INTERNATIONAL SYMPOSIUM on MUSICAL and ROOM ACOUSTICS
ISMRA 2016
September 11-13, 2016
La Plata, Buenos Aires, Argentina

MA-IM (Instrument making): ISMRA2016-47

The violin: Studying the influence of the model by means of a free sorting task

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Abstract

In the last few years, various blindfolded playing tests have been conducted in order to better understand how violinists evaluate violins. They mostly involved preference rankings and evaluation of different criteria using scales. These tests have shown a large intra-individual consistency but generally a rather low agreement between players, regardless of the age, the make, the price and the mechanical properties of the violins used in the studies, making the correlation between the perceptual and the physical (mechanical and geometrical) properties of the violins difficult. Another approach has been used here, based on categorization in order to identify the unknown properties on which the global judgments of violinists could rely : 21 violinists had to sort freely nine violins, i.e. they had to arrange the violins into categories by putting together the ones that they judged similar and in different groups the ones that they judged dissimilar, without any constraint on the number of categories. Six of the nine violins were Stradivarius models (two genuine, seven recent copies), while the other three were del Gesu models (one genuine, two recent copies). The additive tree resulting from the statistical analysis of the data (similarity matrix) shows an interesting differentiation between the Strad and the del Gesu models, even if none of the participants mentioned being aware of such a difference. The analysis of the verbal comments that the participants made on their categories shows a large disagreement between players and seem to challenge the common belief of specific properties to Strad and del Gesu models.

Keywords: violin, free sorting task, (construction) model

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1 Introduction

While Stradivari is by far the most renowned violin maker among the general public, another Cremonese maker of the same period, Guarneri del Gesu, is well appreciated by violinists and collectors too. Therefore models by these two masters are extensively copied by violin makers nowadays. Differences in the model will of course affect the sound and the response of the instruments, but so will differences in wood, glue, varnish, set up, … In addition, there is not a unique Strad or del Gesu model, but many different models. However, it is believed that there are characteristics specific to del Gesu instruments compared to Stradivarius instruments, as categories. For instance, one can read on the blog of the famous restorer and dealer Andy Fein: “Guarneri del Gesu violins tend to exhibit a deeper, darker tone than the silky, rich tone of a Strad. Players who prefer a shorter scale length, a darker sound, and a limitless cache of tonal variance tend to prefer a Guarneri. Players who prefer precision and refinement tend to prefer a Stradivari” [1]. The purposes of this study is to investigate whether such overall characteristics exist – first (here) as cognitive representations related to the musicians’ sensory experience and social representation of a « good violin », and then (in a later stage) as physical properties – , by asking players to blindfolded evaluate a series of instruments.

The free sorting task derives from theories making use of the concept of natural category to describe the human cognition process, and was elaborated in the field of cognitive psychology along with the theory of natural categorisation [2, 3, 4, 5]. It is a common method in psychology –, especially in the fields of sensory analysis [6], and of sound perception [7, 8] –, to explore criteria of categorization from a subject point of view in order to prevent a priori physicalist conceptions, but to our knowledge, has never been used for instrument evaluation by players (only by listeners [e.g. 9]). This method appears as to be a powerful tool in our case as it will allow us to see whether the del Gesu models are indeed grouped together and along which characteristics, without the experimental methodology imposing any a priori on the players.

2 Experiment

2.1 Protocol

Nine violins were displayed on a table, in a very large hotel room, in dim lighting to prevent a priori identification from visual processing. Players, wearing welding goggles and using their own bow, were asked to play the violins freely and to arrange them on another large table and/or the bed by putting the ones that were similar together, and the ones that were dissimilar

in different groups. They were allowed to make as many categories as they wished, and were afterward asked to describe orally each of the categories.

The output data consist therefore in clusters of instruments and verbal comments upon these categories, which were taken as notes in real time by the first author.

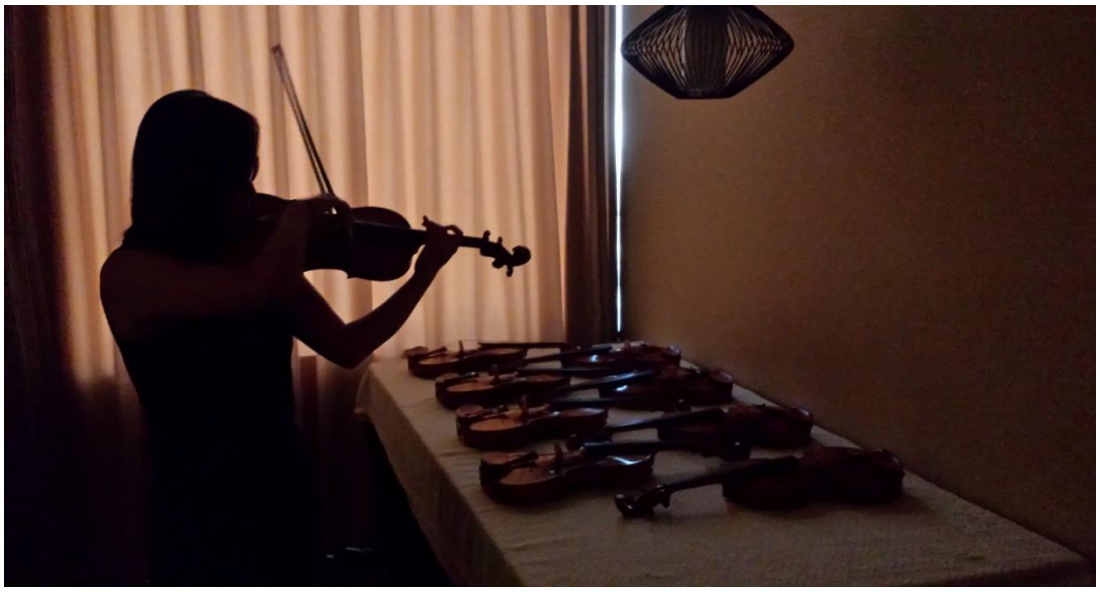

Figure 1: Experimental setting

2.2 The violins

Nine violins were gathered for the experiment. Among the six that were new (made between 2005 and 2014), two were made on a del Gesu model, three on a Stradivarius model and onewas an innovative “ultralight” model, designed for increased power and projection. The remaining three violins were Old Italian violins, two Stradivari and one Guarneri del Gesu.

Table 1: Instruments used in the experiment

Violin	Maker/age	Model
V1	Stradivari	Strad
V2	Guarneri del Gesu	Del Gesu
V3	Stradivari	Strad
V4	new	Del Gesu

V5	new	Strad
V6	new	Del Gesu
V7	new	Strad
V8	new	Strad
V9	new	ultra-light

2.3 The participants

21 violinists took part in the experiment: 15 were professionals (among whom a dealer and collector) and six amateurs, among whom two were also makers. Except one amateur who practiced only two hours per week, they all played/practiced at least 10 hours (and up to 60 hours!) per week. They were all classically trained, and the average price of their violins was $40000.

3 Results

3.1 Hierarchical tree

In the absence of previous knowledge about the dimensional nature of the attributes that define the categories, a distance analysis was preferred to a dimensional analysis such as e.g. multi-dimensional scaling. Each sorting led to a co-occurrence matrix, whose values are 1 at the intersection between row i and column j if instruments i and j are in the same category, and 0 if not. For each excerpt, the total co-occurrence matrix M is the sum of the N=21 individual co-occurrence matrices. A total distance matrix can be computed as $D = 1 - M/N$ [9,10].

An agglomerative hierarchical cluster tree was then computed using the Matlab function 'linkage'. The resulting tree is represented in figure 2. A measure of how faithfully the tree represents the dissimilarities among observations is given by the the cophenetic correlation which is defined as the linear correlation coefficient between the cophenetic distances obtained from the tree, and the original distances (or dissimilarities) used to construct the tree. In our case, this coefficient is equal to 0.81, which is relatively high.

One can see two main groups, each divided in two subgroups. One of these subgroups contains violins V2, V4 and V6, which correspond to the three del Gesu models (2 being a genuine one). Within the same group, the other subgroup contains two Strad models, one genuine, the other being recent. The second group contains violins V1, V5, V8 and V9, divided in two subgroups, V1-V5 and V8-V9. V1, V5 and V8 are Strad models (V1 being genuine), while V9 is an original design, but made by the same maker as V8.

Two points are of particular interest. First, although model was almost never mentioned (one player did say that violin 6 felt like a del Gesu; another player said that V1 and V8 were 'Strady'), the three del Gesu models were very often grouped together (see Table 2) and

therefore appear close in the hierarchical tree. Second, the three old instruments are spread across the groups: there is no grouping according to age, which is in agreement with previous studies showing that players cannot distinguish old from new violins, as there do not seem to be unique qualities to one or the other category [11,12].

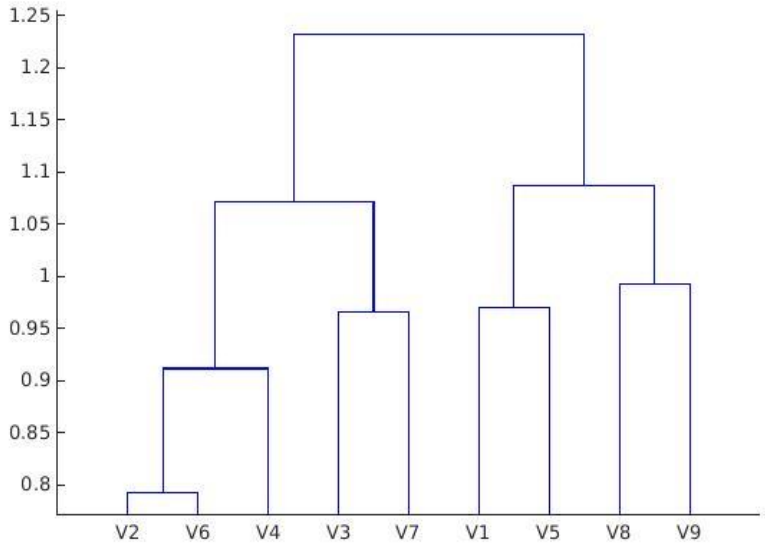

Figure 1: Agglomerative hierarchical cluster tree representation of the 9 instruments.

Table 2: Number of players who grouped the violins of each consensual subcategory

Violins	Number of players who grouped them
V2-V6, V2-V4, V4-V6 V2-V4-V6	18 6
V3-V7	8
V1-V5	7
V8-V9	8

3.2 Verbal data

While the players were only asked to describe the different categories at the end, they all commented on each violin during the task and/or at the end when describing in a bit more detail

the different groups. We can therefore look at their comments on the different categories as well as at their comments about the individual instruments.

The analysis of the first comments should reflect the consensual categories shown on the tree which may differ from the actual categories made by each player. Therefore, only the actual categories close to the consensual categories were considered in the analysis of the verbal data in practice, only the subjects' categories that included at least two instruments of the four sub-categories were thus considered.

We just give here (see Table 3) the raw data of the verbal comments. A linguistic analysis is currently processed based on a procedure which has already been used regularly to elicit the characteristics along which there is agreement as well as disagreement between the participants (e.g. [9] for electric guitar evaluation)

Table 3: Descriptions given by the players (named P1 to P21) for the four consensual groups.

Group V2-V4-V6	*Thin on the E string. Limited in the roundness, fullness. Dry. No ring, no freedom, distasteful.* (P1) *Less attractive sound. Softer than I wish, even softer than the previous two. Have to work harder. Relatives you don't see often.* (P2) *Very nice, but not as good as others. Orchestral violins.* (P3) *Rich. Powerful enough. Balanced. Have their personality. Are playable. You can find the sound that you want.* (P4) *Feel old, i.e. feel less healthy but lead you to do something with them.* (P5) *Group of violins that I like. Beautiful sounding. Sunnier, sweeter than other group I like*. (P6) *The bassiest. A lot of lower end. But not particularly bright. Bass end is strong.* (P8) *Sound close to my face (which I like because I'm feeling it more), bright.* (P9) *Almost as good as top 3 [V1-V5-V9] but lacking this kind of magic of the overtones. On another day, with different temperature and humidity, could prefer them to my favourites.* (P11) *These are my favourites for very different reasons. V2 has sizzle, very strong high end, but balanced, very nice balance. V6 has more a low end, but they both play very well.*(P12) *Same as [V2+V5+V7] but better. Also in the bright group. But more colour, more palette, more range than [V2+V5+V7]. Bright not like harsh but bright like focused (Dark equals more hollow, woody, open).* (P13) *Middle group. Nasal and pleasant sound. Sound pretty even. Don't project as much as others. Do not have the power. Easy to play. Not penetrating enough.* (P14) *Good but less good as the others. Range of colours less. Less layers. Some are hard to play.* (P15)

	Slightly muted. Nasal. Unremarkable on high strings. Low power. Weaker. A bit nasal on the G&D. Muted overall. Playing soft on these, the characteristics are nice but not when playing forte. (P17) *Darker. Less projection under the ear. Though probably fine in a hall. V7 had a bit more colour, more overtones, while V4 and V6 are more basic.* (P18) *Sound is open and is sensitive to change in colours. Easy to play.* (P19) *Instruments with warmer and darker sound. Are more direct, but shrill. Warm, dark.* (P20) *The most overtones. The most old sounding instruments.* (P21)
Group V3-V7	*Plenty of sound but not so pretty. Hard to play.* (P1) *Favourites. Most sophisticated sounding. Great capabilities. Solo violins.* (P3) *Feel old, i.e. feel less healthy but lead you to do something with them* (P5) *Sound close to my face (which I like because I'm feeling it more), bright.* (P9) *Like the least. Slightly closed sound. Not as open and projecting as the others. Lack of focus, sound is not pure.* (P10) *Good violins but less good as the others. Range of colours less. Less layers. Some are hard to play.* (P15) *Sound is open and is sensitive to change in colours. Easy to play.* (P19) *More resonant than previous. Brighter but still warm. Well balanced* (P20)
Group V1-V5	*They have a voice but a little bit sluggish, they don't ring as freely as V8. Have a nice voice. A nice round sound. Not as strong at the bottom as V8. A little more work to play than V8. V1 slightly above V5. I like the range of volume of V1.* (P1) *I do like them but I wonder whether they punch, if they go out. I can't figure them out. They are comfortable to play but the sound is softer/sweeter than the three others. I would get frustrated with them in a dead place compared to the others which still ring in a dead place. These are nice cousins.*(P2) *One dimensional violins.* (P3) *My favourites.* (P11) *Stronger, project more and speak louder than [V2-V3-V4]. Dark, full, rich, big low string. Project well but not as much reserve as [V6-V8-V9]. Attractive initially but not for me.* (P17) *Orange colour, speak very clearly, articulate clearly.* (P18) *Most direct, thinnest sound, loud.*(P20)
Group V8-V9	*They speak to me. I like them. Would like to take them home. They speak very quickly. I don't need to work hard to get colours and volume. I could marry one of them. (P2)* *Instruments I'm not interested in.* (P6) *The brightest, strong punchy metallic kind of sound.* (P9)

	Each have some lopsided in terms of strengths and weaknesses. V9: Good power but quality is lacking in the sound. V8: Great bass but it felt muddy. (P12) *Bottom group. Sound is uneven. Not violins he would consider. Sound is easy to break. Quality of the sound is a bit rough. Not easy to control and play.* (P14) *Wide range of sounds. So many colours/layers. Dark and bright. Easy to play. Response quick. Everything I like.* (P15) *Stronger than the other violins. Bright. You can pull much more than on [V1-V5-V7]. The highest quality. Though one or two may be too bright (for instance V8). Complex on the top. Dramatically more powerful. Ring a lot on the high strings. You feel that you can overpower an orchestra. Great for Tchaikovsky, but less good for Debussy (soft, subtle). Speak very well. Lots of reserve. Great for big concerto. Others from other groups would be better for chamber music.* (P17) *Bright and direct, sound not as round.* (P20)

Table 3 shows a large variety of statements, with very little agreement between players for all four subcategories. Descriptions for each subcategory go from *instruments I'm not interested in* to *instruments I could marry*, from *bright* to *dark*, from *easy to play* to *hard to control*, from *powerfu*l to *not penetrating enough*. This echoes previous studies showing very little agreement between players in terms of preference but as well in terms of evaluation on more "analytical" criteria [13,14].

4 Conclusions

In this study, 21 violinists evaluated 9 violins (3 del Gesu models, 5 Strad model and 1 innovative design) and free-sorted them into groups according to their perceived similarity. The resulting hierarchical tree shows four subcategories, one of them containing all three del Gesu models. While this may suggest specific qualities can be attributed to del Gesu model violins, nothing similar appears for Strad models, which were divided among three groups – one group being closer to the del Gesu group than to the other Strads. Two players refer to model in describing specific instruments, but none use model to differentiate between groups. Moreover, individual players can give sharply varying – even diametrically opposed - descriptions of a given group.

This study therefore suggests that, contrary to the common belief, universal descriptors cannot be easily applied to a violin model, and that some Strad model violins can seem more similar to del Gesu model violins than other Strads, implying that there may be no specific qualities – independent from the musicians' interaction with the violins – to Strad models. On the other hand, a larger sample of Stradivari (and Guarneri) model violins might begin to show common characteristics not found here. Indeed, the grouping together of the three del Gesu models suggests as much, though more research is needed to investigate whether this grouping is due to these three particular instruments or to more general characteristics of del Gesu models.

Analysis of the radiation spectra of these nine instruments may well shed light on the underlying acoustical properties of the different groups.

Acknowledgments

We would like to thank the 21 violinists for their participation as well as the makers and players who let us instruments for the experiment.

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