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## Vocal Registers Transitions Phenomena in trills used in Mongolian Long Song productions

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measured from inverse filtering of the audio signal, using the custom made DeCap software (Svante Granqvist) and the commercial Soundswell software. Fundamental frequency F0 was measured from the EGG signal using the Soundswell CORR tool. Complementary measurements of F0 were made from both historic and contemporary commercial recordings of other Iranian singers.

Analysis of the formants used in the scales revealed that for most of the vowels analysed the singer tuned F1 to a spectrum harmonic in all scale tones. The F0 curve for the tone reiterations showed rapid repetitions of the same tone with continuous phonation. Both these tone reiterations and alterations between two tones were sung without changes of type of phonation. However, the melodic tahrir ornaments, referring to a series of melismatic transitions between melody tones sung in the modal register, contained short falsetto register episodes that marked the boundaries between the tones. These observations will be discussed in relation to findings previously reported by Caton 1974 and Castellengo et al 2009.

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Johan Sundberg is professor of Music Acoustics, retired in 2001, but still active in research. The singing voice and

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*Vocal Registers Transitions Phenomena in trills used in Mongolian Long Song productions* – C Pillot-Loiseau, L Crevier-Buchman, A Rialland, T Narantuya, C Vincent, A Desjacques

There are many acoustical studies about vibrato in classical singing (Horii 1989; d'Alessandro & Castellengo 1994; Dromey et al. 2003), but few studies about trills (Hakes et al. 1987; Castellengo 1991; Castellengo et al. 2007). Moreover, 1) the laryngeal behaviour in the Mongolian Long Song during trills, 2) the vocal registers transition phenomena during this particular vocal technique have not been studied with quantitative data. This paper presents the results of a fiberoptical and acoustical analysis of "Mongolian Long song", a long and slow versified melody with multiple ornaments (Desjacques 1990). Our goal is to quantify the vocal registers transition phenomena during the trills that occur during these Mongolian Long Song productions. The study includes: 1) videofiberoptic laryngeal data of the 61 ornaments of a song produced by a famous Mongolian singer, Narantuya, with quantitative analysis (distance between the left and right arytenoids); 2) an acoustical analysis of the fundamental frequency F0 and intensity I curves of the ornaments: from these curve we extracted the relative rate and the extent of the F0 (FM) and I (AM) modulations (Dromey et al. 2003), the correlations between F0 and I for each ornament. We also calculated (Castellengo et al. 2007) the F0 jump value and the time separating the two frequency jumps during the register transitions phenomena in trills. Moreover (Neumann et al. 2005), we compared the amplitude of the second (H2) and the fourth (H4) harmonics to the first (H1) and third (H3) in the spectrum of [a] sang during the chest and head voice passages in each trills.

The fiberoptic analysis showed two main laryngeal behaviour in producing ornamentations, with a leitmotiv: 1) "lyrical" vibratos mobilizing the entire laryngeal block; 2) "Mongolian" trills with essentially supraglottic movements, the left arytenoid being mobilized independently of the rest of the laryngeal block. In those trills, there is a regular distance oscillation value between the

left and the right arytenoids; the value of this oscillation is the same as the mean frequency rate value. The acoustic analysis showed: 1) for the "lyrical" vibrato: according to Horii 1989, F0 and I were in-phase, with a moderate extent (on average: 1.8st (semitones) for the F0 according to Hakes et al. 1987, 4.9 dB for the I, Horii 1989; on average 5.1 modulations/s according to Dromey et al. 2003); 2) for the "Mongolian" trill: F0 and I were in opposite phase, with an important extent (3.7st for F0, 7.7 dB for I; and 6.1 modulations/s). All these values are significantly higher for the trill than the vibrato. All the trills are sung between 370Hz and 565Hz, where a vocal registers transitions phenomena can occur. Although we didn't have electroglottographic recordings to verify this, the acoustical indications of changes of laryngeal vibratory mechanisms are 1) frequency jump values situated between 2 and 7 semitones, according to Castellengo et al. 2007; 2) the time separating the two frequency jumps between 40 and 80ms; 3) according to Neumann et al. 2005, the amplitudes of H2 and H4 are smaller than those of H1 et H3 for the head register part in [a] trills; it's the opposite case for the chest register part in those ornaments. In this multiparametrical study of Mongolian Long song with previously unpublished physiological data, we defined two ornamentations used by the singer in the same melody, corresponding to different laryngeal movements and different acoustic characteristics: "lyrical" vibrato and: "Mongolian" trill where there are acoustical cues of vocal registers transitions phenomena.

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*Portuguese North Folk Singing: preliminar results from a case study – A Araújo, F Lã, J Sundberg*

Portugal's folk singing has its roots in a multipart female singing repertoire. It usually accompanied outdoor activities associated with agriculture (e.g. harvests) or religious festivities (e.g. Romarias, pilgrimages and Christmas). The female soloists of these groups, usually called cantadeiras in the north region of Portugal (i.e. Minho, between Douro and Minho rivers), are chosen according to essential hegemonic oral culture expectations of specific vocal characteristics, namely: ability to sing high pitches loudly (Muszkalska, 2000). Since the 1930's until present days, the Portuguese folk music panorama has gone through an important transformation, associated with the creation of several folk and ethnographic groups, known as Ranchos (Carvalho, 1996). However, unlike folk singing styles in other countries (Ross, 1992; Stone et al., 1999; Cleveland et al., 2001; Thalénet et