

Analyzing Modulation in Scales (Rāgams) in South Indian Classical (Carnātic) Music: A Behavioral Study

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ABSTRACT

Background

Individuals around the world appreciate music but they differ radically from each other in how they process the various features of music. Systematic studies have included various aspects of music perception, such as harmony, rhythm and melody. These studies usually involve stimuli from western music that have been constructed specifically for the study.

One particular area of interest in music perception is how and when the brain processes shifts in tonality. Modulations in music are shifts of key (of tonal scale) that are primarily done to change the mood of the song (e.g., from happy and bright to serious and dark, depending on what the composer desires to convey). Modulations are not unique to Western music. Indian music also employs modulations, and great composers have exploited this for centuries. Modulations introduce chords and tones in a new key that are unexpected in the original key. Previous investigations with event-related potentials (ERPs) and modulation in western music have shown that unexpected chords or tones are recognized by the brain within 200 ms of its onset. Behavioral responses, on the other hand, though measured for accuracy, have rarely been measured for response time. The present study investigates the behavioral processing of tonal modulations in South Indian Classical (Carnātic) music measured in terms of accuracy and latency.

Like keys and scales in western music, Carnātic music has rāgams. A rāgam is an abstract melodic entity with internal embellishments and ornamentation. A salient feature of Carnātic music is modulation. There are two types of modulation – grahabēdham and rāgamālikā. Grahabēdham is similar to modulation in western classical music. The tonal center of the scale (the “tonic”) is shifted in the middle of the song to a “new tonic”. Now the musician is playing/singing a new rāgam based on the new tonal center. This shift occurs while the “sruthi” (drone) box continues to emit the tonic-dominant-octave notes of the original tonal center. When the tonal center is shifted, the pattern of whole and half step intervals relative to that new tonal center is different. A western analogy, though not equivalent, would be a shift from a major scale to its relative minor (e.g., C major to A natural minor). No accidental notes (temporary alterations of scale notes by one semitone) are introduced to signal a modulation. In fact, in Carnātic music, the concept of accidental notes does not exist. Also, no additional notes are included in the new scale (as for example in western music a melodic or harmonic minor scale that includes sharps that were not present in its relative major scale). After a brief foray into the new key and new rāgam (about a minute), the performer must return to the original scale. Only a very few eminent musicians perform grahabēdham, as it

requires tremendous training and implicit knowledge of the rāgams. It is very easy to get sidetracked into the new rāgam, which creates difficulties in getting back into the original rāgam. Grahabēdham is very controversial. Not many schools of music believe in this technique. Many people are cynical about it because to a layperson grahabēdham sounds as though the performer is going off-key. So musicians tend to perform grahabēdham very briefly (mostly for a minute to a minute and a half) and then they come back to the original scale. There are rules as to where it must be performed (usually in the ālāpanai at the beginning, or in the kalpanā swaram towards the end).

Rāgamālikās are more popular. Here the tonal center remains unchanged while the rāgam changes. An analogous shift in western music would be a modal shift from the major scale to the minor scale with the same tonal center (e.g., C major to C minor). The rāgams in a rāgamālikā can have any number of note combinations in their scales. They are chosen by composers in such a way that each rāgam is very different in character from the one preceding or succeeding it.

Cognitively, modulations such as grahabēdham or rāgamālikā can be detected by becoming aware of certain changed notes in the modulated segment of the song and by the way the original emphasis on certain notes changes to other notes. This requires a mental representation of the notes in the original rāgam. In addition, grahabēdhams can be detected by the dissonance created by the shift of tonic with the constant drone emitted throughout the concert.

Aims

The current research was a cross-cultural behavioral study that addressed the following questions:

- Are listeners able to recognize modulations in familiar and unfamiliar music?
- If so, what cues do they use to discern such modulations?
- Do listeners' age and musical experience influence perception of modulation?

The purpose of the study was to extend the previous findings in the literature by using a cross-cultural approach with a higher ecological validity. Previous research involving short constructions of western chords or melodies has generally been exploratory in nature. In the current study, we used natural music (i.e., recorded from live performances) from a non-western culture (i.e., South India) that had some similar concepts as western music to ascertain if certain universal principles, such as, tonal hierarchy and melodic expectancies, are in fact universal.

Method

The study investigated whether sensitivity to shifts of tonality in Carnātic music varied with nationality and type of modulation. Stimuli consisted of the two types of modulations in Carnātic music - rāgamālikā and grahabēdham. Indian and western participants indicated while listening the point at

which modulations occurred, and their responses were measured in terms of accuracy and latency. All the stimuli also had superficial modulations (not actual modulations but shifts of emphasis that sounded close to changing rāgam or the tonal center). The listener was thus confronted with the problem of discriminating actual modulation from the similar sounding passages.

Results

Age did not have a significant effect on the results. Therefore, the discussion below only includes musical experience, type of modulation, and nationality. Results indicated that with hits, there were significant main effects of type of modulation, $F(1,133) = 5.46$, $R^2 = .02$, $p = .02$, and nationality, $F(1,133) = 52.53$, $R^2 = .21$, $p < .001$, and a significant interaction of type of modulation and nationality, $F(1,133) = 55.3$, $R^2 = .22$, $p < .001$. Overall participants were more accurate with grahabēdhams ($M = 34.12$) than with rāgamālikās ($M = 31.6$). Indian participants ($M = 36.77$) were more accurate than western participants ($M = 28.95$). Cross-culturally, Indian participants ($M = 39.52$) performed better than western participants ($M = 23.68$) with rāgamālikās, but both groups performed similarly on grahabēdhams ($M = 34.02$ vs. $M = 34.23$). The significant interaction indicated that Indian participants performed better on rāgamālikās ($M = 39.52$) than on grahabēdhams ($M = 34.02$). On the other hand, western participants performed better on grahabēdhams ($M = 34.23$) than on rāgamālikās ($M = 23.68$).

With false alarms, there were significant main effects of musical experience, $F(1,133) = 6.08$, $R^2 = .02$, $p = .015$, type of modulation, $F(1,133) = 5.31$, $R^2 = .02$, $p = .02$, and nationality, $F(1,133) = 107.39$, $R^2 = .42$, $p < .001$. Experience influenced false-alarm rate for both Indian and western participants. Teachers ($M = 20.88$) made fewer errors than students ($M = 28.48$). Also, participants made fewer errors with rāgamālikās ($M = 21.12$) than with grahabēdhams ($M = 28.23$). Finally, Indian participants ($M = 8.69$) made fewer errors overall than western participants ($M = 40.66$).

With response time, there was a significant effect of type of modulation, $F(1,133) = 72.57$, $R^2 = .14$, $p < .001$, and a significant interaction of type of modulation and nationality, $F(1,133) = 290.24$, $R^2 = .57$, $p < .001$. Overall, participants responded faster to shifts in rāgamālikās ($M = 4.36$ s) than to shifts in grahabēdhams ($M = 6.2$ s). Indian participants were faster at identifying rāgam changes in rāgamālikās ($M = 2.66$ s) than in grahabēdhams ($M = 8.19$ s). On the other hand, western participants were faster at identifying rāgam changes in grahabēdhams ($M = 4.21$ s) than in rāgamālikās ($M = 6.06$ s). Western participants, while slower than Indian participants on rāgamālikās ($M = 6.06$ s vs. $M = 2.66$ s), were in fact nearly twice as fast as their Indian cohorts on grahabēdhams ($M = 4.21$ s vs. $M = 8.19$ s).

Conclusions

Results confirmed that listeners were able to recognize modulations in familiar and unfamiliar music. Qualitative responses obtained at the end of the study gave an insight into what cues participants used to discern such modulations. While listeners' age had no effects cross-culturally, musical experience influenced perception of modulation. Teachers were more accurate and faster than students which could be

attributed to an enhanced representation for systems of pitches and modalities as a result of training.

Though the study indicated that participants with familiar and unfamiliar music were able to discern modulations, we were unable to ascertain the specific cues that they used. Participants' responses to the question "What specific technique did you use to discern the shifts?" provided some insight. Indian participants said that they were familiar with most of the rāgamālikās used in the study. Sometimes they anticipated the change and were able to respond quickly. They were unfamiliar with most of the grahabēdham stimuli used in the study. They waited for the new rāgam to be elaborated upon before responding. Many Indian participants reported discomfort in responding to grahabēdham shifts because of unfamiliarity.

Western participants, on the other hand, did not understand the shifts in rāgamālikās. As soon as they heard a note being held for a long duration, they responded to it, that is, they responded to the psychophysical cues. They were mostly unsure of whether they had identified the shift correctly. With grahabēdhams, they heard a distinct clash between the original drone from the sruti (drone) box and the new tonic held for a long duration, which gave them the cue to respond. All western participants reported that identifying shifts in grahabēdhams was easier than in rāgamālikās. The results also indicated that western participants could apply their skills cross-culturally to discern modulations that they are more familiar with (i.e., grahabēdhams).

Keywords

cross-cultural, modulation, musical cues, musical training, tonality shifts