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The Role of Instrument Properties in Music Performance: Variations in Sound and Movements Induced by Baroque-Violin Playing

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Since the end of the 1960's both musicologists and musicians have made a significant contribution towards the revival of ancient instruments and repertoire, as well as towards the reconstruction of interpretative style. The interesting point here is that one single repertoire is played in different ways, on different instruments. This peculiarity in the history of interpretation provides an unique opportunity to study the effects of various constraints on musical performance. According to K. Newell's (1986) definition of action as emerging from the interaction between organism, environment and task, music performance may be viewed as resulting from the interplay between performer, interpretative tradition, instrument and musical work. This unique situation is also a way to assess the lag between musical plans (projects) and their performance (achievement).

Method

Three groups of violinists of roughly equal expertise participated in the study (high level students of Paris Conservatories). The first group consisted of musicians specializing in ancient instruments (i.e. baroque violin) and is considered as the control group. The second group involved musicians specializing in both baroque and modern instruments. Lastly, the third group was composed of modern violinists who have never tried to play an ancient instrument.

All participants had to play the first two musical phrases from the "Gavotte en Rondeau" BWV1006 by J.S. Bach along two different interpretative styles (baroque vs. modern) and on two different violins (baroque vs. modern). This imitation task has the advantage to impel the musical intention of the musician, hence to exert control on the sound production. Besides the musicians of the first group who played only baroque violin (control group), all performers played the musical phrases along the two "styles" (baroque and modern) on both violins (baroque and modern). Consequently we are able to compare the arm movement and the sound production of each violinist while performing baroque and modern interpretation on both instruments.

Each performance was recorded by means of a minidisc recorder synchronized with two video cameras (sampling rate 50 hz).

Results

For each performance we conducted an analysis of the sound signal, and a kinematic analysis of the right arm movements (bow arm). These analyses should allow us to characterize: (1) the variation in sound production due to instrument's properties, (2) the adaptation of the bow movements and the arm coordination to the instrument's properties, and (3) the effect of musicians' competencies (familiarity with baroque instruments) on arm coordination.

Sound analysis: A "baroque" musical scale

A specific method of sound analysis based on acoustical correlates of interpretative styles was developed to assess the imitation task of interpretative styles. The first step of this method was to establish sounds parameters that allow for characterizing each note along its temporal and dynamic traits (note duration, parameters of sound envelope, attack, sustain, release, symmetry). In order to determinate acoustical correlates able to differentiate interpretative styles we performed multivariate statistics on 28 commercial recordings classified as modern or baroque versions. This research of acoustical correlates was also driven by the principles of interpretation described in various treatises from the Baroque period. A set of 18 criteria was established: 9 criteria describe timing variations and 9 characterize dynamics. To evaluate in a synthetic way the imitation task, we ended up establishing an interpretative style scale on the basis of the previous analysis and in agreement with the methodological principles developed in psychometry. Application of this method to the 28 commercial recordings revealed a significant difference between modern and baroque recordings ($p < 0.01$ Mann-Whitney, see Figure 1). We consider this result to be a kind of validation of the scale.

This global analysis confirms that all violinists are able to imitate the two interpretative styles. There is a significant difference between versions that do not depend on the violin type except for musicians of third group (modern violinists) who had difficulties imitating a modern style on the baroque violin. Their modern versions on baroque instruments were surprisingly a bit more baroque than their baroque version on modern violin! This result suggests that experience is most probably needed to use an instrument in an unexpected way.

Movement analysis

The kinematic analysis was based on a 3D reconstruction of the movement from the video recordings. We focused on two main aspects of bowing movements: the bow trajectory and the coordination of the right arm (bow arm). The main goal of this analysis was to describe the immediate variations induced by the different constraints (type of violin and interpretative style). See Figure 2.

The variations in bow use contrasted with the reorganization of the arm coordination across the three groups. All the violinists tended to use a smaller portion of the bow when playing with a baroque bow; furthermore, playing a

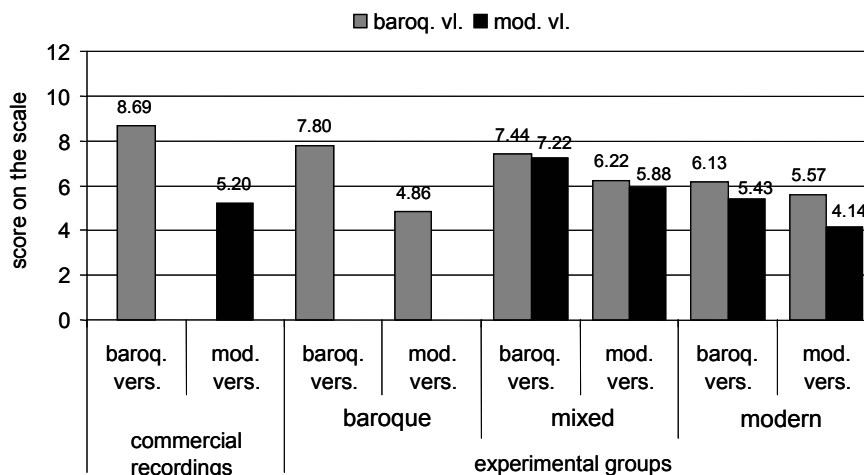


Figure 1. Baroque scale applied to baroque and modern commercial recordings of the "Gavotte en Rondeau" BWV1006 by J.S. Bach (left) and experimental performances from the three groups of violinists when playing in baroque and modern interpretative styles; baroque violinists play on baroque violin (gray bars) whereas mixed & modern violinists play on modern ones (black) as well.

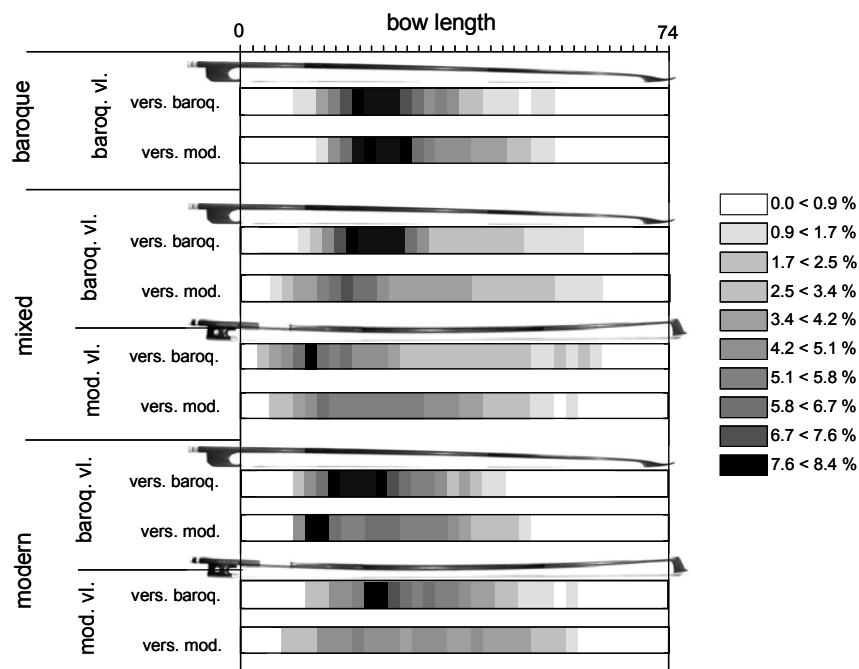


Figure 2. Bow use depending on musician (baroque, mixed or modern experts), violin (baroque or modern) and interpretation mode (baroque or modern): frequency of use of the bow (in 2cm segments) over whole musical performance.

baroque version enhanced this outcome (Figure 2). Concerning the arm coordination measured through the contribution of the elbow joint to the total elbow-shoulder angular variation (Figure 3), modern violinists showed differences neither attributable to the instrument nor to the interpretation. Baroque and mixed violinists exhibited a significant difference depending on the interpretation (smaller contribution of elbow for baroque version on baroque violin), while mixed violinists show no difference between interpretative version when playing a modern violin.

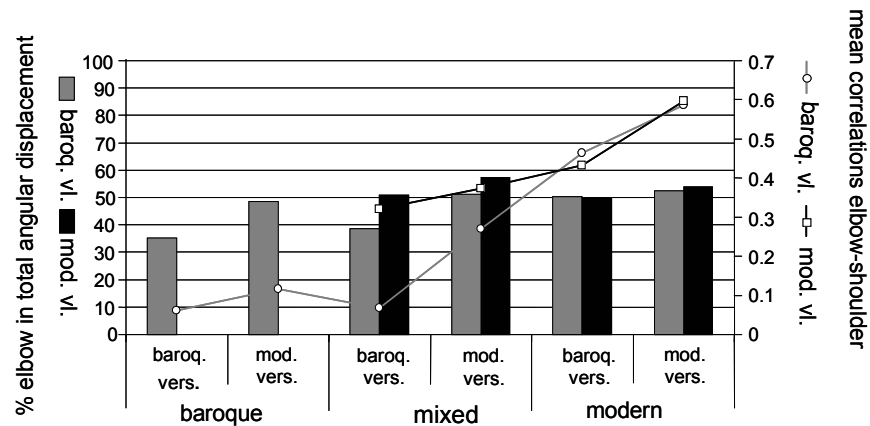


Figure 3. Right arm coordination, contribution of elbow to the elbow-shoulder angular displacement for baroque, mixed, and modern violinists when they play on baroque (grey bars) or modern (black bars) violins; correlation (dots) are between angle variations of the elbow and the shoulder.

Discussion

As shown in more simple tasks (Vereijken 1991; Goldfield 1993), this experiment stresses the importance of mastering the instrument's properties to develop specific and adapted movements. While all violinists adapted to the bow properties, this was not the case for their right arm coordination. "Mixed violinists" only exhibited different patterns of coordination depending on the violin. This could explain why, contrary to mixed violinists, modern violinists have a sound production significantly different when playing a modern version on a baroque or modern violin. These results highlight the fact that the arm movements and the working point trajectory (bow movements) do not refer to the same reality. However these preliminary results allow us to reconsider the direct links often regarded by musicians between movements and sound production.

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