Perceiving Tonality in South Indian Classical Melodies by Indian and Western Musicians and Nonmusicians

Rachna Raman, Ph.D.   W. Jay Dowling, Ph.D.

Contact: rachna.raman@utdallas.edu

UT DALLAS — School of Behavioral and Brain Sciences

UTD

ABSTRACT

This study examined the differences between musicians' and nonmusicians' perception of tonality in familiar and unfamiliar melodies. Indian and western musicians and nonmusicians rated brief South Indian classical excerpts in four modes (rāgams) using Toiviainen and Krumhansl's (2003)[1] concurrent probe-tone technique. Results indicated that nonmusicians' responses differed from the musicians'.

BACKGROUND

Previous investigations show that:

(a) people form mental representations of tonal hierarchies of a musical scale at a very young age.[2]

(b) age and musical experience did not affect the formation of mental representations of tonal hierarchies; mere exposure to an individual's culture determines the strength of such representations, whereas training enhances it.[3]

(c) even nonmusicians have a sophisticated implicit understanding of tonal hierarchy and expectancies in music.[4]

(d) these mental representations have a neural basis in the prefrontal cortex, which keeps track of tonalities.[5]

(e) listeners access their mental representations of the hierarchy of notes in musical scales of their own culture when listening to familiar and unfamiliar melodies.[6]

(f) with familiar music, listeners use culture-specific and psychophysical cues, whereas with unfamiliar music they use psychophysical cues[7] and schematic knowledge imported from their own culture.[6]

PARTICIPANTS

Music Teachers
- 10 Indian (I) and 10 western (W)
- age range = 59 to 78 years (I: 71.5 years, W: 69.6 years)
- musical training, I: 27.4 years, W: 27.7 years
- music teaching, I: 24.3 years, W: 25.1 years
- performance, I: 29.3 years, W: 35.8 years

Nonmusicians
- 10 Indian and 10 western
- age range = 56 to 88 years (I: 69.5 years, W: 69.3 years)
- musical training, I: 1.5 years, W: 1.2 years

STIMULI

- Four excerpts each in a different rāgam (mode).
- Excerpts were clippings of 15 to 17 s taken from CD recordings.
- Excerpts have a strong single tonal framework; did not modulate to another key.
- Each excerpt was presented 13 times forming a block.
- Trial 1: practice trial; participants heard the excerpt in both ears without the probe tone.
- Trials 2 to 13: participants heard the excerpt in one ear only; in the other ear, they heard a constant drone (i.e., probe tone) corresponding to one of the 12 pitches in the octave (i.e., C, C#, D, D#, etc.)
- Each probe tone consisted of sine waves sounded in 3 octaves (in the range of A3 to D7) spanning the range of the melodies.

RESULTS – INDIAN AND WESTERN MUSICIAN AND NONMUSICIAN PROFILES

Figure 1. Top panel (a to d)—Profiles of Indian musicians and nonmusicians. Middle panel (e to h)—Profiles of Western musicians and nonmusicians. Profiles of Indian musicians (blue line) are superimposed for comparison. Bottom panel (i to l)—Notes of each rāgam depicted on a piano keyboard with C as tonic.
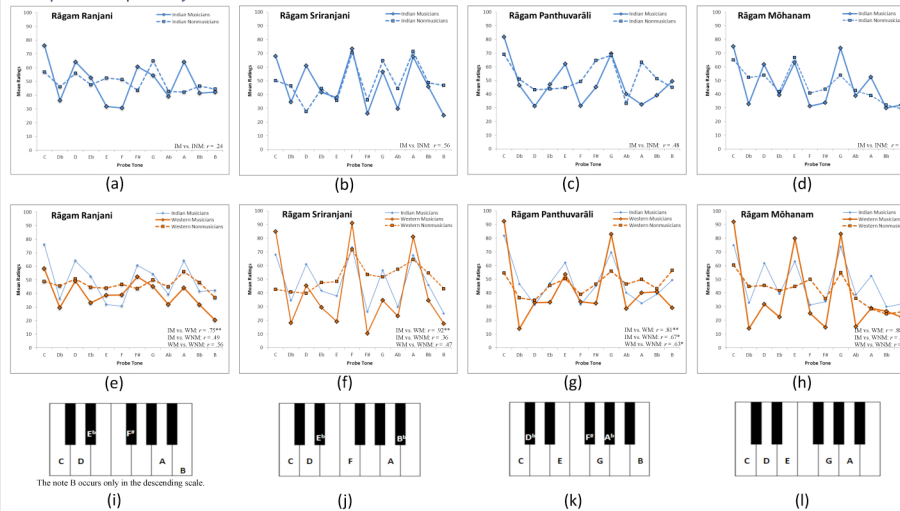
RESULTS – PSYCHOPHYSICAL AND WESTERN SCHEMATIC CUES

Table 1. Correlations between Indian and Western Profiles and Percentage Values of Frequency of Note Occurrence.

Rāgam	Indian		Western	
	Musicians	Nonmusicians	Musicians	Nonmusicians
Ranjani	0.87**	0.01	0.67*	0.34
Sriranjani	0.82**	0.56	0.81**	0.54
Panthuvarāli	0.76**	0.30	0.44	0.53
Mōhanam	0.86**	0.68*	0.73**	0.40

* p<.05. ** p<.01.

Table 2. Correlations between Indian and Western Profiles and Percentage Values of Note Duration.

Rāgam	Indian		Western	
	Musicians	Nonmusicians	Musicians	Nonmusicians
Ranjani	0.85**	0.14	0.73**	0.32
Sriranjani	0.85**	0.71**	0.90**	0.69*
Panthuvarāli	0.85**	0.43	0.65*	0.64*
Mōhanam	0.91**	0.77**	0.89**	0.49

* p<.05. ** p<.01.

Table 3. Correlations between Western Musicians' and Nonmusicians' Profiles and Krumhansl and Kessler's (1982) Western Major and Vuvan et al.'s (2011) Three Minor Profiles.

Rāgam	Major		Natural Minor		Harmonic Minor		Melodic Minor	
	M	NM	M	NM	M	NM	M	NM
Ranjani	0.64*	0.35	0.10	0.27	0.02	-0.23	-0.02	0.08
Sriranjani	0.59*	-0.02	0.28	0.07	-0.01	0.02	0.29	0.10
Panthuvarāli	0.89**	0.48	0.69**	0.47	0.46	0.77**	0.55	0.69**
Mōhanam	0.90**	0.73**	0.50	0.15	0.28	0.00	0.32	-0.02

Note. M = musicians; NM = nonmusicians.
* p<.05. ** p<.01.

Table 4. Correlations between Indian Musicians' and Nonmusicians' Profiles and Krumhansl and Kessler's (1982) Western Major and Vuvan et al.'s (2011) Three Minor Profiles.

Rāgam	Major		Natural Minor		Harmonic Minor		Melodic Minor	
	M	NM	M	NM	M	NM	M	NM
Ranjani	0.41	0.76**	0.24	0.46	0.27	0.22	0.33	0.28
Sriranjani	0.65*	0.32	0.34	0.33	-0.08	0.17	0.26	0.49
Panthuvarāli	0.69*	0.57*	0.43	0.24	0.38	0.14	0.34	0.33
Mōhanam	0.84**	0.65*	0.39	-0.03	0.26	-0.20	0.25	-0.31

Note. M = musicians; NM = nonmusicians.
* p<.05. ** p<.01.

TASK

Rate how well each tone fits the melody on a 0 to 100 scale.

DISCUSSION AND SUMMARY

Musicians
- Indian and western musicians' responses were similar on rāgams resembling western modes (see Figure 1f & h) but differed with rāgams unfamiliar to westerners (see Figure 1e & g).
- Our findings supported previous research and identified three types of cues that musicians used:
1) culture-specific cues—theoretical knowledge of the rāgams and familiarity with the excerpts in the study—employed by Indian musicians (compare Figure 1a to d with i to l),
2) psychophysical cues—frequency of note occurrence (see Table 1) and note duration (see Table 2)—employed by Indian and western musicians, and
3) transference of western schematic knowledge by western musicians (compare Tables 3 & 4).

Nonmusicians
- Nonmusicians' responses differed from the musicians', particularly in less differentiation of scale steps vs. non-scale pitches.
- Their partial use of culture-specific, psychophysical, and western schematic cues suggests that musical training facilitated performance on the binaural probe-tone task and in applying these cues.

REFERENCES

[1]Toiviainen, P., & Krumhansl, C. L. (2003). Measuring and modeling real-time responses to music: The dynamics of tonality induction. Perception, 32(6), 741-766.

[2]Dowling, W. J. (2002). The development of music perception and cognition. In D. J. Levitin (Ed.), Foundations of cognitive psychology: Core readings (pp. 481-502).

[3]Halpern, A. R., Kwak, S., Bartlett, J. C., & Dowling, W. J. (1996). Effects of aging and musical experience on the representation of tonal hierarchies. Psychology and Aging, 11(2), 235-246.

[4]Bigand, E., & Poulin-Charronnat, B. (2006). Are we "experienced listeners"? A review of the musical capacities that do not depend on formal musical training. Cognition, 100(1), 100-130.

[5]Janata, P., Birk, J. L., Van Horn, J. D., Léman, M., Tillmann, B., & Bharucha, J. J. (2002). The cortical topography of tonal structures underlying western music. Science, 298(5601), 2167-2170.

[6]Curtis, M. E., & Bharucha, J. J. (2009). Memory and musical expectation for tones in cultural context. Music Perception, 26(4), 365-375.

[7]Balkwill, L.-L., & Thompson, W. F. (1999). A cross-cultural investigation of the perception of emotion in music: Psychophysical and cultural cues. Music Perception, 17(1), 43-64.

ACKNOWLEDGEMENTS