Sounds like melted chocolate: How musicians conceptualize violin sound richness

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Sounds like melted chocolate: How musicians conceptualize violin sound richness

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Abstract

Results from a previous study on the perceptual evaluation of violins that involved playing-based semantic ratings showed that preference for a violin was strongly associated with its perceived sound richness. However, both preference and richness ratings varied widely between individual violinists, likely because musicians conceptualize the same attribute in different ways. To better understand how richness is conceptualized by violinists and how it contributes to the perceived quality of a violin, we analyzed free verbal descriptions collected during a carefully controlled playing task (involving 16 violinists) and in an online survey where no sound examples or other contextual information was present (involving 34 violinists). The analysis was based on a psycholinguistic method, whereby semantic categories are inferred from the verbal data itself through syntactic context and linguistic markers. The main sensory property related to violin sound richness was expressed through words such as full, complex, and dense versus thin and small, referring to the perceived number of partials present in the sound. Another sensory property was expressed through words such as warm, velvety, and smooth versus strident, harsh, and tinny, alluding to spectral energy distribution cues. Haptic cues were also implicated in the conceptualization of violin sound richness.

Keywords: Violin, Semantics, Perception, Acoustics

1 INTRODUCTION

The overall goal of the research presented here is to better understand how musicians evaluate violins within the wider context of finding relationships between measurable vibrational properties of instruments and their perceived qualities. Contrary to the typical approach of beginning with a physical hypothesis based on structural dynamics measurements [1, 2] or audio feature extraction [3, 4], a method that relies on theoretical assumptions about cognitive-semantic categories and how they relate to natural language [5, 6] was used to identify and categorize concepts of violin sound richness emerging in spontaneous verbal descriptions. These were collected during a carefully controlled playing experiment [7] and in an online survey where no sound examples or other contextual information was present.

Using the same method in earlier violin playing experiments, whereby skilled string players ranked a set of instruments based on preference and described their criteria through free verbalization tasks [8], we previously explored how violin quality in general is conceptualised by the musician [9, 6]. Specifically, eight semantic categories (concepts or meta-criteria) were identified: 1) TEXTURE (distribution of spectral content); 2) RESONANCE (intensity "under the ear" and via "felt" vibrations); 3) PROJECTION (intensity "at a distance"); 4) RESPONSE (ease of playing and responsiveness); 5) CLARITY (lack of audible artifacts in the sound); 6) BALANCE (of sound and response across strings and registers); 7) INTEREST (affective-hedonic reactions); 8) RICHNESS (amount of spectral content). The latter emerged as a key perceptual factor in assessing violin quality. A statistical analysis of the preference judgments collected in the same and subsequent experiments corroborated that violin preference is strongly associated with perceived richness in the sound [10, 8, 11, 12, 7].

Importantly, it was shown that while perceived variations in violin quality rely on variations in style and the expertise of different musicians, the broader semantic categories emerging from verbal descriptions remain common across diverse musical profiles, thus reflecting a shared perception of acoustic information. This allowed us

to develop a musician-driven framework for understanding how the dynamic behavior of a violin might relate to its perceived quality [6]. Furthermore, the verbal data revealed that vibrations from the violin body and the bowed string (via the bow) are used as extra-auditory cues that not only help to better control the played sound but also contribute to its perceived qualities. Indeed, recent research on the evaluation of violin and piano quality has revealed that an increase in the vibrations felt at the left hand of violinists and the fingertips of pianists can lead to an increase in the perceived richness as well as loudness of the sound [13].

Here we further investigated the perceptual and cognitive processes involved when violinists evaluate violins by focusing on how they describe perceptions of sound richness. Verbalizations were analyzed on the basis of semantic proximities in order to identify emerging concepts that could be coded under broader categories acting as psychologically relevant descriptors of violin sound richness. Semantic proximities were inferred from syntactic context and linguistic markers (e.g., reformulation, explanation, comparison, negation). The coding process was based on the inductive principle of Grounded Theory, where a system of ideas is constructed not starting from a hypothesis (or a set of hypotheses) but from the data itself [14].

2 METHOD

2.1 Online survey

Taking into account the lingual diversity of Québec, where this research took place, bilingual questions in English and French were compiled, and participants were invited to respond in the language they felt most comfortable with. Similarly to our previous work [6], very general open-ended questions were formed to avoid confining the responses into pre-existing categories. Two respondents chose to reply in French and it was decided not to translate their responses but include them in the analysis directly.

Thirty-four violinists (20 female; average age = 42 yrs, SD = 17 yrs, range = 19–73 yrs) provided written responses to the questions (French version is given in parentheses) **Q1:** ***What does richness mean for you?*** (*Qu'est-ce que la richesse signifie pour vous?*) and **Q2:** ***How would you evaluate a violin in terms of richness?*** (*Comment évalueriez-vous un violon en termes de richesse?*). Respondents had at least 14 years of violin experience (average years of violin training = 31 yrs, SD = 15 yrs, range = 14–65 yrs), with 13 describing themselves as professional musicians. Musical profile information for each violinist is reported in Table 1.

2.2 Playing experiment

2.2.1 Musicians, violins and controls

Sixteen violinists participated in the playing experiment (8 female; average age = 32 yrs, SD = 8 yrs, range = 21–55 yrs). They had at least 15 years of violin experience (average years of violin training = 25 yrs, SD = 8 yrs, range = 17–48 yrs) and were remunerated for their participation. Eleven participants described themselves as professional musicians. Musical profile information for each violinist is reported in Table 2. Musicians #10 and #11 had previously participated in the online survey (respondents #25 and #23 in Table 1, respectively).

Five violins of different make (Europe, North America, China), year of fabrication (1914–2011) and price ($2.7k–$71k) were chosen from two luthier workshops in Montreal, Canada, in order to form, as much as possible, a set of instruments with a wide range of characteristics [7]. The respective luthiers provided the price estimates and tuned the instruments for optimal playing condition based on their own criteria. Participants' own violins were not included in the set of instruments in order to avoid possible preference biases caused by the mere exposure effect [15] by which familiarity with a stimulus object increases preference toward it.

Low light conditions and dark sunglasses were used to help hide the identity of the instruments as much as possible and thus circumvent the potential impact of visual information on judgment while ensuring a certain level of comfort for the musicians, as well as safety for the violins. To avoid the potential problems of using a common bow across all participants (e.g., musicians being uncomfortable with a bow they are not familiar with, bow quality), each violinist used their own bow. Furthermore, violinists were given the option to either use a provided shoulder rest (Kun Original model), or use their own, or use no shoulder rest. Sessions took place in

Table 1. Musical profile of online survey respondents and semantic categories they used.

	Musical profile			Semantic categories							
	Practice (yrs)	Skill	Style of music	Fu	Wa	Reso	Cl	Vi	Resp	Ba	In
1	17	Amateur	Classical, Folk	✗	✗					✗	✗
2	16	Amateur	Classical	✗	✗					✗	
3	14	Amateur	Classical	✗	✗						✗
4	16	Amateur	Classical	✗	✗	✗	✗		✗		✗
5	18	Amateur	Classical, Jazz, Folk	✗		✗			✗		✗
6	23	Professional	Classical, Jazz	✗	✗	✗					✗
7	44	Professional	Classical, Contemporary	✗	✗	✗	✗			✗	
8	23	Amateur	Classical, Baroque	✗							✗
9	20	Amateur	Classical, Jazz, Folk	✗				✗		✗	
10	17	Professional	Classical, Contemporary	✗		✗	✗	✗	✗		
11	20	Professional	Classical, Baroque, Contemporary	✗	✗	✗	✗		✗		✗
12	39	Professional	Classical, Contemporary	✗	✗	✗			✗	✗	✗
13	45	Amateur	Classical	✗	✗			✗			
14	50	Professional	Classical, Contemporary	✗							
15	34	Amateur	Classical	✗	✗	✗					✗
16	35	Amateur	Classical	✗							
17	25	Amateur	Classical	✗	✗						
18	56	Amateur	Classical, Contemporary	✗			✗				
19	19	Professional	Classical, Jazz	✗	✗	✗	✗	✗			✗
20	15	Amateur	Classical, Jazz	✗		✗					
21	15	Amateur	Classical, Folk	✗	✗	✗					
22	27	Professional	Classical, Baroque	✗	✗		✗				✗
23	25	Professional	Jazz, Folk	✗	✗	✗			✗		
24	31	Professional	Classical, Baroque	✗		✗					✗
25	48	Professional	Classical, Folk	✗	✗						✗
26	18	Professional	Classical, Baroque	✗		✗					
27	44	Professional	Classical	✗							✗
28	30	Amateur	Classical	✗		✗					✗
29	65	Amateur	Classical, Baroque		✗						
30	40	Amateur	Classical, Contemporary		✗	✗		✗			
31	50	Amateur	Classical, Baroque	✗	✗		✗				✗
32	60	(not reported)	Classical, Baroque	✗							
33	38	Amateur	Classical, Folk	✗	✗						
34	22	Amateur	Classical	✗							✗

acoustically dry rooms to help minimize the effects of room reflections on the direct sound from the violins.

2.2.2 Tasks and procedure

In the playing experiment, musicians were asked to "rank-rate" the five violins in terms of richness in two tasks. In each task, violinists simultaneously rated each of the violins using separate, identical on-screen sliders, thus providing a ranking of the instruments at the same time. They were instructed to always rate their top choice as 1 and their lowest as 0, and were not allowed to assign the same rank-rating to two or more instruments. Musicians were instructed to maximise evaluation speed and accuracy, and were encouraged to play their own violin whenever they needed a reference point during the experiment. To minimise fatigue, violinists were encouraged to take breaks between trials whenever needed.

The first task involved playing the eight notes of the chromatic scale *G2* $\rightarrow$ *D3 détaché*, first *without vibrato*

Table 2. Musical profile of playing test participants and semantic categories they used.

	Musical profile			Semantic categories							
	Practice (yrs)	Skill	Style of music	Fu	Wa	Reso	Cl	Vi	Resp	Ba	In
1	21	Professional	Classical	✗	✗	✗				✗	✗
2	23	Professional	Classical	✗	✗		✗				✗
3	21	Professional	Classical	✗		✗					
4	18	Professional	Contemporary	✗		✗		✗			
5	17	Amateur	Classical					✗			✗
6	30	Professional	Classical	✗							
7	26	Professional	Classical	✗		✗				✗	
8	20	Amateur	Classical	✗						✗	
9	25	Amateur	Jazz	✗							
10	48	Professional	Classical	✗	✗	✗					✗
11	22	Amateur	Classical	✗	✗	✗		✗			✗
12	34	Professional	Classical	✗		✗	✗				✗
13	17	Professional	Folk	✗							
14	20	Amateur	Classical	✗	✗		✗				
15	32	Professional	Classical, Folk	✗		✗				✗	
16	28	Professional	Classical		✗						✗

followed by a repetition *with vibrato*. Violinists were instructed to follow a 50 bpm tempo and use the whole bow. The second task involved playing the opening solo passage from Max Bruch's Violin Concerto No. 1 in *G* Minor, Op. 26 (Movement I: Prelude). The particular excerpt was chosen because it incorporates the whole range of the instrument (as opposed to the first task) as well as a variety of techniques and dynamics. Violinists were instructed to follow the temporal and expressive markings as much as possible (i.e., a certain degree of personal interpretation was expected).

Upon completing the second task, participants provided written responses to the same two questions as in the online survey. Two violinists chose to reply in French and it was decided not to translate their responses but include them in the analysis directly.

2.3 Analysis

Following the data coding steps that form the constant comparison method within the Grounded Theory framework [14, 6], our analysis started from the verbalizations collected in the online survey. First, groups of words indicating a concept of violin sound richness, henceforth called verbal units, were extracted from musicians' responses to the first question and classified in semantic categories. Inter-categorical associations were then established, at which point a tentative core for our conceptual framework had been formed. We next scanned the verbal responses to the second question. New concepts were identified and the core was updated to fit with the new data. The analysis was then extended to the verbal responses collected in the playing experiment on the basis of the updated core, wherein no further concepts emerged. Consequently coding was stopped as theoretical saturation had been reached.

Each verbal unit corresponded to a semantically distinct violin quality characteristic. Semantic proximities were assessed through syntactic context and linguistic markers such as the use of apposition, opposition, reformulation, explanation, comparison, or negation. For example, the phrase *"a complex and pleasant sound"* contained two verbal units, namely "complex" and "pleasant," whereas the phrase *"resonant sound that is not weak"* constituted a single unit which, however, comprised two manifestations of the same quality characteristic with opposite meanings, namely "resonant" (positive connotation or desirable quality) and "weak" (negative connotation or undesirable quality).

3 RESULTS

3.1 Semantic categories

In total, 211 verbal units were extracted from the responses collected in the online survey (34 violinists, 6 units per respondent on average) and 75 units in the playing experiment (16 violinists, 5 units per respondent on average), and were classified in eight distinct semantic categories, revealing a common framework for semantic features given to "rich" as a qualifier of violin timbre and sound quality:

1. A strong consensus was observed with the use of *full* (*plein* in French), describing a certain sensory property referring to the perceived amount of spectral content as in the perceived number of partial frequencies present in a violin note. This sensory property was also described, with some approximation, by other semantically related sensory adjectives such as *deep*, *dark* (*sombre* in French), *dense*, *complex*, *big* (*ample* in French), *wide* (*large* in French), and *thick*, or semantic opposites like *thin*, *narrow*, *small*, *light*, and *nasal*. Some musicians described this characteristic of a rich violin sound in acoustical (i.e., technical) terms—*lots of/an abundance/variety of harmonics/overtones/dynamics*)—while others tried to qualify a rich violin sound by referring to the *ease/flexibility* of the instrument to produce *a variety/palette of colours/timbres* and to *react a lot in terms of sound changes, colours*, thus *enabling a violinist to create appropriate sounds for the chosen repertoire* and having *a shimmering quality whereby the sound changes constantly as one draws the bow*. Along the same line of conceptualization, one violinist described a rich sound as being *generous* (*généraux* in French).

2. Another sensory property was expressed through words such as *warm*, *velvety*, *smooth*, *round*, *sweet*, and *mellow*, versus *strident*, *harsh*, *tinny*, *brassy*, *squeaky*, *metallic*, and *bright*—borrowed from the semantic field of texture. Also referring to spectral content, such conceptualizations direct to the distribution of spectral energy between the bass, midde, and treble registers in a played note; undesirable qualities are associated with disproportionately more treble or not enough bass frequencies (*mellow tone on lower strings, no stridency on upper ones*). This sensory property of a rich violin sound was also described in acoustical terms by some performers: *evenness of projection across the frequency range*; *the sound has to contain a particular amount of energy in the different range of frequencies*; *combined with a good dose of lower frequencies for warmth*.

3. Strong consensus was also observed with the use of *resonant*, *strong*, *ringing*, *powerful*, *sonorous*, *sustained*, *lively*, and *projective*, versus *weak*, *muffled*, and *closed*. The semantic field summarizing these verbalizations can be described as action-presence [6] and suggests an evaluation of "how much sound" comes out of the violin based on estimated intensity and spatial attributes (*a rich sound has to vibrate naturally and to go far without forcing*), but also on the "amount of felt vibrations" from the body-bow system (*how much you feel the sound in your body when you hear it*) [13].

4. Yet another sensory property associated with a rich violin sound was expressed through words and phrases such as *clarity*, *pure*, *precise*, *focus*, *speakability* or *how freely each string speaks*, *the sound can take a lot of pressure without cracking*, *lack of grainy tonality*, and *direction* (as in *focus*). Here violinists tried to describe a violin tone perceived as having more distinct and well-defined spectral components, especially in the low register where different notes may be heard as "blending into each other" or "unfocused" due to overlapping overtones. Some violinists specifically referred to a clear sound as lacking audible artifacts such as a wolf tones (oscillating beat when note frequency too close to the resonance frequency of the violin body).

5. Some musicians tried to qualify a rich violin sound as *varying with/responding to vibrato* and offering *lots/nuances of vibrato* or *un vibrato nerveux, ample, leger ou inexistant* (*a vibrato that is nervous, full, light or non-existent*).

Table 3. Distribution of categories within and across responses to questions (N = total units; # = coded units; % = proportion).

	Online survey						Playing experiment					
	Q1 ($N = 132$)		Q2 ($N = 79$)		ALL ($N = 211$)		Q1 ($N = 46$)		Q2 ($N = 29$)		ALL ($N = 75$)	
	#	%	#	%	#	%	#	%	#	%	#	%
Fu	69	52	19	24	88	42	20	44	8	28	28	37
Wa	30	23	7	9	37	18	8	17	5	17	13	17
Reso	9	7	23	29	32	15	7	15	7	24	14	19
Cl	5	4	10	13	15	7	5	11	-	-	5	7
Vi	3	2	4	5	7	3	-	-	3	10	3	4
Resp	-	-	6	8	6	3	-	-	-	-	-	-
Ba	1	1	5	6	6	3	1	2	3	10	4	5
In	15	11	5	6	20	10	5	11	3	10	8	11

6. Some violinists qualified a rich violin sound by referring to the responsiveness of the instrument (i.e., how quickly the violin responds to different bowing gestures): *if the violin answers tenderly to the bow*; *I pay attention to reactions to different strokes*; *it is important that* [the violin] *responds quickly and evenly*; *the sensitivity/response of the violin is helpful*; *it is important that it responds quickly and evenly*; *il faut sentir la sensibilité jusqu'au bout des doigts* (*you have to feel the sensitivity right down to your fingertips*.

7. Some violinists qualified a rich violin sound as being *well-balanced for both low and high notes* or *stable (if the sound is good in all the ranges)*, or having *equal resonance on all strings... thus making the richness of tone consistent throughout*. In particular, some musicians explicitly referred to the responsiveness of the violin in higher positions on the lower strings (G and D). As one violinist put it, *I often find a rich sounding violin starts to get a weak sound as I strain the string by going higher*.

8. Finally, many musicians referred to global affective-hedonic qualities that do not reflect the perception of certain physical parameters and could thus qualify any sensory property irrespective of modality: *beautiful*; *pleasant/not irritating*; *has personality*; *unmusical tonality*; *the heart-melting sound*; *richness is the difference between butter and margarine*; *richness is indulgence*; *the instrument blooms... has the sensation that you can sink in to it*. Or as one violinist said: *I judge richness based on how much the sound reminds of melted chocolate.*

Table 1 reports the musical profile of each respondent in the online survey along with information on whether they used verbal expressions within a given category (Fu = fullness; Wa = warmth; Reso = resonance; Cl = clarity; Vi = vibrato; Resp = responsiveness; Ba = balance; In = interest). Corresponding information for the musicians in the playing experiment is reported in Table 2. No obvious relationship between having a certain style and/or level of experience and attending to particular attributes was observed. Consequently, Table 3 summarizes the across-musicians distribution of semantic categories within each and over all responses to the different questions. Occurrences were further summarized across questions due to similar trends.

3.2 Discussion

In order to identify how the definitions of violin sound richness proposed by the experts (i.e., the violinists) position themselves in relation to dictionary definitions of the adjective *rich* in English, we have noted definitions and synonyms from two sources:

- Oxford English Dictionary (OED; 2nd Edition): 1) Of things: Powerful, strong. 2) Wealthy in, having abundance of, amply provided with, some form of property or valuable possessions. 3) Of choice or

superior quality; esp. of articles of food or drink with reference to their stimulative or nourishing effects. 4) Of a full, ample, or unstinted nature; highly developed or cultivated. 5) Of colour: Strong, deep, warm. 6) Of musical sounds: Full and mellow in tone. 7) Of odours: Full of fragrance.

- WordNet (www.wordnet.princeton.edu; a large network of semantic relations between words based on psycholinguistic and computational theories of human lexical memory [16]): 1) Having an abundant supply of desirable qualities or substances. 2) Fat, fertile, productive (marked by great fruitfulness). 3) Deep (strong; intense). 4) [Of wine, food, etc.] full-bodied, racy, robust (marked by richness and fullness of flavor). 5) [Of sound] pleasantly full and mellow. 6) Ample, copious, plenteous, plentiful (affording an abundant supply).

It appears that rich is conceptualized in a highly similar fashion across sensory modalities (taste, smell, vision, audition) but also in more abstract nonsensory domains (wealth, strength, abundance). Central to all conceptualizations of *rich* is the idea of "affording an abundant supply" of one or more “desirable qualities,” which is reflected in the first semantic category identified in the experts discourse (*full sound*; *lots of harmonics/overtones*). Furthermore, qualifying a rich violin sound as *resonant/powerful/strong* (third semantic category) and as offering *lots/nuances of vibrato* (fifth semantic category) can be regarded in the same light as the global "lots of" definition of *rich*. The agreement of OED and WordNet in how *rich* is defined for sounds suggests that its qualification as both *full* and *mellow* (second semantic category) is considered beyond violin sound to any auditory scenario.

The semantic categories of *clear/focused* and *balanced* are more specific to musical sound and to the violin in particular, where tones in the middle and low registers should not be “muddy” or “blurry”, and those in the high register should not be “thinner” or “weaker” (cf. [6]). Characterizations of a rich violin sound as *beautiful*, *pleasant*, *heart-melting*, and *reminding of melted chocolate* assume a cognitive evaluation of the subjective-affective state of the musician in response to their imaginary (online survey) or physical (playing experiment) interaction with the violin and its sound.

Descriptions of responsiveness (of the instrument) were the least recurrent in both the imaginary and physical situations. In fact, this semantic category did not emerge at all in the playing experiment, while in the online survey it emerged only in responses to the question *How would you evaluate a violin in terms of richness?* (Q2). It is plausible that, for the violinists who responded to the online survey, the type of question at hand may have affected how different facets of *rich* are negotiated. That is, the use of the word “evaluate” in Q2 could have evoked notions of musician-instrument interaction and playability, whereas the formulation of Q1 led to a prioritization of primarily sound attributes. Similarly, the violinists who took part in the playing experiment were asked to first respond to the question *How and based on which criteria did you make your preference ranking?* before answering Q1 and Q2. A look at those responses, which is beyond the scope of the present analysis, indeed reveals descriptions of responsiveness.

4 CONCLUSIONS

The present analysis provides further evidence that metaphorical linguistic structures such as *rich sound* are central to the process of conceptualizing timbre by allowing the musician to meaningfully perceive and communicate subtle acoustic variations in terms of other, more commonly shared experiences [17].

While individual conceptualizations of violin sound richness are very subtle and can overlap, the broader semantic categories emerging from the collected verbalizations reflect a shared representation of what a rich violin sound may mean. This can be seen as a first step in translating the semantics of violinists’ expressions into perceptually meaningful descriptors of violin sound quality. Importantly, it demonstrates that violin players with different levels of experience and expertise share a common framework for differentiating the sensory meanings of auditory cues.

We expect that there are variations of the language (i.e., the specific lexicon and its meaning) used by musicians from place to place (sometimes resulting from a strong influence by one or more particular teachers

in an area). The present analysis might thus be biased toward a verbal tradition specific to the Montreal region. Nevertheless, this research provides a resource that should be consulted by any researchers planning to conduct perceptual studies of violin quality (i.e., when designing the language used in their experiments).

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