Effects of Music Training and Familiarity on the Time Course of Responses to Modulations in Classical Music

Rachna Raman, Zachary Wallmark, & W. Jay Dowling

Contact: rachna.raman@utdallas.edu

UT DALLAS
School of Behavioral and Brain Sciences

SMU

BACKGROUND

Previous investigations show that:

(a) People form mental representations of tonal hierarchies of a musical scale at a very young age[3].

(b) Age and musical experience have little effect on the formation of mental representations of tonal hierarchies; mere exposure to an individual's culture leads to the formation of such representations, whereas training enhances it[4].

(c) Nonmusicians have a relatively sophisticated implicit understanding of tonal hierarchy and expectancies in music[5].

(d) Listeners access their mental representations of the hierarchy of notes in musical scales of their own culture when listening to culturally familiar and unfamiliar melodies[6,7].

(e) Musicians can track modulations successfully, whether with schematic chord sequences[2], continuously modulating melodies[8], or excerpts of real music[1,7].

PARTICIPANTS

UTD Orchestra Members
• N = 12; age = 18 to 27 years; musical training = 6.5 to 18 years

Undergraduate Music Majors
• N = 12; age = 18 to 24 years; musical training = 5 to 16 years

Musicians (Non-Orchestra/Non-Music Majors)
• N = 12; age = 16 to 34 years; musical training = 6 to 20 years

Moderate Musicians
• N = 12; age = 18 to 30 years; musical training = 1 to 5 years

Nonmusicians
• N = 12; age = 17 to 34 years; musical training = less than 1 year

STIMULI

• Dvořák's "American" String Quartet, Op. 96, Finale (first 2 min)
    Keys: F-major, a-minor, C-major, A♭-major

• Excerpt was taken from CD recording by the Juilliard String Quartet.

• Excerpt was presented 12 times, each time with a different probe.

• Participants heard the excerpt in one ear; in the other ear, they heard a constant drone (probe tone) corresponding to one of the 12 pitch classes in the octave (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 middle range of the quartets.

TASK

• Listeners used the mouse to rate continuously how well each probe tone fit the melody at every moment, on a 0 to 100 scale.

• The melody was rated 12 times, once for each probe providing tonal hierarchy profiles for approximately 5-s periods aligned with modulations throughout the excerpt. We correlated these profiles with the standard profiles of the keys involved. We manipulated familiarity strongly for orchestra members, who rated the piece before encountering it, again in the middle of rehearsals, and after performing the piece 3 months later. The other groups followed the same schedule but without studying the piece.

• We ran a 3 Sessions x 4 Keys x 10 Periods ANOVA for each of the 5 groups.

• The dependent variable was the set of correlation coefficients for each listener between standard key tonal-hierarchy profiles and profiles of ratings in the 10 periods. The periods were often separated by points of modulation (vertical lines in the figures).

## CORRELATIONS OF PROFILES OF ORCHESTRA MEMBERS

Figure 1. Top panel (a, b)—Orchestra Members. Middle panel (c, d, e, f)—Music Majors and (Non-Orchestra/Non-Major) Musicians. Bottom panel (g, h, i, j)—Moderate Musicians and Nonmusicians. Vertical lines indicate points of modulation. Responses were averaged and smoothed across a jumping window of time. Finally each profile generated was correlated with profiles of the corresponding major and minor keys[2].

(a) (b)
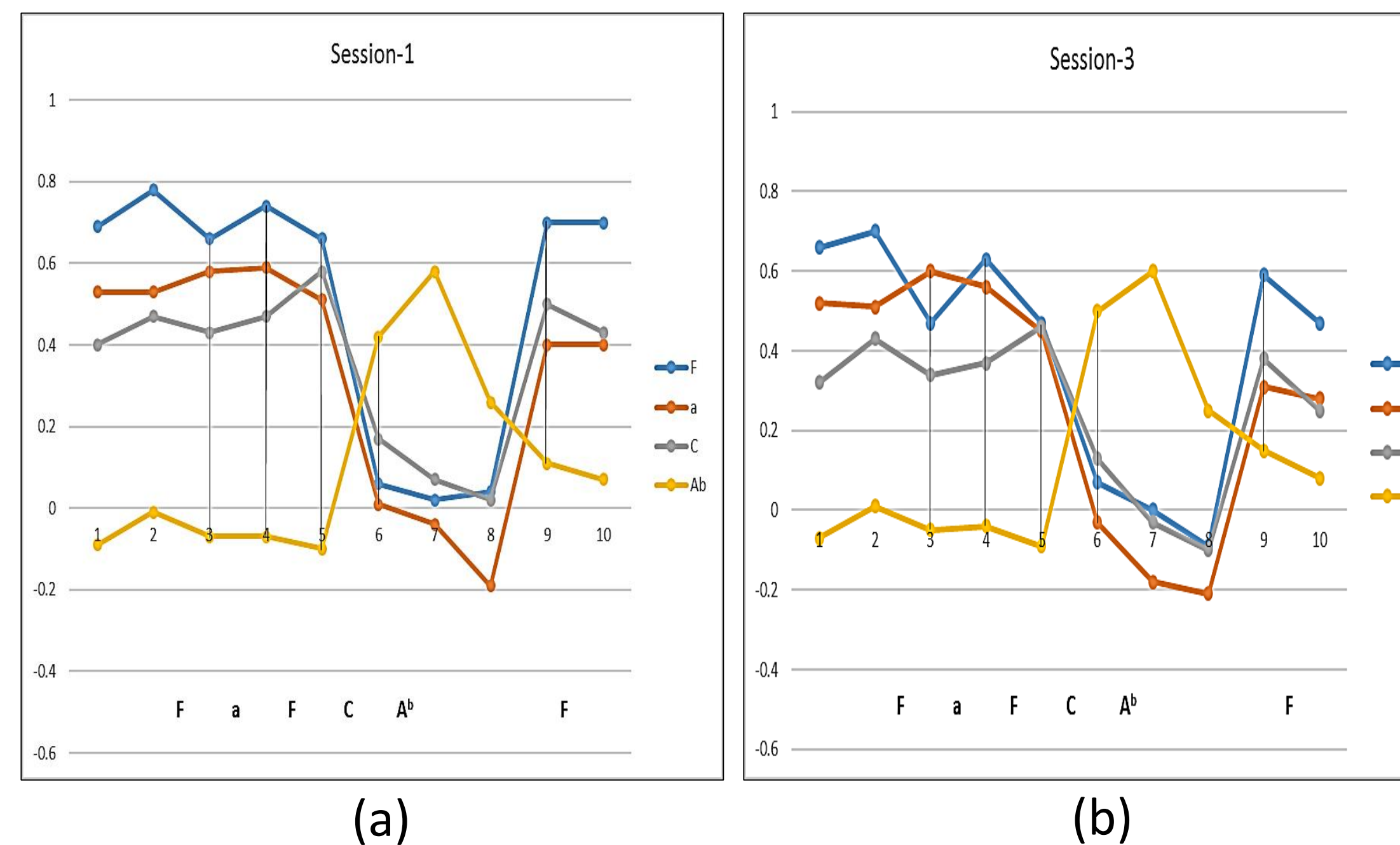
CORRELATIONS OF PROFILES OF MUSIC MAJORS AND MUSICIANS

(c) (d) (e) (f)
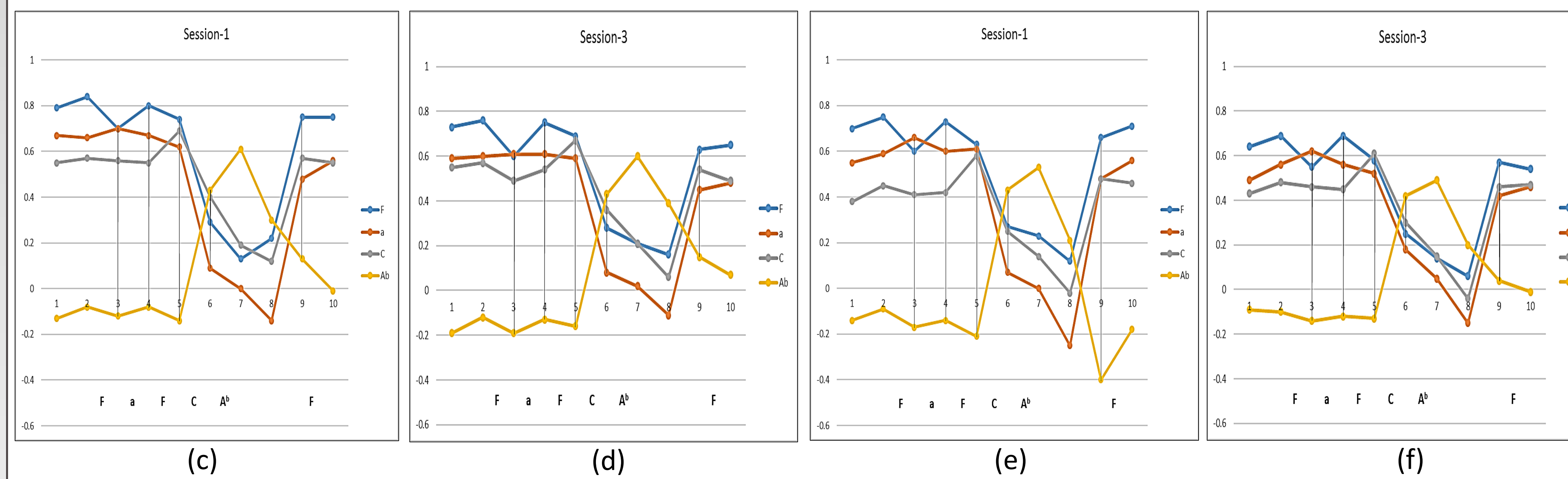
CORRELATIONS OF PROFILES OF MODERATE MUSICIANS AND NONMUSICIANS

(g) (h) (i) (j)
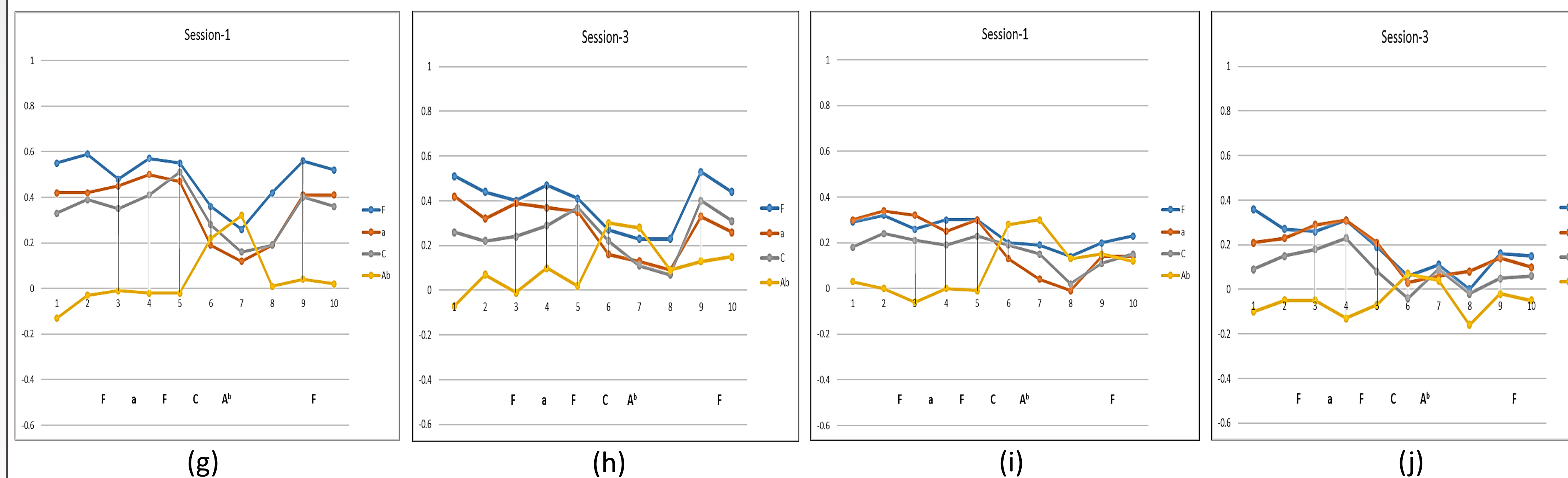
DISCUSSION AND SUMMARY

• All the groups appear to have established their overall degree of differentiation of the various keys in the piece during Session 1, and maintained that performance in Sessions 2 & 3. That is, the patterns established in Session 1 did not change sufficiently across sessions to register a significant interaction of session with period and key.

• The 5 groups showed different levels of differentiation of keys across the periods as indexed by total η[2] (see Table 1). Differentiation clearly decreased across the decreasing levels of involvement with the music and training.

• It is noteworthy that the least experienced listeners were nevertheless consistent in their treatment of the different period-key combinations, as indicated by their significant Period x Key interaction. That interaction, however, accounted for only a small part of the variability of their scores (see Table 1).

TABLE

Table 1. Effect size (total η^2) for statistically significant results in the ANOVAs of the 5 groups. (Values within parentheses indicate tendencies that only approach significance; $p < .20$.)

EFFECT	SESSION	PERIOD	KEY	SESSION x KEY	PERIOD x KEY	SESSION x PERIOD x KEY
ORCHESTRA	(.01)	.15	.11	(.01)	.35	
MUSIC MAJOR		.10	.24		.35	
MUSICIAN		.10	.22		.21	(.005)
MODERATE MUSICIAN		.03	.18		.08	
NONMUSICIAN		.03	.06		.06	

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] Krumhansl, C. L., & Kessler, E. J. (1982). Tracing the dynamic changes in perceived tonal organization in a spatial representation of musical keys. *Psychological Review, 89*(4), 334-368.

[3] Dowling, W. J. (1999). The development of music perception and cognition. In D. Deutsch (Ed.), *The perception of music* (2nd ed., pp. 603-625). Orlando, FL: Academic Press.

[4] 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.

[5] 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.

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

[7] Raman, R., & Dowling, W. J. (2016). Real-time probing of modulations in South Indian classical (Carnātic) music by Indian and Western musicians. *Music Perception, 33*(3), 367-393.

[8] Janata, P., Birk, J. L., Tillmann, B., & Bharucha, J. J. (2003). Online detection of tonal pop-out in modulating contexts. *Music Perception, 20*(3), 283-305.

ACKNOWLEDGEMENTS