

Motion capture recordings were made at IDMIL/McGill using a Vicon 460 system with six cameras placed around the performer. Video and audio were recorded in synchrony with the motion capture data. Full body measurements were made using the Plugin-gait marker placement (39 markers). The position and orientation of the violin and the bow were tracked by five markers on each object. Additional sensors were placed on the bow for measuring bow force and acceleration [4]. This setup allowed for an accurate calculation of all relevant bowing parameters, including bow velocity, bow-bridge distance and bow force, as well as the angles of the bow relative to the violin [11].

## 3. GLOBAL FEATURES

As a first step in the analysis, global features were studied using the video recording as source material.

### 3.1 Video analysis

*Motiongrams* created from the video recordings of the fiddle performance are shown in Fig. 1. The motiongram technique is based on calculating the normalized mean value of



[1]See recordings of Fiddler performances at http://www.youtube.com/schoondw

each column or row in a *motion image* (frame-difference image) [6]. As opposed to traditional keyframe displays, where individual video frames are plotted next to each other, motiongrams can show the temporal and spatial unfolding of movement over time.

The horizontal motiongram in Fig. 1, which shows information about movement in the vertical plane, provides the clearest information of the rhythmical body movements during the performance. The upper part mainly shows the movement of the bowing arm, whereas the lower part represents the clogging pattern produced by the legs. Interestingly, a clear transition in the clogging pattern can be distinguished halfway through the performance, which coincides with the reprise of part A of the reel. The transition marks an increased intensity of the performance.

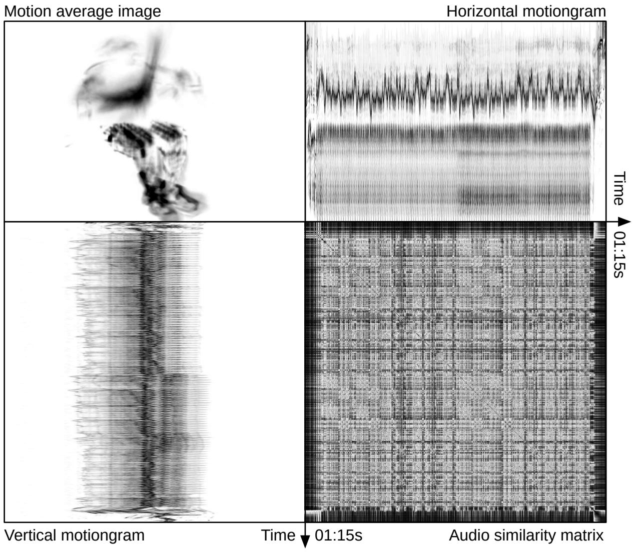


**Figure 1: Motion average image, horizontal and vertical motiongrams of the video recording, and a similarity matrix of the spectrogram of the audio recording.**

The *motion average image* in Fig. 1 is based on calculating the mean matrix of all motion image frames. The result is a "blurred" image displaying the spatial distribution of motion for the whole recording. Here we can see the movement of the bowing arm and the pronounced movement of the legs corresponding to the clogging. Furthermore, it can be seen that the range of motion in the right leg was larger than that in the left leg.

As a reference to sound, we have also included a similarity matrix of the sound recording in Fig. 1. Since time runs in two dimensions in a similarity matrix, it can be used to compare sonic features to motion features in both motiongram directions. Notice how the repetition structure of the performance (A-A-B-B-A-A-B-B) can be clearly distinguished in the similarity matrix.

## 3.2 Sonification of motiongrams

Since motiongrams share many visual properties with spectrograms, they can be used as the basis for an 'inverse spectrogram' approach, as suggested in [13]. This way we can create a direct mapping from motiongram to spectrogram.

An implementation of such an inverse spectrogram technique for sonification of motiongrams is based on reading each row in the motiongram matrix and mapping them directly to an interpolated oscillator bank, which does the additive synthesis. The final result is a direct sonification of the motion, where low frequencies are controlled by movements in the lower part of the image and higher frequencies by movements in the upper part.

An example of a sonification based on the video recording of the fiddler shows how present both the bowing and clogging patterns are in the sonification.[2]

# 4. MOTION CAPTURE ANALYSIS

A selection of particular features of the performance were analyzed in more detail using the 3D motion capture data.

## 4.1 Bowing

The extracted bowing parameters allowed for some general observations regarding the use of the bow. The piece mainly consists of 16th notes, which were played détaché or in short two- or three-note slurs. The range of bowing parameters was mainly in a "comfortable zone;" the middle of the bow was used, the bow velocity was ~1 m/s, and the bow-bridge distance was ~4 cm. A rather large range of bow force was used, with pronounced peaks revealing a strong accentuation pattern.

A peculiar feature of the bowing was that the performer used a pronounced backward tilt (i.e. *rotation around the length axis*) of the bow. Interestingly, a backward tilt of the bow is uncommon and even discouraged in classical playing, as it creates a rough sound. An acoustical explanation for this is related to partial slips, causing spikes in the bridge force signal making up the sound [8, 9]. The consistent use of backward tilt suggests that this roughness might be a desirable aspect of the sound quality in fiddling.

Another interesting element present in the performance was the use of the *shake*, a type of bowing ornament commonly used in French-Canadian fiddling as well as other fiddling styles. The shake could be characterized as "a rapid and indistinct bowed triplet, more of a scratch than a series of notes."[3]

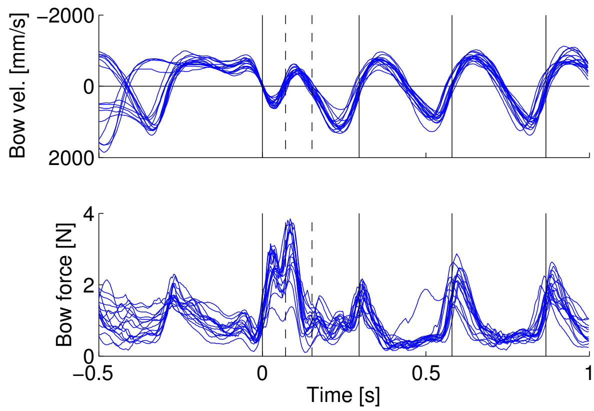


**Figure 2: (a, b) Overlapping bow velocity and bow force profiles of 16 occurrences of the main motif, consisting of a shake (at t=0) followed by four 16th notes. The solid vertical lines indicate half beat durations (8th note level). The dashed vertical lines show the subdivision of the shake.**

Fig. 2 shows overlapping bow velocity and bow force profiles of 16 selected occurrences of the main motif of the piece consisting of a shake followed by four 16th notes. The timing profiles extracted from the bow reversals (zero crossings in bow velocity signal) are shown in Fig. 3. The profiles

[2]Video at http://www.youtube.com/watch?v=pV8JglqB94k
[3]Definition found on an internet discussion forum.

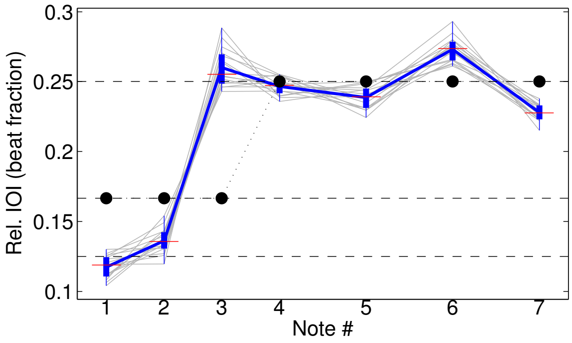


**Figure 3: Timing profiles of the main motif shown in Fig. 2. The dashed lines indicate the nominal values of 8th notes, triplets, and 16th notes. Nominal durations of the notes (according to a transcription) are indicated by black dots.**

reveal a high degree of consistency, both with regard to the use of the bowing parameters, as well as the rhythmic performance. The shake was played as two rapid notes (32nd) followed by an 8th note. The two first notes were played with a high bow force (2–4 N), showing a pronounced double peak; in combination with the small bow displacement this resulted, indeed, in a scratchy sound with a more or less percussive character.

Figs. 2 and 3 also give insight in the accentuation pattern of the 16th notes. The first and the third notes (played up bow) were accented; the strongest accent fell on the third note, resulting in a syncope-like effect. The accentuation was achieved by a combination of (1) bow force, showing strong peaks at the attack of the first and third notes; (2) asymmetry in the bow velocity pattern, showing a shorter attack time (steeper slope) at the beginning of the first and the third notes; and (3) prolongation of the first and the third note at the cost of notes two and four; the third note was consistently played the longest, whereas the fourth note was consistently played the shortest.

## 4.2 Clogging

The perhaps most special feature of the fiddling performance presented here is the clogging with the feet, used as a rhythmic accompaniment of the playing. As already suggested by the horizontal motiongram in Fig. 1, there was a transition in the clogging pattern in the middle of the performance. The motion capture data reveals that in the first part the beats were divided in a long-short-short rhythm, with tapping pattern: right heel / right toe / left foot. In the second part the beats were subdivided in four 16th notes with tapping pattern: right heel / left heel / right toe / left toe.

The patterns, as well as the transition between them, are illustrated in Fig. 4 by the vertical movement of the knees. The right leg shows the largest movement amplitude, confirming the initial observation from the motion average image in Fig. 1. An explanation for this is that the player stressed the strong metrical events (first and third within a group of 16th notes), which coincide with the tapping of the right leg. In the first part, the left foot taps on every fourth within a group of 16th notes. In the second part the movement pattern of the left leg is similar to that of the right leg, but shifted in phase by one 16th note so that the taps are alternating. The transition seems to occur suddenly from one stable coordination pattern into another,

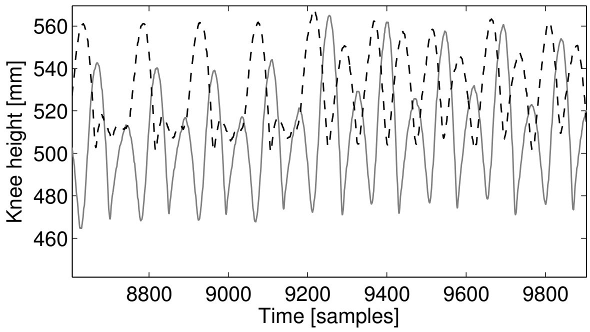


**Figure 4: Height of right knee (grey) and left knee (dashed) versus time. The selected intervals show the different clogging patterns present in the performance, as well as the transition between them.**

which indicates a highly efficient motor control.

The kinematic profile of the right leg (knee, heel, toe; seen from the side) is shown in Fig. 5. The position of the leg is marked in bold at instances of tapping with heel and toe. The motion consists of a combined up-down and forward-backward movement of the lower leg: the leg moves forward before tapping with the heel, and backward before tapping with the toe. An interesting detail here is that in preparation for the heel tap the leg is pushed up by flexion of the foot after the toe tap, minimizing the effort of lifting the leg.

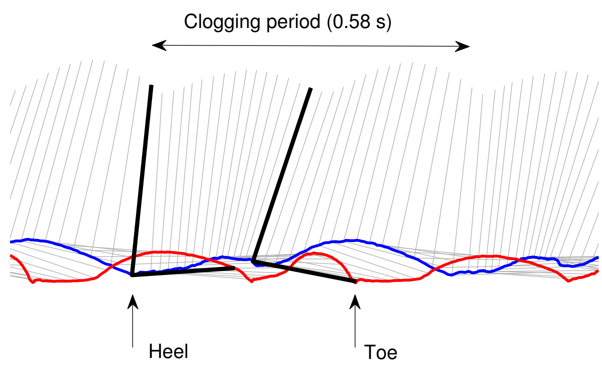


**Figure 5: Kinematic representation of the clogging pattern of the lower right leg. The sticks show the connections between knee, heel and toe markers. Movement trajectories are shown for the heel and the toe. The tapping events of the heel and the toe are marked by arrows. The time interval between the shown frames is 20 ms between frames; a translation to the left with increasing time is applied for a clear presentation of how the movement unfolds.**

The moments of impact of the feet were extracted from the vertical displacement of the heel and the toe markers of the right and the left foot, using a peak picking algorithm (with knowledge of the periodicity of the signals). This allowed for extracting timing characteristics of the clogging patterns, shown in Fig. 6. The clogging pattern in the first part shows a clear long-short-short pattern, consisting of an 8th note interval followed by two 16th note intervals. The first of the two short intervals was consistently prolonged at the cost of the second one. The clogging pattern in the second part showed rather regular 16th note intervals. The first

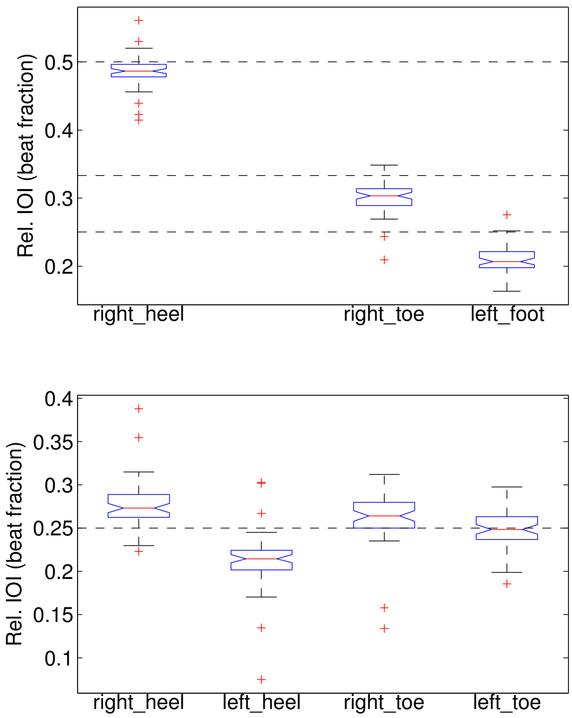


**Figure 6: Timing profiles (normalized IOI) of the two clogging patterns. The dashed lines indicate nominal values of 8th notes (0.5) and 16th notes (0.25).**

and the third intervals were slightly prolonged, consistent with the timing profile of the bowing in Fig. 3. However, in the clogging the first interval was longest, and not the third as in the bowing.

## 5. DISCUSSION AND CONCLUSIONS

In this study video recordings and 3D motion capture data have been used to reveal different aspects of a fiddler's performance. Motiongrams and a motion average image, in combination with a sound similarity matrix, were used to distinguish global patterns in the performance. They revealed the spatial distribution of motion in the performance, as well as a transition in the clogging pattern halfway through the performance. Analysis of the motion capture data provided detailed information of special performance features, including the shake, and kinematic features of the clogging and timing profiles.

Analysis of the bowing provided some indications of differences between fiddling and classical performance, which might be traced back to a different sound ideal. Three distinct features regarding the use of the bow we described are: (1) the backward tilting of the bow, (2) the accentuated use of bow force in détaché bowing, and (3) the "shake," a special ornamentation technique. These features contribute to a highly articulated sound containing scratchy elements, whereas classical performers generally strive for a more homogeneous and "polished" sound quality. Even though the data of only one player have been shown, such features can be commonly observed in other fiddlers' performances within the same and other traditions (e.g. Celtic, Scandinavian).

Besides the sound-producing effects, the performer's movements may also be interpreted at an expressive level, providing the performance its special character and style. The bow velocity and bow force profiles provide insight in the expressive shaping of the performance by means of accentuation and expressive timing. The combination of clogging and bowing also provides a nice illustration of a complex coordinated motion involving all four limbs.

While the violin is not a new instrument for musical expression, its use in fiddling and in combination with other musical elements (e.g. clogging) provides for a different musical experience. We hope that alternative performance studies of other (traditional) instruments may open for a broader understanding of musical instruments and their use in performance.

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