Shaping the resonance. Sympathetic strings in Hindustani classical instruments

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2pMU6. Shaping the resonance. Sympathetic strings in Hindustani classical instruments

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Most chordophones of the contemporary classical Hindustani tradition are characterized by the presence of numerous sympathetic strings (taraf), sometimes up to over 30. Generally tuned according to the rag, they are inserted within the handle of the plucked lutes sitar and sarod, and next to and below the main strings of the bowed fiddle sarangi. In some cases (e.g. some of sarangi's taraf and all of the sitar's taraf) are also equipped with a curved bridge, increasing the spectral richness of the sounds produced by these strings. Players consider the taraf's response as fundamental to the instrument's sound. Based on field recordings realized at the ITC Sangeet Research Academy (Kolkata, India) this study aims to determine the contribution of these strings to the resulting sound of the different instruments and settings. Acoustical analyses are complemented with ethnomusicological analyses, in order to evaluate the taraf's aesthetic, musical and perceptual role.

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1. Introduction

Hindustani classical music is a very rich and complex tradition. Among the instruments, the chordophones (*tata vadya*) played a prominent role in the history and development of Hindustani classical music. Nowadays, the *sitar*, *sarod* and to a lesser extent the *sarangi* (Figure 1) are the most revered solo melodic instruments and the most widely used in classical performances [Sorell and Narayan 1980, p. 34]. Plucked lutes *sitar* and *sarod* as well as bowed fiddle *sarangi* share a common feature: they comprise sympathetic strings (Figure 2).

Figure 1. From left to right. *Sarangi*, Inv. Nr 2010.057, Musical Instruments Museum, Brussels; *Sarod*, ITC-Sangeet Research Academy, Kolkata, *Sitar*, Inv Nr. 2007.001, Musical Instruments Museum, Brussels. Left and right photos: S. Egan © mim; centre: Stéphanie Weisser.

According to iconographic evidence, the introduction of sympathetic strings on Indian instruments is estimated to date back to the beginning of the 17th century [Bohr 1986-7, pp. 55-56]. Nevertheless, its generalization in classical music context is more recent: the *sitar* became equipped with *taraf* by the end of the 19th century [Junius 1974, p. 20]. The *sarod* was elaborated during the second half of the 19th century from the *rabab*, a Pathan instrument (east of Afghanistan-north of Pakistan) also equipped with *taraf* strings [McNeil 2004, pp. 11-25, 88-96]. The *sarangi*, historically associated with singing and dancing courtesans, progressively entered the field of classical music during the 20th century [Qureshi 1997].

Figure 2. From left to right. *Taraf* (sympathetic strings) of *sarangi*, *sarod* and *sitar*, ITC-Sangeet Research Academy, Kolkata. Photos: Stéphanie Weisser.

Taraf settings are different according to the instruments, the *gharana* (socio-aesthetical tradition), and often the personal taste of the player. However, some general remarks can be made, for example regarding the number, material and location (see Table 1).

Table 1. *Taraf* settings and characteristics according to instrument type.

<i>Taraf</i> setting and characteristic	<i>Sarod</i>	<i>Sitar</i>	<i>Sarangi</i>
Material	Metal	Metal	Metal
Bridge	Sharp bridge shared with playing strings; <i>taraf</i> pass through holes	Wide and curved, independent from the playing strings	Sharp bridge shared with playing strings; <i>taraf</i> pass through holes
Tuning	According to the <i>rag</i>	According to the <i>rag</i>	According to the <i>rag</i> and chromatically (all notes)
Number	From 11 to 15, grouped in a single set	From 11 to 13, grouped in a single set	Up to over 35, grouped in four sets (two sets sometimes with additional small curved wide bridges)
Location	In the closed handle and under the curved frets ¹	In the closed unfretted handle, next to the playing strings	Partly in the open unfretted handle, partly next to the playing strings

In comparison with the wide curved bridge (*jawari*), the other specific feature of Hindustani chordophones, the *taraf* strings (and sympathetic strings in general) are scarcely studied from an acoustical point of view, except for Besnainou and Castellengo's paper [1995, p. 60] in which sounds of a *sarangi* are visualized with spectrograms and *taraf* effect briefly described as "an echo that makes the sound shimmers" and "wonderfully complex". In musical and musicological literature on Indian music, few mentions of this effect are found, usually limited to the number of sympathetic strings, their location on the instrument and their tuning. Sometimes, their effect on sound is briefly mentioned: "[they] gave a boost to amplification and sustenance" [Raja 2005, p. 297]. However, N. A. Jairazbhoy and A. W. Stone [1963] observed that on the *sitar* the presence of sympathetic strings may have an important effect on intonation: the sympathetic strings may cause the pitch of the main string to drop rapidly and beats to become audible. They measured "a difference of as much as 20 cents in extreme cases between the pitch at the moment of impact and the levelling of the tone" [Jairazbhoy and Stone 1963]. Priyamvada [2009] also notes that sympathetic strings' response is maximum when the interval between the played sound and the *taraf* is a unison or an octave, and to a lesser extent a fifth. The author describes the *taraf*'s effect as "a lingering halo of sound", and as a way to "enhance the sound of the instrument" [Priyamvada 2009, vol. 2, p. 379].

From a conceptual point of view, Napier [2003-2004] considers that the "resonant haze of the *tarab* (sympathetic strings)" is one of the several "basic phenomenon of Indian music". *Taraf* effect can be considered as one of the way to attain the Indian aesthetic ideal of saturation [Napier 2003-2004, pp. 128-129], defined as the preference for continuity of the melodic line, ornamentation and "a 'sonic depth' or textural richness that must be achieved without compromising the dominance and subtlety of melody" [*Ibid.*, p. 116] – or the *fear of the void*, to sum it up. *Taraf* strings are constituent parts of the instruments and the sonorous event. In this paper, their role will be analyzed and evaluated, from musical, perceptual and acoustical points of view.

2. Material and methods

Several scholars of the ITC-Sangeet Research Academy (Kolkata, India) were interviewed and recorded. Tones were recorded one by one, first with the *taraf*'s normal setting and second with the

¹ Unlike frets in Western instruments, the *sitar* frets are curved and the musician can control pitch by pulling the string along the fret (the *meend* technique). The pitch produced with this technique can raise up to a fifth.

taraf vibrations being stopped by a cloth wrapped around them. Musicians were asked to let each sound vibrate until natural tone extinction occurs before playing the next one. Tuning and *rag* was left to their choice.

Recordings took place in a sound-proof room of the Academy, with a two-channel Sound Device 702 portable audio recorder and two cardioid MBHO NBNM 440 CL microphones. Interviews took place most of the time before or after the recording sessions. Personal information such as age, musical experience, musical preferences were collected, then open questions about sound and *taraf* were asked (“What do *taraf* do?”, “What is a good *taraf* contribution?”, etc.) in order to engage in an informal discussion. Information collected in Belgium from Indian musicians on tour or professional European players of Hindustani music were added to the corpus of statements.

About 13 pairs of sounds from one instrument of each type (*sarangi*, *sarod* and *sitar*) were selected, edited with Sound Studio software and analyzed with the Timbre Toolbox [Peeters *et al.* 2011] for calculation of the following timbre descriptors: (1) Log-Attack-Time; (2) Spectral Centroid (Mean and Standard Deviation); (3) Tristimulus 1, 2 and 3; (4) Decrease Slope. Fundamental Frequency was calculated using the IRCAM’s software Audiosculpt, and Roughness with MIRTtoolbox using Vassilakis’ model [Lartillot and Toiviainen 2007].

In total, 40 pairs of sounds (with and without *taraf*) were analyzed and Percentage Increase/Decrease of descriptor values for sounds with and without *taraf* were calculated (see Table 2). Information from interviews was categorized into three main categories: Intrinsic (related to sound itself), Extrinsic (related to symbolic associations activated by the sounds) and Practical (related to settings, tuning, playing, etc.). The Intrinsic information category, consisting of 56 statements, was subdivided into Information related to global sounds category and Information related to *taraf* sounds. These two subcategories were further divided according to content (see Table 3).

3. Results

Contribution of the *taraf* to global sounds is noticeable in all calculated descriptors (see Table 2).

Table 2. Percentage Increase/Decrease (unless stated otherwise) in descriptor values due to *taraf*’s contribution, for *sarangi*, *sarod* and *sitar*.

Percentage Increase/Decrease	<i>Sarangi</i>	<i>Sarod</i>	<i>Sitar</i>
Spectral Centroid (SC) mean/f0	+8%	-9%	+9%
Spectral Centroid (standard deviation)	+1%	-14%	+28%
Attack Duration	+13%	+3%	-2%
Tristimulus 1 (T1)	+74%	+16%	-8%
Tristimulus 2 (T2)	-12%	-5%	-5%
Tristimulus 3 (T3)	+1%	-14%	+8%
Intervals between F0 with and without <i>taraf</i> (absolute values in cents)	6.93	4.56	3.6
F0 with <i>taraf</i> < f0 without <i>taraf</i> (in % regarding the corpus)	77%	64%	31%
Roughness (mean)	-5%	+52%	+33%
Roughness (standard deviation)	+11%	+50%	+18%
Decrease Slope	N. P.	Increase	Increase

SC mean values are raised in *sarangi* and *sitar*, but lowered in *sarod*. The Standard Deviation values for this descriptor are also increased for *sarangi* and *sitar*, whereas they are lowered for *sarod*. Attack duration is more important for *sarod* and *sarangi*, but less for *sitar*. Spectral repartition is changed for all instruments: T1 is increased for *sarod* and *sarangi*, T3 for *sitar*. Roughness (mean) diminishes only for *sarangi*, but increases for *sitar* and *sarangi*. Standard Deviation of the Roughness

increases for all instruments. T2 decreases for all instruments. Only these last two descriptors are influenced in a similar way by the presence *taraf* for all instruments.

Content analysis of players' information shows that most of the information related to the Intrinsic category regards sound color (14 statements for Global sound category, 8 on *Taraf* sound category, see Table 3), followed by non-timbral sound features (10 statements on global sounds, 10 on *taraf* sound). The latter were mostly expressed by *sarod* players or *sarodiya* (11 statements), whereas statements focusing on sound color were in majority (9) expressed by *sitar* (6) and *sarangi* (3) players.

Table 3 Content-analysis table of intrinsic information from musicians' interviews, with number of statements for each category and example(s).

1.1. Global sound (30)	1.1.1 Non-timbral feature (10)	" <i>Taraf</i> increase the resonance/sustain"(3)/"the duration of the sound"(4)
	1.1.2. Change sound colour (14)	" <i>Taraf</i> bring extra vibration to/enrich the sound"(3)/"bring sweetness/softness to the sound"(2)
	1.1.3. Change quality/beauty (6)	" <i>Taraf</i> make the sound very beautiful/Sound with <i>taraf</i> is very good"(6)
1.2. <i>Taraf</i> sound (26)	1.2.1. Non-timbral feature (10)	" <i>Taraf</i> must sound for a long time"/"as loud as possible" (3) /"not too much" (4)
	1.2.2. Sound quality (8)	" <i>Taraf</i> must sound mellow" (2), "echo-like" (1)
	1.2.3. Heterogenic responses (8)	"Some <i>Taraf</i> respond more" (6)/"All <i>taraf</i> must respond equally" (2)

4. Discussion

The differences in statements according to an instrument's type (*sarod* vs. *sitar* and *sarangi*) underline the fact that *taraf* play a different role according to the presence or absence of *jawari* (wide curved bridge)² for all or some of them. This difference is also noticeable in the desired intensity of the *taraf* contribution (part of category 1.2.2): most *sarodiya* (three out of the four players who explicitly mentioned this feature) want a maximal or loud contribution of the *taraf*, whereas all the four *sitar* and *sarangi* players desire a more controlled (limited) contribution. Contributions of *taraf* to the sound color of the global sound are evoked in quite diverse terms. The most frequent statement relates to "extra vibration/enrichment of the sound" (two *sitariya*, one *sarangiya*), followed by "*taraf* bring sweetness/softness to the sound" (one *sitariya*, one *sarangiya*).

Some statements of the Intrinsic category seem contradictory: "*taraf* make the sound rounder" (*sarodiya*) vs "*taraf* improve the clarity of the sound" (*sarangiya*). If this contradiction can be, once again, explained by the presence of the *jawari*, the following is more intriguing. Two *sitariya* stated

² Almost all *sarodiya* interviewed (5 out of 7) are studying under the guidance of Pandit Buddhadev Das Gupta (Shahjahanpur Gharana). In this tradition, *sarod* is not equipped with *jawari*, in opposition with the Maihar Gharana, for example. One of the most famous tenants of the latter, Ustad Ali Akhbar Khan, even considered that instruments played by these two *gharana* were so different that they should be spelled differently, using *sarode* instead of *sarod* (D. Trasoff, personal communication, October 2011). It can also be noted that one of the *sarangi* players interviewed, Pandit Dhruva Ghosh, took away several *taraf* as well as the two *jawari* on his instruments.

respectively “*taraf* bring lightness to sounds” and “*taraf* make the sound deeper”. However, conjunct analyses can explain this apparent contradiction: the “roundness” brought to the sound by *taraf* according to a *sarod* player (vs the brought “clarity” according to a *sarangi* player) can be related to the lowering of the SC – related to brightness – for *sarod*.

Other correlations between measurements and statements can be made: the “extra-vibration” noted by *sarangi* and *sitar* players can be correlated with the increase of roughness for sounds with *taraf*. The lowering of Standard Deviation of spectral centroid (SC) measurements for the *sarod* can indicate a more homogeneous response of the *taraf* (or a ‘homogenizing’ effect on global sounds due to the contribution of the *taraf*) for this instrument, and can be linked with the two statements in favor of homogeneous responses (category 1.2.3). The increase of T1 for *sarod* can be linked with statements of two *sarodiya*, who consider that low-pitched strings generate better *taraf* responses than high-pitched ones, and that *taraf* tuned in unison respond the best. As for *sarangi*, the increase of T1 could also be correlated with the rather unexpected lowering of mean roughness, as the latter would be much more important in case of spectral enhancement in higher frequencies (as the critical bandwidth increases with frequency) than in lower ones.

Eventually, the increase of Standard Deviation for Roughness measurements can also be correlated to the “extra life” brought to the sound by the *taraf*. Changes in fundamental frequencies (f_0) can also be directly linked with the total number of sympathetic strings: the more numerous the *taraf* (as in *sarangi*), the more important the change of f_0 .

5. Conclusions

Acoustical and ethnomusicological information confirm that *taraf* are indeed a very important feature of the instruments they are part of. The *taraf*’s effects vary deeply according to instruments, settings and played notes; so far, it does not seem possible to categorize specific behaviours, within instrument types, according to registers, scale degrees nor sounds produced by open strings/fingering. This underlines the variability of non-western, non-standardized instruments, and also the important degree of personal “fine-adjustment” of the timbral characteristics of instrumental sounds by the players.

In a North-Indian classical music performance, all the sonorous possibilities are explored. From sounds lasting until their natural extinction to sounds played with extreme speed, from the lowest pitch possible on an instrument to the highest, from softest to loudest (pitch, speed and loudness usually increasing together from introductory part *alap* to climatic ending *jhala*), musicians use the entire range of sounds their instrument can produce – with their timbral diversity. Such variability needs to be taken into consideration, in ethnomusicological studies as well as in acoustical studies, as this variety is a key feature of this fascinating musical system.

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