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Investigating the origin of inter-individual differences in the preference for violins

Charalampos Saitis
Computational Acoustic Modeling Laboratory, Centre for Interdisciplinary Research in Music Media and Technology, Schulich School of Music, McGill University, Montréal, Québec, Canada.

Bruno L. Giordano
Music Perception and Cognition Laboratory, Centre for Interdisciplinary Research in Music Media and Technology, Schulich School of Music, McGill University, Montréal, Québec, Canada.

Claudia Fritz
Lutheries-Acoustique-Musique, Institut Jean Le Rond d'Alembert, Université Pierre et Marie Curie, UMR CNRS 7190, 4 place Jussieu, 75005 Paris, France.

Gary P. Scavone
Computational Acoustic Modeling Laboratory, Centre for Interdisciplinary Research in Music Media and Technology, Schulich School of Music, McGill University, Montréal, Québec, Canada.

Summary
In a recent study by the authors [1], it was shown that violin players are self-consistent when evaluating different violins in terms of overall preference. However, a significant lack of agreement between individual violinists was observed. A new perceptual experiment was thus designed to further investigate whether there will be more between-individual agreement if violin players are asked to focus on specific attributes of the instrument. Skilled violinists were asked to play a set of different violins and evaluate them according to specific criteria. The criteria were determined based on (a) the analysis of verbal data collected in the previous study, and (b) potential correlation with measured vibrational properties of the violin. Low light conditions and dark sunglasses were used to help hide the identity of the instruments as much as possible. Considering the bow as an extension of the player, violinists were asked to carry out the task using their own bow. Results confirm the presence of large inter-individual variations in the preference for violins. Further analyses suggest that such variations originate from inter-individual differences in the perception of different violin attributes rather than from inter-individual disagreement in what properties a "good" violin should possess.

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1. Introduction

Attempts to quantify the characteristics of "good" and "bad" violins from vibrational measurements and/or listening tests have largely been inconclusive [2]. On the one hand, this may be due in part to overly broad characterizations of "good" and "bad." On the other hand, listening tests end up focusing more on the performer than the instrument and no tactile feedback information is provided [4]. The violin, as any musical instrument, is part of a system that involves the player. In fact, the violin, player, and bow form a complex system of interactions where the sounds created by the interaction between the bow and instrument are shaped by the player. Consequently, we need to better understand how players evaluate the quality of violins. This is a critical aspect of violin acoustics that has only recently been considered essential in developing an understanding of what distinguishes one instrument from another [3]. In particular, we need to know how consistent skilled players are at assessing violin quality and whether there is agreement between players.

In a previous study, a perceptual experiment was designed to examine both within-individual consistency and between-individual agreement across a certain range of violins [1]. Skilled classical violinists were asked to play a set of eight different violins, evaluate their quality, and order them by preference. Preference judgments were collected as a measure of subjective evaluation of the quality of a violin based on

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choice behavior. Upon completing the task, participants had to comment on the ranking process and provide rationale for their choices. Results showed that violin players are self-consistent when evaluating different violins in terms of overall preference. However, a significant lack of agreement between violinists was observed.

The large amount of inter-individual differences in the preference for violins might have three different origins. Firstly, various sources of noise may have been present in the measurement of preference within the experimental context (e.g. fatigue, low familiarity with the task). Secondly, individuals may have different opinions concerning what particular attributes a "good" violin should possess (e.g. some violinists may strongly favor violins with rich sound irrespective of variations in other attributes, whereas others may favor violins that are easy to play, independently of sound richness or the lack thereof). Thirdly, individuals may evaluate those attributes deemed important for estimating the overall quality of the violin in different ways (e.g. all individuals may favor violins that produce rich timbres, but different individuals may have different perceptions of the richness of the timbre of the same violin). A novel experiment was carried out to tease apart these potential sources of across-individuals variation in preference.

In the study presented here, violinists were asked to play a set of different instruments and evaluate them according to specific criteria related to the attributes of the violin as well as according to their overall preference. The methodology and experimental design are described in Sec. 2. Section 3 presents the analyses carried out and discusses the results. Section 4 summarizes the work presented here, concludes and discusses future directions.

2. Method

2.1. Procedure

The experiment took place in an acoustically dry room (surface = $27m^2$). In order to remove visual cues that may influence judgment, low light conditions were used and participants were asked to wear a pair of specially designed dark sunglasses. To keep the experiment ecologically valid, no constraints were imposed on the playing and evaluation process. For the bow, two options were considered, using a common bow across all participants or asking players to use their own bow. Although neither solution is ideal, considering the bow as an extension of the player (second option) was preferred to the potential problems of using a common bow (e.g. participants being uncomfortable with such a bow). The experimental session lasted approximately two hours and was organized in four phases.

First, participants were presented with the evaluation criteria and the violins. They were asked to play the violins for twenty minutes in order to familiarize themselves with the instruments and explore the range and variation of each criterion across the set of violins. Subsequently, participants were asked to do a short training session using a violin not included in the original set in order to familiarize themselves with the evaluation task. On each trial of the third phase, participants were presented with one violin at a time and were asked to play and rate it according to each criterion using on-screen sliders. For each criterion, a phrase describing the violin attribute appeared above the rating scale (see 2.2). The right end of the rating scale was labeled as "strongly agree," whereas the left end was labeled as "strongly disagree." Each of the ten violins was presented once on each of three subsequent blocks of ten trials. The order of presentation of the violins within each block of trials was randomized. Players were instructed to maximize evaluation speed and accuracy. To end a trial and start the succeeding one, the participant clicked on an on-screen button labeled "Next." At the end of the third phase, violinists were asked to fill in a questionnaire.

2.2. Criteria

To obtain the evaluation criteria, a rudimentary selection process based on the verbal responses of violinists to the question "How and on which criteria did you make your ranking?" from the previous study was designed. Those words, phrases or expressions indicating an attribute of the violin were extracted and classified depending on whether they described the sound (e.g. richness), the instrument (e.g. strings), or the interaction between the player and the instrument (e.g. response). Four criteria were thus determined, considering those class-attribute pairs that were mentioned by at least 25% of the participants (e.g. sound-richness). Furthermore, an underlying goal of the research presented here is whether such subjective attributes can be correlated with measured vibrational properties of the instrument. A fifth criterion was thus chosen based on its potential in this context. Finally, preference was used as a sixth criterion. The six evaluation criteria were presented in the form of phrases alongside short descriptions to ensure a common meaning for all participants:

- *The violin is easy to play*: it requires minimal effort to produce sound, easy to avoid wolfs, easy to "get around" the instrument;
- *The violin responds well*: it produces desired sounds using a wide range of bowing gestures, it responds well to a wide range of actions of the player;
- *The violin has a rich sound*: the violin produces a sound that is rich in harmonics and overtones;
- *The violin is well balanced across the strings*: the playing behavior of this violin is similar across all strings;

Table I. Origin, age and price of the different violins used in the study. For confidentiality purposes, the names of currently active luthiers will not be provided.

Violin	A	B	C	D	E	F	G	H	I	J
Origin	Italy	Italy	Italy	Germany	France	Québec	China	France	France	Germany[1]
Maker	Storioni	Sderci	Gagliano	Fisher	Kaul	-	-	Guarini	-	Unknown
Year	1799	1964	1770-75	1787	1933	2005	2006	1877	2009	Unknown
Price	$44K	$20K	$250K	$22K	$20K	$6K	$2K	$11K	$17K	$8K

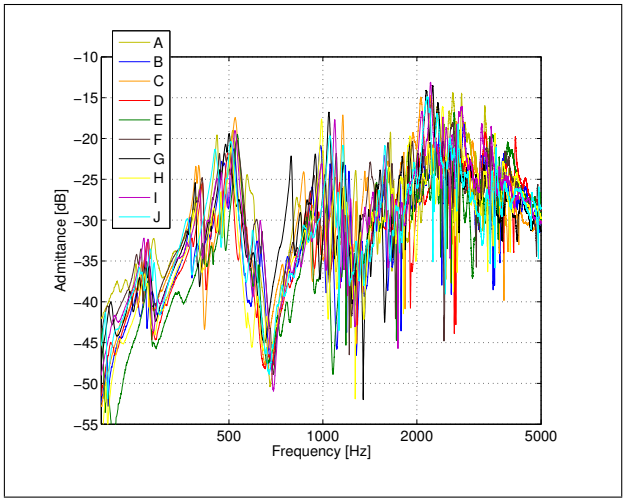

Figure 1. Bridge admittances of the ten violins used in the experiment, obtained by exciting the G-string corner of the bridge with a mini impact-force hammer and measuring the velocity at the E-string corner of the bridge with a laser Doppler vibrometer.

- *The violin has a broad dynamic range (from piano to forte)*: it can produce sounds of a wide range of dynamics, from piano to forte;
- *The violin is the one I prefer the most* (self-explanatory).

2.3. Violins

Ten violins of different make and age were selected. More specific information about the origin, age, and price of the instruments can be found in Table I. Figure 1 depicts the bridge admittance of all violins. Each violin had the strings and chinrest originally placed by the owner, and a Kun Original shoulder rest placed by the experimenter.

2.4. Participants

Participants ($N = 13$; 9 females, 4 males; mean age = 28 yrs) were selected according to their musical background. They had at least 15 years of violin practice (mean violin practice = 22 yrs; mean violin practice per week = 25 hrs) with some experience in evaluating instruments. The group consisted of 11 professional and 2 amateur violinists (8 native English speakers, 4 native French speakers, 1 native Polish speaker). Three of them had participated in the previous study reported in the Introduction.

3. Results

An initial analysis was carried out to compare the level of disagreement between and within individuals for each of the rating criteria. For each criterion, the first step involved computing a 39×39 matrix of Spearman correlations between the ratings on each of the 3 blocks of trials for each of the 13 experiment participants. Across the 741 cells of the lower triangular part of this correlation matrix, there were 702 correlated blocks of trials from different participants and 39 correlated blocks of trials from the same participant. For each participant, two consistency scores were computed. The first measured the intra-individual consistency and was defined as the median of the correlations between the three blocks of trials for the given individual. The second measured the consistency between the specific participant, on the one hand, and all the other participants, on the other. This between-individuals measure of consistency was defined as the median of the correlations between the three blocks of trials for the specific participant, on the one hand, and those for all the other participants, on the other. For each criterion, a paired-samples Wilcoxon signed rank test was then adopted to test whether the measures of intra-individual consistency were significantly different from the measures of between-individuals consistency. For all criteria but easy to play, consistency was significantly higher within individuals than between individuals, $p = .251$ for the easy to play scale and $p \leq .027$ for all other scales (see Figure 2). Finally, a paired-samples Wilcoxon signed rank test was adopted to test whether the measures of between-individuals consistency for the non-preference ratings differed significantly from what was observed for the preference ratings. For all criteria but easy to play and richness, the measures of between-individuals consistency were significantly lower than those of preference, $p \geq .146$ for easy to play and richness and $p \leq .046$ for all other criteria.

[1] This is based on a luthier's analysis, as there is no information regarding the make and age of this violin.

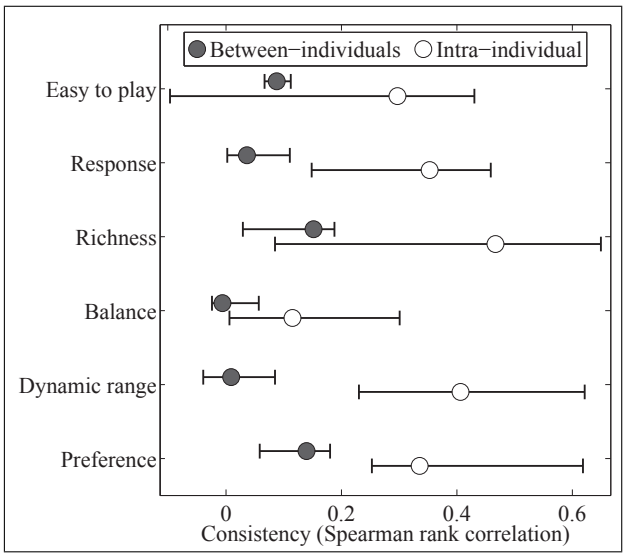

Figure 2. Intra- and between-individuals consistency for each of the rating scales (ordinate). Symbols = across-individuals median; error bars = interquartile range.

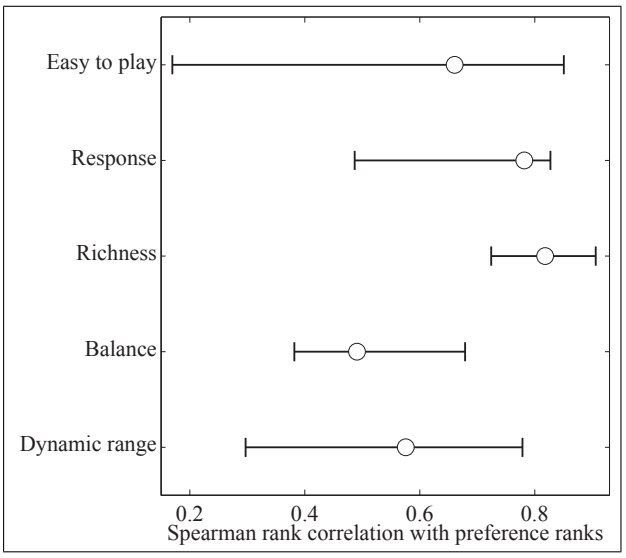

Figure 3. Correlation between preference ratings, on the one hand, and non-preference ratings, on the other. Symbols = across-individuals median correlation; error bars = interquartile range.

The results of this initial analysis confirmed the presence of a large amount of between-individuals differences in the preference for violins. The same result appeared to hold for the perceptual evaluation of the five violin attributes used in the experiment. This initial analysis also showed that the amount of between-individuals agreement for the evaluation of these attributes is, in general, even lower than what observed for the ratings of preference. Indeed, among these attributes, only easy to play and richness where characterized by levels of between-individuals agreement that did not differ significantly than what observed for the preference ratings. Overall, the results of this analysis support the hypothesis that the large between-individuals variation in the preference for violins is caused, at least in part, by large inter-individual differences in the perceptual estimation of those attributes of a violin that contribute to its overall quality.

The remaining analyses focused on the assessment of the relationship between preference ratings and ratings on non-preference scales (i.e. violin attributes). All analyses considered participant-specific data collapsed across blocks of trials, i.e. for each of the rating criteria, the data of each participant was the median rating across the three blocks of trials. An initial step aimed at determining whether the preference ratings of each participant were accurately predicted by the participant's ratings on non-preference scales. To this end, we computed the proportion of the variance in the ranks of the preference ratings explained by a regression model that included all of the non-preference ratings as predictors. Across participants, the non-preference ratings explained a median 90% of the variance in the ranks of the preference ratings (minimum = 0.78; maximum = 0.97). Thus, the ratings on the violin attributes accurately predicted the preference for the violins in the current experiment, confirming the results of the analysis of verbal data on the violin attributes used by participants in the previous experiment (see Sec. 1).

The final analysis step aimed at quantifying the extent to which different individuals evaluated the quality of the violins by focusing on different attributes. To this end, the Spearman rank correlation between the preference ratings on the one hand, and the ratings for each attribute, on the other, was computed for each participant (see Figure 3). For each non-preference scale, a Wilcoxon signed rank test was adopted to test whether the correlation with the preference scale was significantly different than zero. Interestingly, for each of the attributes the correlation with preference was significantly higher than zero, $p \leq .002$. This signifies that despite the large amount of inter-individual differences in the perceptual evaluation of each of the violin attributes, a significant level of agreement was present concerning the influence of each of these attributes on the preference for a violin. On the other hand, this could be the product of the particular experimental method and of a procedural bias. For example, the fact that participants rated both preference and non-preference criteria on the same trial might have produced a tendency to use the various rating scales in a correlated manner (e.g. a hypothetical participant might have given the same ratings along each of the scales). To this end, it is important to note that the strength of the correlation with the preference ratings was not the same for all attributes, and the between-individuals variation within the same measure differed widely across the different attributes. For example, ratings along the richness scale were

strongly correlated with the preference ratings for all participants (i.e. most-preferred violins also had a rich sound), whereas the easy to play-preference correlation was much lower and more variable across participants (i.e. some participants strongly preferred violins that were easy to play, whereas others preferred violins that were characterized as both hard and easy to play).

4. Conclusion

This paper reports a perceptual experiment designed to investigate the origin of inter-individual differences in the preference for violins in the context of better understanding how skilled players evaluate the quality of violins as well as what distinguishes one violin from another. Overall, the results confirm that there is a large amount of between-individuals differences in the preference for violins, even when players are asked to rate specific attributes of the instrument. Considering the large inter-individual variations amongst skilled violin players, it is not surprising that it has been difficult to find correlations between their judgments and measured vibrational characteristics of the instrument.

However, further analyses interestingly suggest that despite the large inter-individual differences in their preference, violinists demonstrate substantial levels of agreement on what attributes a "most preferred" violin possesses. In particular, the richness of the sound produced by a violin appears to have a strong influence on the preference of all players. As such, it appears plausible that the between-individuals differences in the preference originate from large variations in the perception of different violin attributes, rather than from large disagreement about what properties a preferred violin possesses.

Future complementary work will focus on the exploitation of the verbal data collected in both the present and the previous studies using psycholinguistic methods [4]. It is important to understand the evaluation process of skilled players when assessing specific violin attributes.

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