International Symposium on Performance Science
ISBN 978-94-90306-01-4

Analyzing and representing Transylvanian village music by using motion capture

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Techniques based on motion capture can be useful to analyze and transcribe a foreign musical system: Transylvanian village music. Two musical parameters were the object of study: rhythm and desynchronization between two performers, a violinist and a viola player. Results showed that rhythm is a local variant of the *aksak* system and is based on two duration units (S=short, L=long), which respect the formula $^{2}/_{3}<{}^{S}/_{L}<{}^{3}/_{4}$. Performances are characterized by large deviations of the $^{S}/_{L}$ ratio from period to period, which have an expressive function. Deviations are related to a swinging interpretation, consisting of a voluntarily desynchronization between the performers.

Keywords: ethnomusicology; Transylvania; gesture; rhythm; desynchronization

Analysis and transcription of non-western music has always been a controversial subject in ethnomusicology (England 1964). The Western musical theory and notation system are often unadapted to describe musics of oral traditions that rely on different concepts of rhythm, scale, interval, etc. which are often implicit. For this reason, ethnomusicologists have progressively developed specific techniques in order to analyze and represent formal proprieties of the music they study (Rouget 1981). Emerging technologies based on motion capture offer new possibilities for a deeper understanding of music production and perception (Leman 2007). The main idea underlying the present study is that these techniques can be particularly useful to analyze and represent Transylvanian village music.

Two musical parameters of the *de meseli* or *de jale* repertoire ("table songs" or "songs of sorrow") were the objects of study: rhythm and desynchronization between two performers, a violinist and a viola player. These parameters are particularly apt to be studied by motion capture because they are directly related to body movements. The metrical-rhythmical system of these slow listening tunes belong to the family of *aksak* (from the Turkish "lame") rhythms, which have been documented in different parts of the world and especially in Turkey and the Balkan region (Brăiloiu 1952). A rhythm is an *aksak* when (1) it is periodical and (2) each period is composed by the combination of two duration units (short=S and long=L), which are in a ratio of $S/L = 1/1.5 = 2/3$ (Brăiloiu 1952). *Aksak* rhythms are usually indicated by the series constituting the period, for example 2.2.3, 2.3.2, 2.2.2.3, etc. The repertoire concerned here is characterized by a 2.3 period. *Aksak* has been at the center of controversial debates in French ethnomusicology, and there is no agreement on the way to theorize it (in terms of an irregular bichrone beat, or of an underlying monochrone beat; see Arom 1992, Bouët 1997, Cler 1994, Cler and Estival 1997). Rather than with theoretical matters, the present study deals with a concrete issue: precise measurement of the S/L ratio, which is an important indicator of how the *aksak* model is locally conceived by musicians. A related issue concerns deviations of S/L ratio from norm values in live performance. Our hypothesis is that *aksak* deviations are related to a swinging effect, consisting of a voluntary desynchronization between performers.

METHOD

Participants

Two professional gypsy musicians from Ceuaş, a small village of the Tîrgu Mureş region, were invited to the INSERM Laboratory of the University of Burgundy. They are among the best (and last) interpreters of Transylvanian village music, were born in 1953 and 1951, and have played together since they were children. Csanyi plays the melody on the violin and Csangalo the rhythmic-harmonic accompaniment on the *contră*, a specially prepared viola with three strings tensed on a bridge with a flattened curve, tuned A-D-G.

Materials

The movements of 38 retroreflective markers (15 mm in diameter), placed at various anatomical locations on the body, were measured using an optolectronic device, Smart (BTS, Milan, Italy). Six infrared-emitting cameras were

attached to six tripods, 2 m from the ground on each side of the subject, at a distance of 3 m from each subject's body. In this experiment, the motion of only two markers was analyzed—that is, the ones located on the top of the bows. Kinematic parameters in three dimensions (X, Y, and Z) were calculated from successive frames taken at 10 ms intervals. Kinematic variables were low-pass filtered using a digital second-order Butterworth filter at a cut-off frequency of 5 Hz. Sound was recorded separately and the session was filmed with two additional standard cameras. Synchronization between sound and image was obtained by using a clapper board equipped with two additional retroreflective markers.

Procedure

Musicians were standing at the center of a circular region surrounded by the six infrared cameras. They were asked to play 30 s fragments of six tunes issued from the local *de meseli* repertoire. One tune (Duo14, test melody) was played 3 times (Duo12, Duo13, and Duo14). The session lasted about 3 hours and musicians, who are used to much longer musical performances, felt comfortable in the experimental setting.

RESULTS

Figure 1 shows the rhythmical pattern obtained by tracking the marker positioned at the top of the viola bow on the Y dimension. The periodical cycle of the *aksak* rhythm is clearly recognizable. The short (S) and long (L) durations for each period were obtained by measuring the time interval between one pick and the next. The picks indicate a change in the bow direction, corresponding to the beginning of a short rhythmic unit (superior picks) and of a long rhythmic unit (inferior picks). This measure was obtained with a margin of error of ±7 ms. For the test melody (Duo14), short and long durations vary as follows: 1.05 s≤S≤1.127 s, and 1.541 s≤L≤1.817 s. The mean value of $^{S}/_{L}$ ratio for Duo14 is 0.7 (corresponding to $^{S}/_{L}=^{2.2}/_{857}$, if S=2 as in *aksak* convention), and varies largely from period to period in the same performance ($^{2}/_{3.044}\leq{}^{S}/_{L}\leq{}^{2}/_{2.448}$). The mean values of $^{S}/_{L}$ ratio for the three performances of the same melody are very similar: $^{S}/_{L}$=0.695 for Duo12 and 0.696 for Duo13. Finally, for all 8 melodies the proportion $^{S}/_{L}$ respected the formula: $^{3}/_{4}\leq{}^{S}/_{L}\leq{}^{2}/_{3}$ (see Table 1).

Desynchronization was analyzed by superposing the movements of the violin bow (melody) with those of the viola bow (accompaniment) (Figure 2 top). These patterns were projected on a stave to obtain a musical transcription (Figure 2 bottom). Musicological analysis linked the notes of the melody

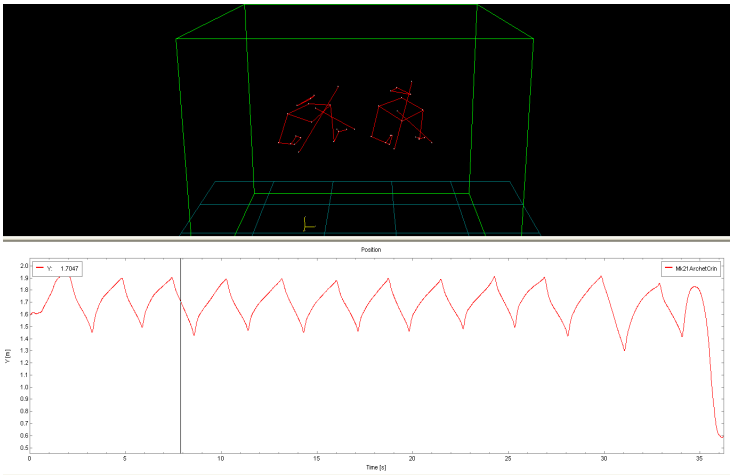

Figure 1. SMART viewer window. Top: Musicians' virtual silhouettes (violinist left, violist right). Bottom: Rhythmical pattern of Duo14, obtained by tracking the marker positioned at the top of the viola bow on the Y dimension. (See full color version at www.performancescience.org.)

Table 1. $^{S}/_{L}$ mean values for eights de meseli tunes (Duo12, Duo13, and Duo14 are different performances of the same tune). Aksak ($^{2}/_{3}$) and $^{3}/_{4}$ ratio are included in the table for comparison.

	Ratio $^{S}/_{L}$ (mean)	*Rhythm (S, L)*
Aksak norm	0.667	2.3
Duo12	0.695	2.2, 878
Duo13	0.696	2.2, 874
Duo14	0.700	2.2, 857
Duo18	0.735	2.2, 721
Duo19	0.679	2.2, 946
Duo20	0.689	2.2, 903
Duo21	0.687	2.2, 911
Duo22	0.729	2.2, 743
3.4	0.750	2.2, 667
Mean value on 8 tunes	0.701	2.2, 853

with the expected chords of the accompaniment (Figure 2 bottom). What emerges is a desynchronization between the two performers at almost each period: melody both anticipates and follows the relative chords.

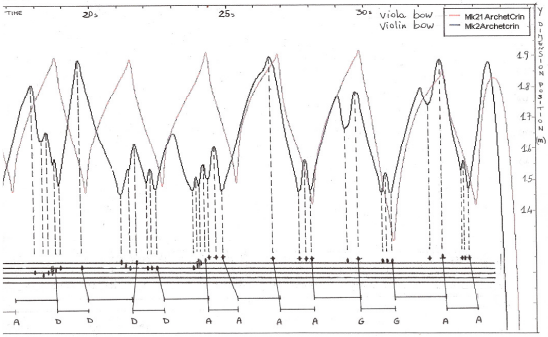

Figure 2. Top: Superposition of violin and viola bow movements for Duo14 (extract). Bottom: Transcription of melody (violin bow) and harmonic-rhythmic accompaniment (viola bow) obtained from changes of bows directions. Lines linking melody to accompaniment highlights desynchronizations between the two performers.

DISCUSSION

Motion capture technologies have been used here to study two parameters of Transylvanian *de meseli* repertoire in live performances: rhythm and "swing," defined as the desynchronization between melody and harmonic-rhythmical accompaniment. The tracking of only two markers (positioned at the top of the bows) allowed us to obtain easy readable representations of (1) *aksak* rhythmical patterns and (2) type and degree of desynchronizations. These gesture-based representations served here both as a measuring tool and as a support for musicological analysis and transcription.

While measures have been done for Turkish village music (using a sound analyzer, Cler and Estival 1997), to our knowledge Transylvanian *aksak* repertoire has been analyzed only qualitatively (Bouët 1997). In relation to a similar repertoire as the one concerned here, Bouët (1997) raised the problem of determining if musicians conceive the rhythm in terms of an "orthodox" *aksak* (2.3) or of a "heterodox" *aksak* (3.4). Results showed that the rhythm concerned here is between the two: the *de meseli* repertoire is based on a local variant of *aksak* characterized by the function $^{2}/_{3}<^{S}/_{L}<^{3}/_{4}$.

Deviations from norm durations, which are generally linked to expressivity in live performances (Gabrielsson 1995), were found. While in the case of turkish *aksak,* Cler and Estival (1997) described a stability of $^{S}/_{L}$ deviations along the entire performance, our results showed that they vary widely from period to period. This difference may be attributed to the different social function of the repertoire studied. Transylvanian listening tunes, as opposed to Turkish dance tunes, may leave to the performers more liberty in rhythmi-

cal deviations. We advanced the hypothesis that these deviations in *aksak* proportions are related to a swinging interpretation, intended as a desynchronization between the two performers. Motion capture, associated to musicological analysis, attested the large presence of desynchronizations between melody and accompaniment, which suggests that they are introduced voluntarily. Further research is needed to confirm if *aksak* deviations and desynchronizations are systematically linked and in which manner they depend from the musical structure of the *de meseli* tunes.

Acknowledgments

The first author has conducted field research in Transylvania from 2004-06 thanks to a CNRS doctoral grant. This study was realized thanks to a financial support of the CNRS "Music, Cognition, Society" network.

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