

# Returning to Musical Universals: Question of Equidistant Scale

Rytis Ambrazevičius

*Faculty of the Humanities, Kaunas University of Technologies, Lithuania*  
*Dept. of Ethnomusicology, Lithuanian Academy of Music and Theatre, Lithuania*  
rytisam@delfi.lt

## ABSTRACT

It is widely accepted that asymmetries in intervals of the musical scale (i.e., inequalities of the interval steps) serve as “orientation points so that we can know ‘where’ we are in the scale” (Krumhansl, Snyder). This feature is often treated as universal (Dowling, Harwood, Trehub, etc.). At the same time, there is evidence of equitonics (equidistant scales) in various world musics.

Examples of equitonics can be found in European folk music (Grainger, Sachs, Seivåg, etc.), as well as in “exotic” music cultures. Often such scales are anchored on a framework of a fourth or fifth (i.e. the strongest consonances) and filled in with “loosely-knit” (Grainger) intermediate tones. The result is “anhemitonic heptatonism” (Seivåg). Measurements of the musical scales in Lithuanian songs (ca 100 examples) show intermediate cases between equitonics and 12ET-diatonics, however, the principle of equitonicism predominates. Their transcribers and authors of numerous theoretical notes, however, misinterpret the scales as “Ancient Greek” and/or characteristic of “chromaticisms”.

Equitonics may be more widespread throughout the world than presumed. Often diatonic “Ancient Greek” scales and scales with chromaticisms are mere misinterpretations of “anhemitonic heptatonism”. Equitonics can be regarded as a “more ancient” universal characteristic of the early stages of musical phylogenesis (Alexeyev) and ontogenesis (Zurcher).

## I. INTRODUCTION

The first part of this paper is an analysis of musical scales in Lithuanian traditional singing. Four sample repertoires containing 96 songs in total and representing quite a wide spectrum of vocal traditions are employed. The results of the acoustical measurements and statistical generalizations show that the scales under investigation can be considered to be based on equitonic principles. Second, similar phenomena in other musics (centering on some European examples) are discussed. The discussion raises questions about the place of equitonics in the system of musical universals.

## II. ANALYSIS OF MUSICAL SCALES

The present study applies the data of acoustical measurements already described in my previous papers (Ambrazevičius, 2006 and 2008). Here I briefly repeat the information about the samples discussed and the acoustical methods applied.

### Samples

Samples of four repertoires of Lithuanian traditional singing were chosen. Three repertoires include examples of solo singing and one contains polyphonic *Sutartinės*. Two solo repertoires represent two male idiolects of *Dzūkai* (Southern Lithuania) vocal tradition. Both singers – Jonas Jakubauskas (henceforth Sample JJ) and Petras Zalanskas (henceforth Sample PZ) – were outstanding representatives of the tradition.

Most of the recordings were made in the last three decades of the 20th century. The third solo repertoire group reflects the dialect of *Suvalkiečiai* (Southwestern Lithuania; henceforth Sample S) vocal tradition. The recordings of various singers were made in the 1930s.

*Sutartinės* are Lithuanian polyphonic songs, which can be considered as a type of *Schwebungsdiaphonie* (“beat diaphony”) as the majority of the intervals formed by the voices are seconds. They formed part of *Aukštaičiai* (Northeastern Lithuania) musical heritage and have vanished (as an unbroken tradition in rural areas) in the middle of the 20th century. The recordings of several groups of singers investigated in the present study were made in the 1930s (henceforth Sample A).

The statistical samples of the four repertoires contain, correspondingly, 26, 20, 25, and 25 songs.

Since the recordings of the solo songs were relatively long (most of the songs contained from 10 to 20 melostrophes), only one (the second) melostrophe of every song was chosen for the investigation. The recordings of the *Sutartinės* were not that long, thus almost all vocal dyads were considered. An exception was made for some of the dyads of extremely poor recording quality, which did not allow accurate measurement.

### Methods

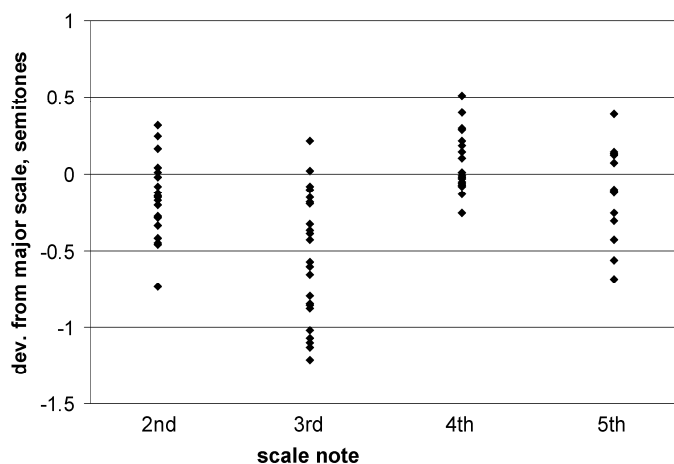
For the acoustical measurements, the software programs Speech Analyzer and, later, Praat, were applied. In the case of solo performances, perceived (integral) pitches of tones were estimated from continuous tracks of log frequency automatically transcribed by the software (refer to Ambrazevičius, 2005-2006, p. 66–67, for details).

In the case of *Sutartinės*, spectra of the vocal dyads were considered. Two outstanding partials (belonging to different voices) in the spectrum of each dyad were selected. Most frequently they were the second partials (the first overtones). Then the calculation of the fundamentals, the corresponding pitches and the intervals between the voices of the dyads was processed.

### Results

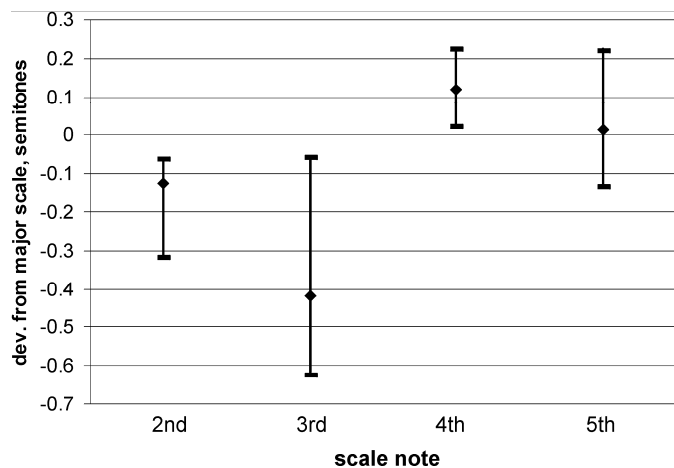
Generally, certain scale notes have more than one occurrence in a melostrophe. The pitches of these occurrences differ somewhat. For the investigation presented below, the pitches were averaged, i.e., the averaged scales were considered. Then relative scales were calculated normalized to tonics, for instance, 0 (tonic), 1.88 (the second; in 12ET<sup>1</sup> semitones), 3.43 (the third), 4.84 (the fourth), and so on (Example PZ1). Finally, the deviations from the 12ET major scale were calculated:  $1.88-2.00 = -0.12$  (the second),  $3.43-4.00 = -0.57$  (the third),  $4.84-5.00 = -0.16$  (the fourth), etc. Fig. 1 shows the results for Sample JJ. It becomes clear that the scale notes acquire quite different pitch versions. Nevertheless, there is no reason to conclude that the versions

differentiate into categories. For instance, the versions of the third cannot be treated as minor and major thirds as the range of the third is quite homogeneous, there are quite a few instances of various “neutral” thirds, and no clusters corresponding to minor (deviation  $-1$ ) and major (deviation  $0$ ) thirds are seen.



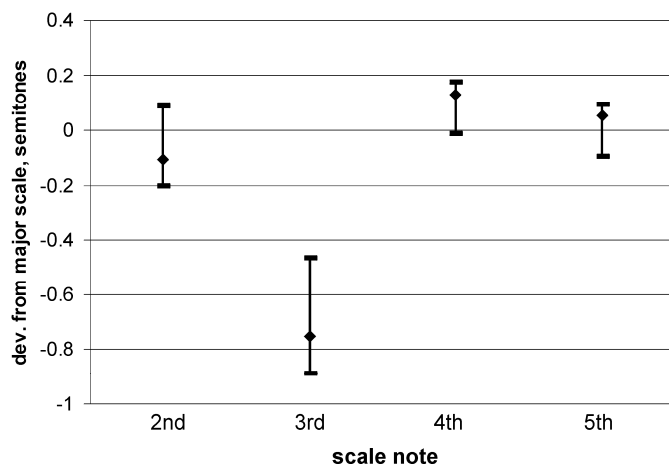
**Figure 1.** Pitches of the scale notes, in relation to the tonics and 12ET major scale. All songs from Sample JJ. The scale notes with few occurrences are omitted

The conclusion on homogeneity can be made for the remaining Samples as well. For easier comprehension and comparison of the different Samples, the results are presented in simplified form: only medians and interquartiles are shown (Figs. 2–5).

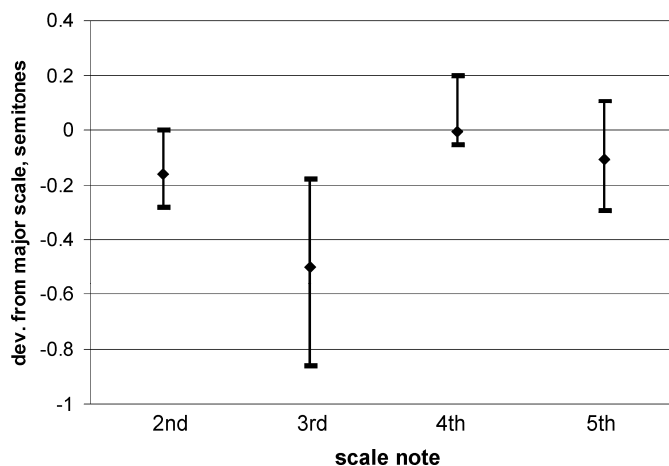


**Figure 2.** The same as in Fig. 1, only medians and interquartiles are shown

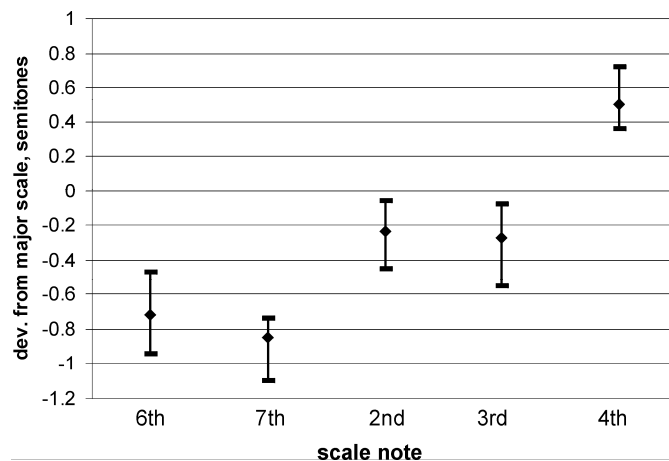
Comparison of the scales found in different samples shows more or less pronounced peculiarities of the Samples. However, some common trends can be identified. First, when considering scale notes from the second to the fifth, the same rules apply. Namely, the second is generally a bit flat in comparison with the 12ET major second, the third is very flat, the fourth is a bit sharp and the fifth is “normal” or a bit flat. Second, the third shows the largest flexibility; its versions cover a large range of pitches. Seemingly, the polyphonic singing (Sample A) stands apart from the solo samples, first of all, because of a very sharp fourth.



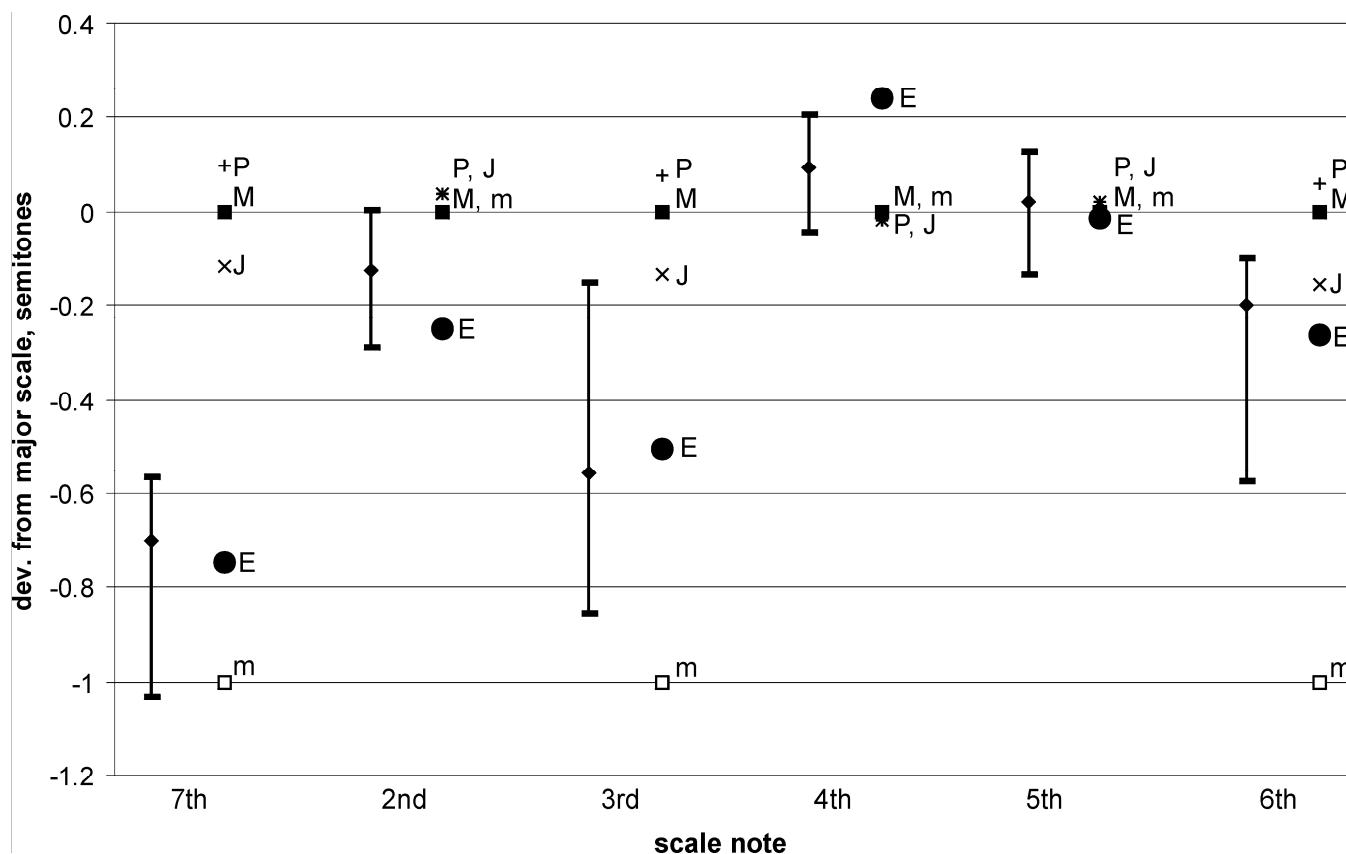
**Figure 3.** The same as in Fig. 2, for Sample PZ



**Figure 4.** The same as in Fig. 2, for Sample S



**Figure 5.** The same as in Fig. 2, for Sample A (6th and 7th scale notes below tonic)



**Figure 6.** The same as in Fig. 2, for cumulative Sample of solo performances (JJ+PZ+S). Also values for theoretical scales are shown: M – 12ET major, m – 12ET minor, P – Pythagorean (major), J – Just intonation (major), E – equitonic with the step of 175 cents (7th scale note – subsecond – below tonic)

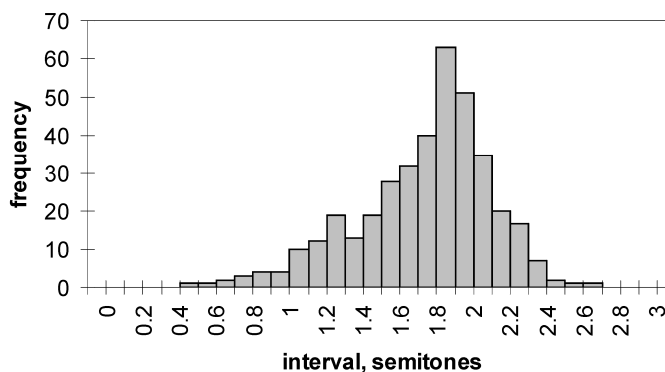
It can be safely concluded that none of the Samples resembles twelve-tone equal temperament, i.e., its diatonic subsets including the minor and major versions and other diatonic scales (e.g., so-called Ancient Greek or Gregorian modes). Possibly, the scales of some songs correspond to the abovementioned theoretical diatonic scales, i.e. they can be treated as diatonic scales with small deviations arising from the tolerable categorical zones of intonation, pitch performance rules, possible mistakes and imperfections, etc. However, the prevailing deviations are too large to be explained by such inconsistencies.

Some may speculate that not 12ET diatonics, but other theoretical diatonic scales (for instance, Pythagorean or Just intonation) are at work. To examine this possibility Figure 6 includes additional marks showing deviations of Pythagorean tuning and Just intonation from the 12ET major scale.

From Fig. 6 it is clear that Pythagorean tuning and Just intonation do not provide a viable explanation. The discrepancies between these scales and the actual scales in the performances under investigation are still very large.

However, deeper examination reveals that the scales in the traditional singing discussed correspond roughly to the theoretical non-diatonic equidistant scales (equitonic). The thick dots in Fig. 6 show the equitonic with the step (the constructive interval between two neighboring scale notes) of 175 cents. The correspondence between this scale and the actual scales seems to be quite reasonable.

The hypothesis regarding the equitonal nature of the scales discussed can be verified by the histogram of distribution of all scale steps found in all Samples under investigation (Fig. 7).



**Figure 7.** Distribution of scale steps (the intervals between the neighboring scale notes) in the cumulative Sample JJ+PZ+S+A

The distribution mean is at 174 cents (median equals 181 cents) and is skewed to the left. Most importantly, the distribution is quite homogeneous. It means that the building intervals of the scales can be regarded as versions (though quite different) of one interval. More precisely, possibly some songs in the Samples have structures close to theoretical diatonics, but cases with equitonic predominate. The small peak at 120–130 cents might result from partial diatonization. Even so, there is no reason to believe that the distribution clusters into two classes of intervals (semitones and whole tones) would mean the prevailing of diatonics.

Of course, it would be naïve to expect the scales discussed to follow an exact scheme of equidistant notes. First, equitonic in practice does not mean an ideally equidistant scale; the deviations from the latter theoretical (mathematical) structure

can be quite significant (see below Alexeyev's  $\gamma$ -intonation). Second, there can be influences of the modified (rationalized) version of equitonicity, i.e. a structure based on the anchored framework of consonant notes (predominantly separated by the pure fourth or fifth) filled in with more flexibly intoned intermediate notes (also see more in the next chapter). From the ethnomusicological perspective, it can be concluded that the Samples discussed contain mostly "quarttonic" and "quinttonic" tonal structures (i.e., based on tonal anchors separated by the fourth or fifth), in various proportions. Thus, the summarized graphs in Figs. 2–6 reflect types of "effective" scales that are intermediate between the 4th- and 5th-based scales. The steps in the two ideal tonal structures equal 166 cents (498/3; 4th-based structure) and 176 cents (702/4; 5th-based structure). In reference to those values, after the calculations of the corresponding values for certain scale notes, the tendencies of "sharpening" and "flattening" in Figs. 2–6 can be explained.

Possibly, the widest range of versions of the third results from the fact that on average the third is the most distant note from the tonal anchors, although in the 4th-based structure, it neighbours with the anchored fourth, but in the 5th-based structure, it is separated from both anchors by additional notes. Due to the significant impact of linear (horizontal) thinking, the additive strategy of the scale design is most probably quite important (as opposed to the divisive strategy in vertical thinking). In summary, the more the intermediate note is distant from the tonal anchors, the more flexible its intonation, since, in a sense, the "flexibilities" are summarized when receding from the tonal anchor.

More details describing the regularities in the scales could be described. However, the most important issue has been discussed: scales found in various examples of Lithuanian traditional vocal music are predominantly of equitonic-type and in most of cases they cannot be treated as diatonic.<sup>2</sup>

### III. DISCUSSION

The starting point of the discussion rests on the contradiction between the origin of musical scales and their ethnomusicological interpretations. In Lithuanian ethnomusicological studies, the scales discussed in the previous chapter are never referred to as equidistant, and always are treated as examples of diatonics. This is because of our 12ET-biased perception: perceptually we successfully force the musical material we hear into the 12ET-frame. From my personal experience with students, even artificially synthesized exactly equidistant pentatonics (i.e., with 240 cents in between the scale notes) tends to be perceived as "normal" pentatonics consisting of major seconds and minor thirds, though accompanied by remarks about some "mistuning".

It is even easier with scales such as the ones analyzed in this paper. It was demonstrated that these scales are (mis)perceived as so-called Ancient Greek or Gregorian scales (Ambrazevičius, 2006) and how fictitious "chromatic changes" appear as the result of slight deviations caused by pitch performance rules (Ambrazevičius & Wiśniewska, 2008). Of course, the problem is closely connected with the transcriptional means provided by the standard Western five-lined staff, which reflects and presupposes diatonical thinking unless special modifications of the orthography are used.

The abovementioned studies dealt with Lithuanian traditional music, but what about other European musical traditions? Contrary to the Lithuanian convention, the phenomenon of equidistant scales was noted, though not often. For instance, Reidar Sevåg found "anahemitonic heptatonics" in the scales of Norwegian *langeleik* (1974)<sup>3</sup> and Percy Grainger has reported "one single loosely-knit modal folksong scale" in Lincolnshire (as cited in Powers & Cowdery, 2001, p. 824).

Russian ethnomusicologist Eduard Alexeyev argues that "tonal subordination" ("t-intonation") corresponding to the modern perception of mode was preceded by "tonal coordination" (" $\gamma$ -intonation") characteristic of roughly proportional steps between "wandering tones" (Alexeyev, 1976, 1986). He found the relics of " $\gamma$ -intonation" in Yakut vocal tradition as well as in various Eastern European traditions. If we apply Haeckel's "biogenetical law", Alexeyev's and similar conceptions on phylogenesis of musical scales are in fair agreement with the observations on ontogenesis of the scales: at a certain stage of development, young children sing "roughly equidistant" scales, i.e., they do not differentiate between the semitone and whole tone, and the tones are "wandering", i.e., the intonation is not fixed. Only later does the intonation stabilize and the contrast of semitone and whole tone appears (Zurcher, 1994, etc.).<sup>4</sup>

Sometimes indirect notes tell us about the probable manifestations of equitonicity. For instance, Nettl wrote, "One interval widely used in primitive music but foreign to Western is the so-called neutral third, which is roughly between the tempered major and minor thirds" (1972, p. 47). If we relate this statement with the results in the previous chapter, it becomes clear that most probably we are dealing with equidistant scales: the third is noticed specifically because of its largest deviation from 12ET while the other intervals deviate less and thus remain acceptable as "normal" (for that point see also Ambrazevičius, 2006).

To summarize, it seems that equidistant scales are found nowadays (or in the not too distant past) not only in exotic musical cultures (Thai music, Indonesian gamelan, African xylophones, etc.), but also in European musical traditions. However, because of the 12ET-biased perception, the latter cases tend to be considered as a manifestation of diatonics. Even the idea that a certain musical scale can be other than diatonic is rarely considered.

It is widely accepted that asymmetries in the intervals of the musical scale (i.e., inequalities of the interval steps) serve as "orientation points so that we can know 'where' we are in the scale" (Rosch, 1975, Krumhansl, 1979, Sloboda, 1989, etc.). This feature is often treated as universal (for instance, Dowling & Harwood, p. 101).

We must consider whether statements regarding the universality of asymmetry are based on a vast array of seemingly diatonic examples that are actually not diatonic at all. It is true that the asymmetries work as reference or orientation points, but maybe they are not that necessary for the perception characteristics of earlier stages of mode development. There may be other means for "finding where we are in the scale" (such as melodic and metrorhythmic markers or pitch performance rules, etc.)? Anyway, it seems that the universal of scale asymmetry works, primarily in contemporary musical thinking, but then it is not clear whether it can be treated as a true universal. Equitonicity can probably be regarded as a "more

ancient” universal characteristic of the early stages of musical phylogenesis and ontogenesis. Thus we can probably think about types of quasiuniversals that sometimes work in different domains, and sometimes overlap.

## REFERENCES

- Alexeyev, E. (1976). *Problemy formirovaniya lada*. Moscow: Muzyka.
- Alexeyev, E. (1986). *Rannefol'klornoe intonirovanie. Zvukovysotnyj aspekt*. Moscow: Sovetskij kompozitor.
- Ambrazevičius, R. (2005-2006). Modeling of scales in traditional solo singing. *Musicae Scientiae, Special Issue "Interdisciplinary Musicology"*, 65–87.
- Ambrazevičius, R. (2006). Pseudo-Greek modes in traditional music as result of misperception. In M. Baroni, A. R. Addessi, R. Caterina, & M. Costa (Eds.), *ICMPC9. Proceedings of the 9th International Conference on Music Perception and Cognition. 6th Triennial Conference of the European Society for the Cognitive Sciences of Music. Alma Mater Studiorum University of Bologna, Italy, August 22–26, 2006* (pp. 1817–1822) [CD]. Bologna: Bononia University Press.
- Ambrazevičius, R. (2008). Psychoacoustical and cognitive basis of Sutartinės. In K. Miyazaki, Y. Hiraga, M. Adachi, Y. Nakajima, & M. Tsuzaki (Eds.), *ICMPC10. Proceedings of the 10th International Conference on Music Perception and Cognition. 25-29 August 2008. Sapporo, Japan* (pp. 700–704) [CD]. Adelaide: Causal Productions.
- Ambrazevičius, R., & Wiśniewska, I. (2008). Chromaticisms or performance rules? Evidence from traditional singing. *Journal of Interdisciplinary Music Studies*, 2 (1&2), 19–31.
- Dowling, J., & Harwood, D. (1986). *Music cognition*. Orlando: Academic Press.
- Krumhansl, C. (1979). The psychological representation of musical pitch in a tonal context. *Cognitive Psychology*, 11, 346–374.
- Nettl, B. (1972). *Music in primitive culture*. Cambridge: Harvard University Press.
- Powers, H. S., & Cowdery, J. (2001). Mode, §IV, 2. Modal scales and melody types in Anglo-American folksong. In S. Sadie (Ed.), *The New Grove dictionary of music and musicians* (pp. 823-829). London: Macmillan Publishers Limited.
- Rosch, E. (1975). Cognitive reference points. *Cognitive Psychology*, 7, 532–547.
- Sloboda, J. A. (1989). *The musical mind. The cognitive psychology of music* (reprint from 1985). Oxford: Clarendon Press.
- Sevåg, R. (1974). Neutral tones and the problem of mode in Norwegian folk music. In G. Hilleström (Ed.), *Studia Instrumentorum Musicae Popularis III* (pp. 207-213). Stockholm: Musikhistoriska Museet.
- Zurcher, P. (1994). *The path of the ant*. Retrieved April 28, 2009, from <http://musicweb.hmt-hannover.de/escom/english/Newsletter/NL9e/ZurcherE.html>

---

<sup>4</sup> I shorten the comprehensive description of the phylogenetical and ontogenetical parallels. It should be stressed that there is fair agreement between not mentioned elements of both geneses as well. Also, see the explanation of the methodological discrepancies in the studies of production and perception (e.g., the studies by Trehub and colleagues) of musical scales by little children (Zurcher, 1994).

---

<sup>1</sup> twelve-tone equal temperament

<sup>2</sup> The closeness of the certain musical scale to diatonics or equitonics can also be quantitatively evaluated with the help of the “coefficient of diatonic contrast”, see Ambrazevičius, 2006.

<sup>3</sup> I would like to quote him again: “...out of the great amount of *langeleik* scales can be abstracted a superimposed scale structure which is heptatonic and has a fixed framework of fundamental, fifth and octave. The other intervals are variable over a spectrum of a little more than a quarter tone... (Sevåg, 1974, p. 210).