

# A situated and cognitive approach of violin quality

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## ABSTRACT

In order to better understand how violinists evaluate violin quality, playing and listening tests were conducted. Three French professional violinists assessed three violins with different qualities. The assessment was conducted orally, with violinists answering open questions regarding the quality of each violin while playing it and then while listening to it played live by somebody else. The violinists were further asked to rank these violins in order of preference. The oral reports were transcribed and linguistically analysed. It first allowed us to identify the linguistic resources in French available to speakers to account for their experience, in particular to describe what appeared as two different entities: the violin and its sound. Secondly, a semantic analysis of the discourses showed that these resources were shared by the participants but were used differently to qualify each violin in the two experiments. In particular, the analysis revealed aspects, like the "ease of playing" or the "projection", which were used frequently in the playing test but very little in the listening test. This can be explained by the fact that, in the listening test, the evaluation is made by relying on the sound only and, therefore, this evaluation is mainly based on the resultant sound without any possible comparison nor control on the nature of the sound and the manner by which it was produced. However such processes of comparison and control on the instrument when producing the sound are essential for the evaluation of the quality of a violin by violinists, as proved by the agency given to the violin in the assessments given during the playing task and the players' statements regarding what is a "good" or a "bad" violin.

## INTRODUCTION

Many studies have been designed to better understand what makes a violin of greater or lesser quality and to find mechanical or structural quality parameters. For instance, based on his measurement of the acoustical properties of a large range of violins that had previously been classified as of very good or moderate quality, Dünwald (1991) suggested four important frequency bands for the judgment of sound quality. In particular, he associated a large amplitude in the band 650-1300 Hz with "nasality" and a low amplitude in the band 4200-6400 Hz with "clarity", but this association was done without any perceptual testing. Fritz et al. (2009) therefore conducted such perceptual tests: they designed listening tests to analyse the relationship of these verbal descriptors to specific acoustical features of computer-generated ("virtual") violin sounds. The results show that Dünwald assumptions were not confirmed. In a more recent study, Bissinger (2008) realised modal-acoustic radiation measurements on 17 "bad-to excellent" quality-rated violins in order to contrast the extensional as well as flexural motions of "excellent" and "bad" violins. He found only one robust quality differentiator, the Helmholtz type A0 cavity mode radiativity at about 280 Hz, where excellent violins were significantly higher.

We can therefore wonder why the 350 years of violin research (Hutchins and Benade 1997) have not managed to find mechanical parameters accounting for the differences in quality evaluation. One reason may be found in the fact that these studies only focused on the violin itself as a mechanical instrument producing sounds but not on the violin as a musical instrument which quality is to be judged within its interaction with a violinist. Actually, the quality of a violin does not exist per se, but results from the evaluation of violinists playing music with them. Our project therefore aims at investigating violin quality from the point of view of the player and understanding how violinists evaluate the quality of a violin. How do they proceed?

What are the criteria they use? Are these criteria the same across violinists? How do they describe a violin and its quality?

Playing and listening tests were thus conducted as a first attempt to address these questions. We were particularly interested in the differences between violinists when evaluating a violin - in their judgments as well as in the criteria they use - and the importance of the sound quality of a violin in the global evaluation of the instrument (by comparing the two types of tests). These tests were designed using a methodology which has been developed in the last decade to overcome the limits of psychophysics. Beyond the knowledge acquired in the field of psychological evaluation of many acoustical parameters, the psychophysical tradition showed indeed its limits to grasp global and holistic phenomena like soundscapes (Dubois et al. 2006), timbre (Castellengo and Dubois 2007) or piano sounds (Bensa et al. 2005). Therefore, new problematics were derived, nourished by the conceptualisations in cognitive sciences: analysis of the categorisation processes (psychology), semantic theories (linguistics) and knowledge modelling (artificial intelligence). A new methodology to access psychological judgements has thus been developed on the basis of a semantic analysis of the discourses produced by different actors implied in the study in the exercise of their daily practices. Dubois (2009) presents examples of the productivity of this methodology in different fields (acoustic comfort, food quality, automobiles, railways, ...).

The aim of this paper is to present the application of such a linguistic analysis to the violin as much as some first results. It is important to note that such methodology implies the study to be done in the native language of the participants. This study having been conducted in French, the results account for the linguistic resources and the semantics of the French language. Therefore, English translations are provided for the comprehension of the reader and do not necessarily correspond to what

English native speakers would have spontaneously said.

## EXPERIMENTAL PROCEDURE

### General setup

The experimental session was organised in collaboration with a violin maker from Grenoble (France), Nicolas Démarais (ND), and took place in his workshop, in a relatively dry room. Three French professional violinists (called E, M and W), between the age of 22 and 45, took part. The session was divided in three tasks for each player, and these tasks are explained below.

### First task : Interviews about what is a good violin

As an introduction to the working session each participant was asked to talk about his professional activities and about his assessment of what a good and a bad violin is. This task usually lasted about 30 min.

### Second task: Playing test

After this general interview, each participant had to evaluate three violins (see below for more details), as if he was about to buy one of these. In order to keep the experiment ecologically valid, there was no constraint on what he was allowed to play and how many times he could play each violin. The three participants played initially the three violins in the same order (V1, V2, V3) followed by their own violin. After they had played one instrument, a semi directed interview was processed in order to get free comments on that instrument, but keeping in mind the following questions (which were used to reopen the topics within the interview):

- How do you like playing on this violin?
- How would you qualify this violin?
- How would you qualify the sound of this violin?
- Could you summarise the qualities and the defects of this violin?

After this initial evaluation of each violin, the participants played again the different violins a few times in order to adjust their evaluation, which they expressed freely, as they played along.

### Third task: Live listening test

After this playing evaluation task, the participants had to evaluate these violins being played by ND. They were blindfolded, sitting on a chair, facing ND, at a distance of 2m. The order in which ND played the violins was random for each player. Again, the participants were involved in a semi-directive interview including some explicit questioning on whether they were able to recognize which violin was played.

### The violins

The playing and listening tasks were done with three violins, chosen by ND for their very different characteristics and their overall distinct quality. Violin 1 is from the 18th century, from a Flemish school. Violin 2 is a relatively modern instrument, made by Lucien Schmitt from Grenoble in 1942. Violin 3 was made in 1802 by Didier Nicolas Aîné in Mirecourt.

Their input admittances, obtained classically by exciting one corner of the bridge with an impact hammer and measuring the velocity at the other corner with a laser vibrometer, are presented in Figure 1.

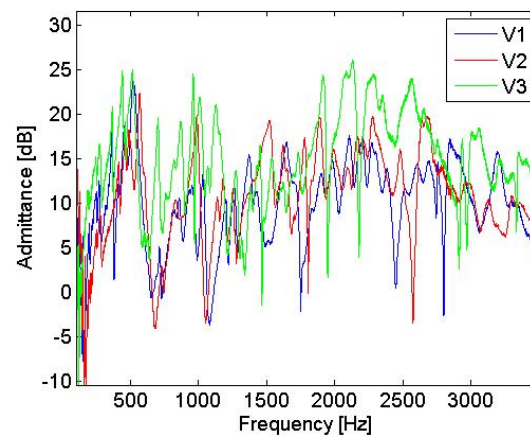


Figure 1: Input admittance of the three violins used in this study

## LINGUISTIC ANALYSIS: SOUND OR VIOLIN EVALUATION ?

### Global analysis

In order to be able to process a precise linguistic analysis, the recorded interviews (about 8 hours) were first integrally transcribed, including pauses, hesitations, truncated words and sentences and reformulations that can be used as indicators of the cognitive representations that the speaker is communicating through his/her discourse (Dubois 2009).

The linguistic analysis of this corpus started with establishing an inventory of the linguistic resources available (in French) for the speakers to account for their evaluations of the violins in the different contexts of production. This inventory was therefore processed on the whole session transcriptions (from the 3 violinists, the 3 violins and the different tasks). The analysis reported here is restricted to the segments of discourse in which the words *violon* (*violin*) or *son* (*sound*) were produced, as a first step in identifying the conceptualisations given to these two objects. A more exhaustive analysis including the evaluations of subjectivity in discourses will be developed in a forthcoming paper.

The first phase consisted in focusing on the linguistic devices used to qualify the violins and the sound: adjectival forms (*chaud* (*warm*) ; *nasillard* (*nasal*)) which are the most usual linguistic forms to account for qualities but also nominal forms referring to the sound or to violin qualities at a more abstract level (*chaleur* (*warmth*) ; *force* (*strength*)). In a second phase, our attention was devoted to verbal expressions, which were divided in two groups depending on the syntactic function of the nouns *son* or *violon*: either grammatical subjects or objects. The examples below illustrate these two syntactic functions:

- Sound as object and subject: *on va le forcer pour qu'il porte loin* (*you will force on it (sound object) so that it (sound subject) carries far*)
- Violin as subject: *qui sonne très clair* (*which sounds very clear*)

The number of occurrences per type of word for each violin is given in Table 1.

The sound is mainly described in the discourse by means of qualifiers and less through complex verbal expressions (respectively 83% vs 17% of the verbal productions on sound). Sound qualifiers are given in both adjectival (57%) and nominal forms (43%). In contrast, the violin is described by as many qualifiers (49%) as verbal expressions (51%). Furthermore, the word *vio-*

		<i>son</i>	<i>violon</i>
qualifiers	adjectives	131	143
	nouns	97	37
	total	228	180
verbal expressions	subject	23	135
	object	23	54
	total	46	189
total		274	369

Table 1: Number of occurrences of each type of word for *son* and *violon*

*lon* is mainly used as the grammatical subject of the sentence (71%) and is mainly qualified by adjectival forms (79%). Overall, the number of occurrences of *violon* is much higher than of *son*.

This first global discourse analysis contributes to the objectification of cognitive differences in the representations of the sound and of the violin. It allows the use of these linguistic indicators for further explorations across tasks as well as across violins in order to access their individual quality properties.

### Comparison between the three tasks

		<i>son</i>	<i>violon</i>
qualifiers	good violin	77	90
	playing	71	84
	listening	80	6
verbal expressions	good violin	16	95
	playing	8	91
	listening	22	3
total	good violin	93	185
	playing	79	175
	listening	102	9

Table 2: Number of occurrences of each type of word, per task, for *son* and *violon*

Besides the regularities mentioned above, some important differences can be observed between the tasks. For *son*, while the number of qualifiers does not vary across tasks, the low rate of verbal expressions is particularly low when playing. In contrast, the analysis of the quotations referring to *violon* reveals a very low rate of occurrences in the listening task, for both qualifiers and verbal expressions.

This result confirms that the task drives the cognitive orientation towards the sound or towards the instrument. In the listening task, the judgments restrictively concern the qualification of sound, whereas in the two other tasks, the evaluation is complex and involves not only the sound but also the instrument and its interaction with the musician. This has to be further explored through a more precise semantic analysis of the verbal productions.

## QUALITY EVALUATION OF THE THREE VIOLINS

### Linguistic analysis

The data given in Tables 1 and 2 were analysed at a global level, in the entirety of the interviews. Here, the analysis is restricted to the parts of the interviews where the violinists were explicitly talking about the three violins (V1, V2 and V3), in the playing and listening tasks, in order to verify whether the results obtained above are evenly distributed across the three violins. The corresponding data are summarised in Tables 3 and 4.

		<i>son</i>			<i>violon</i>		
		V1	V2	V3	V1	V2	V3
qualifiers	adj.	22	18	24	27	19	28
	nouns	6	9	19	3	0	1
	total	28	27	43	30	19	29
verbal exp.	subject	2	2	3	33	13	12
	object	1	2	2	16	6	5
	total	3	4	5	49	19	17
total		31	31	48	79	38	46

Table 3: Number of occurrences of each type of word for *son* and *violon*, for each violin, in the playing and listening tasks.

The results derived from Table 1 were found to be observable for each violin in Table 3. *Son* is mostly described in the discourse by means of qualifiers and less through verbal expressions. In contrast the word *violon* is mainly used as the grammatical subject of the sentence and is mainly qualified by adjectival forms. However, we can notice some variations. Only violin 2 was described by as many qualifiers as verbal expressions. Violin 1 was described by more verbal expressions (62%) while violin 3 was described by more qualifiers (63%). For violin 1, it can be explained by the fact that one participant repeated five times “*ce violon a tout*” (“*this violin has everything*”). The difference for violin 3 can be interpreted by the fact that the term *bien* (*good*) was used 7 times (out of 29 occurrences of qualifiers) by this same participant. This confirms previous findings that positive statements are global contrasting with negative ones which are more specific and analytical (Dubois 2009).

		<i>son</i>			<i>violon</i>		
		V1	V2	V3	V1	V2	V3
qualifiers	playing	9	14	23	27	20	26
	listening	16	13	22	2	0	3
verbal exp.	playing	0	2	4	48	19	17
	listening	0	5	1	0	0	0
total	playing	9	16	27	75	39	43
	listening	16	18	23	2	0	3

Table 4: Number of occurrences of each type of word, per task, for each violin, for *son* and *violon*

The comparison between Table 4 and Table 2 shows no irregularities: all the global results derived from Table 2 are actually valid for each violin individually.

Overall, the discourses on the three violins are qualitatively and formally the same as they use the same linguistic resources. These three violins need therefore to be compared on a semantic level.

### Semantic analysis

In the playing task, the sound of violin 1 was qualified as *acid* (*acide*), *somewhat tinny and metallic* (*un côté un peu nasillard*; *un petit côté presque métallique*) but also with a *certain warmth* (*une certaine chaleur*). When analysing the descriptions referring to the violin itself, we can see that it was judged as *easy to play* (*facile à jouer*). The fact that the musicians focused more on their relationship with the instrument than on the sound itself is illustrated by the use of verbal expressions such as *you can discuss with a violin like this* (*on peut discuter avec un violon comme ça*), *it projects quite well* (*il projette pas mal*), *I give it energy, it has to give it back to me* (*je lui donne une énergie, il faut qu’il me la rende*), *I will ask much more from it than what it has given me here* (*je vais lui demander beaucoup plus que ce qu’il m’a donné là*) and *it responds quickly and well* (*il*

*répond vite et bien*). Moreover, the musicians said that violin 1 has *something inside that needs to be freed* (*y'a quelque chose à libérer là-dedans*) and that it needs to be *compensated* (*je compense*).

In the listening task, violin 1 was still qualified as *warm* (*une certaine chaleur autour de la corde*) but also as *very even* (*très égal*) and *somewhat narrow* (*un côté un peu étroit*).

Both in the playing and listening tasks, violin 2 was mostly qualified from its defects. In both tasks, its sound was described as *somewhat acid* (*un côté un peu acide*) and *somewhat bitter* (*un côté aigre*). We can also find several occurrences of the adjective *tight* (*pincé*), as in *something that remains clear but with a tighter sound* (*quelque chose qui reste clair mais avec un son plus pincé*), *the A string has a tighter sound* (*la corde La a un son plus pincé*), *something tight that really stands out* (*un côté pincé qui ressort d'une façon évidente*). The violin itself was qualified as *somewhat nasal* (*ce côté un peu nasillard*). Moreover, W reported that V2 *lacks a bit of guts* (*manque un peu de ventre*) and *does not have the whole harmonic pyramid for some notes* (*n'a pas toute la pyramide d'harmoniques par rapport à certaines notes*). M pointed out a *poverty on the timbre that makes it limited, narrow* (*une pauvreté sur le timbre qui le rend étriqué, étroit*).

Beside these negative statements, V2 was considered to be *easy to play* (*facile à jouer*), to *speak easily* (*d'émission facile*) and to be *musically inspiring* (*il nous inspire musicalement*). Like V1, V2 *responds easily to what the musician demands* (*répond facilement à ce qu'on lui demande*) and *projects really well* (*projetée véritablement*).

Both in the playing and listening tasks, violin 3 was mostly described through its qualities. V3's sound was qualified as *very very warm* (*très très chaleureux*) by E in the playing task and as having a *certain warmth* (*une certaine chaleur*) by M in the listening task. Likewise, this violin was seen as *powerful: it looks rather powerful* (*il a l'air assez puissant*) for E in the playing task and *considering its load, its power, it's impressive* (*au niveau charge, puissance, c'est du costaud*) for W in the listening task. The musicians also agreed, in the playing task, on the fact that this violin is *harder to play* (*plus difficile à jouer*), that it *requires more efforts to be put into vibration* (*demande plus d'efforts pour le mettre en vibration*) and that it is *more demanding* (*plus exigeant*) than the two other violins. Moreover, this violin induced comments such as *it makes me want to make music* (*il me donne envie de faire de la musique*) or *I need to get to know it* (*il faut que j'apprenne à le connaître*).

From the comparisons the violinists made throughout the playing and the listening tasks, we can observe a general agreement in terms of preference between the players, even if their judgments were sometimes expressed differently.

V3 was qualified as *harder to play* (*plus difficile à jouer*), *more demanding* (*plus exigeant*), *powerful* (*à l'air assez puissant*). It was judged *warmer* (*plus chaud*) and its sound was considered *softer* (*plus doux*) and *richer* (*plus riche ; une palette de son plus riche que V1 et V2*).

V1 came second in the order of preference. It was qualified as *less rich and more even than V3* (*le timbre est moins riche que V3 ; plus égal que V3*), as *warmer than V2* (*un peu plus chaleureux sur les graves essentiellement*) and *a little less bitter* (*un peu moins aigre*) than the two other violins. Moreover, the violinists judged that it was *easier to play* (*plus facile à jouer*) than V2 and V3. Yet, it also seemed to have some limitations: this can be deduced from verbal expressions such as *it does not give as much as what I need* (*il donne pas autant que ce que j'aurais besoin*).

V2 appeared to be the violin that they liked least. This is quite obvious from the fact that, contrary to the other two violins, it was mostly judged from its defects. When comparing it to the other violins, the musicians said that it was *a little less powerful* (*un peu moins puissant*) and that it is an instrument that *lacks* properties like *guts* (*manque un peu de ventre*) and *fullness of sound* (*manque de plénitude du son*).

This is in agreement with the preference they expressed explicitly at the end of the session by ranking the violins in the order V3 > V1 > V2.

## DISCUSSION AND CONCLUSION

All these results tend to show that there are clearly two different objects under consideration for the musician: the violin and the sound. As far as the psychological evaluation is concerned, musicians mainly focus on their relationship with the instrument while playing (in all the polysemy of the word) with it, the produced sound leading to an eventually different evaluation while listening (as it is the case for violin 1). It can be inferred that for musicians, the evaluation of the sound per se, as it is the case in a listening task, relatively differs of the evaluation of the instrument when playing.

Through the common use of some adjectives such as *rich* (*riche*), *bitter* (*acide*), *warm* (*chaleureux*), . . . , for *son* as well as for *violon*, it can be seen that those two objects are intimately related in the musicians' evaluations, with *violon* being, in these cases, used as a shortcut for *son du violon* (*sound of the violin*). However, *violon* is given an agency through frequent verbal expressions, agency which is not shared by *son*. This agency clearly involves the interaction between the musician and the violin, which is fundamental for evaluating a violin. Indeed, what came first in the descriptions of a good violin are phrases like: *the speed with which it'll react to my sollicitations* (*la rapidité avec laquelle il va réagir à mes sollicitations*), *to be able to play pp very softly and play loud with very rich sounds* (*pouvoir jouer pp très doux, voire aller au forte, avec des sons très timbrés*), *to speak readily* (*émettre rapidement*), *to respond everywhere* (*répondre partout*), . . . These aspects can obviously only be evaluated in playing conditions. Therefore the sound as a result of what a violinist can produce with that violin has to be *free* (*sonner librement*), *powerful* (*de la puissance*) and varied (*un violon qui peut nous donner la palette de son*), and has to *carry far* (*qui porte loin*). However, this is only a necessary condition, as the intrinsic sound quality of the violin, given by qualifiers shared by the *violin* and the *sound* like *rich* or *nasal*, has to be "satisfactory" as well, meaning *not too bitter*, *not too tight*, . . .

This interaction between the player and his instrument is complex and will be further studied with a more thorough analysis of the present corpus of evaluations. This pilot study will also be extended to more musicians and to other languages, to generalise these findings in order to develop new hypotheses and introduce new variables for the mechanical modelling of the violin.

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**APPENDIX**

As an illustration of the linguistic analysis, this appendix gives examples of descriptors used to qualify *violon* (in green) and *son* (in black) for violin 1, in the playing and listening tasks. The qualifiers are given first, followed by the verbal expressions.

aigre	E: un grain de son, une voix un peu plus aigre (que V3)	a grain of sound, a voice a little bit more sour
chaud,	W: moins chaud que mon violon	less warm than my violin
chaleur,	M: une certaine chaleur autour de la corde	a certain warmth around the string
chaleureux	E: un peu plus chaleureux sur les graves essentiellement (que V2)	a little warmer, essentially in the low register
égal, égalité	W: beaucoup plus égal (que V3), très égal	much more even (than V3), very even
enveloppe	M: une certaine enveloppe (du son)	a certain envelope (of the sound)
étroit, étiqué	M: un côté un peu étroit	somewhat narrow
puissant, puissance	W: moins puissant (que mon violon)	less powerful than my violin
riche	W: le timbre est moins riche (que V3)	the timbre is less rich (than V3)

Table 5: Listening task

acide	E: un peu acide E: un peu acide	E: slightly acid E: slightly acid
chaud, chaleur, chaleureux	M: une certaine chaleur M: reste plus chaud	a certain warmth stays warmer
couleur	W: c'est un grand mélange de couleurs W: il a un peu d'orange, de vert	it's a large mixture of colors there is a bit of orange, of green
difficile, dur/facile	E: facile à jouer E: plus facile à jouer (que V2 & V3)	easy to play easier to play
flatteur	W: c'est flatteur	it's flattering
métallique	M: un petit côté presque métallique	somewhat almost metallic
nasillard	E: un petit peu nasillard E: ce côté un peu nasillard	somewhat tinny somewhat a little tinny
puissant	M: la corde Sol, je la trouve puissante	the G string, I find it powerful
rond	E: peut-être pas très rond	maybe not very round
compenser	W: je compense	I compensate
demander	W: je vais lui demander beaucoup plus que ce qu'il m'a donné là	I'm going to ask much more from it than what it's given me here
discuter	W: on peut discuter avec un violon comme ça	you can discuss with a violin like this
donner	W: il donne pas autant que ce que j'aurais besoin W: qu'est-ce qu'il me donne?	it doesn't give as much as what I need what does it give me?
libérer	W: y'a des choses à libérer là-dedans	there's something inside that needs to be freed
nourrir	W: c'est moi qui le nourris	I'm the one who feeds it
projeter	M: il projette pas mal	it projects quite well
rendre	W: je lui donne une énergie, il faut qu'il me la rende	I give it energy, it has to give it back to me
répondre	M: il répond vite et bien	it responds quickly and well
sonner	W: on peut tous les faire bien sonner	one can make all of them sound well
sortir	W: il sort plus	it goes out more

Table 6: Playing task