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 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).

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].

*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.

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

In comparison with the wide curved bridge (jwari), 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

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\(^1\) 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.
\textit{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 \textit{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 \textit{taraf} were asked (“What do \textit{taraf} do?”, “What is a good \textit{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 (\textit{sarangi}, \textit{sarod} and \textit{sitar}) were selected, edited with Sound Studio software and analyzed with the Timbre Toolbox \cite{Peeters2011} 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 MIRToolbox using Vassilakis’ model \cite{Lartillot2007}.

In total, 40 pairs of sounds (with and without \textit{taraf}) were analyzed and Percentage Increase/Decrease of descriptor values for sounds with and without \textit{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 \textit{taraf} sounds. These two subcategories were further divided according to content (see Table 3).

### 3. Results

Contribution of the \textit{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 \textit{taraf}’s contribution, for \textit{sarangi}, \textit{sarod} and \textit{sitar}.

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

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

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

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) 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

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 Akbar 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 Dhruba 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 sarodiyar, 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 (f0) 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 f0.

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.

6. Acknowledgements

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7. References


