Music & Consciousness: Shifting Representations in Memory for Music

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Hearing Music

- Vivid experiences of hearing music
- That experience depends on previous experiences with similar music (Leonard Meyer, 1969).
- But even highly experienced listeners don't hear everything there is to be heard on first listening.
- AND – there is a growing body of research showing that even the memory of that first hearing will differ in detail from what was initially heard. (Dowling, Tillmann & Ayers, 2003; Dowling & Tillmann, 2014)

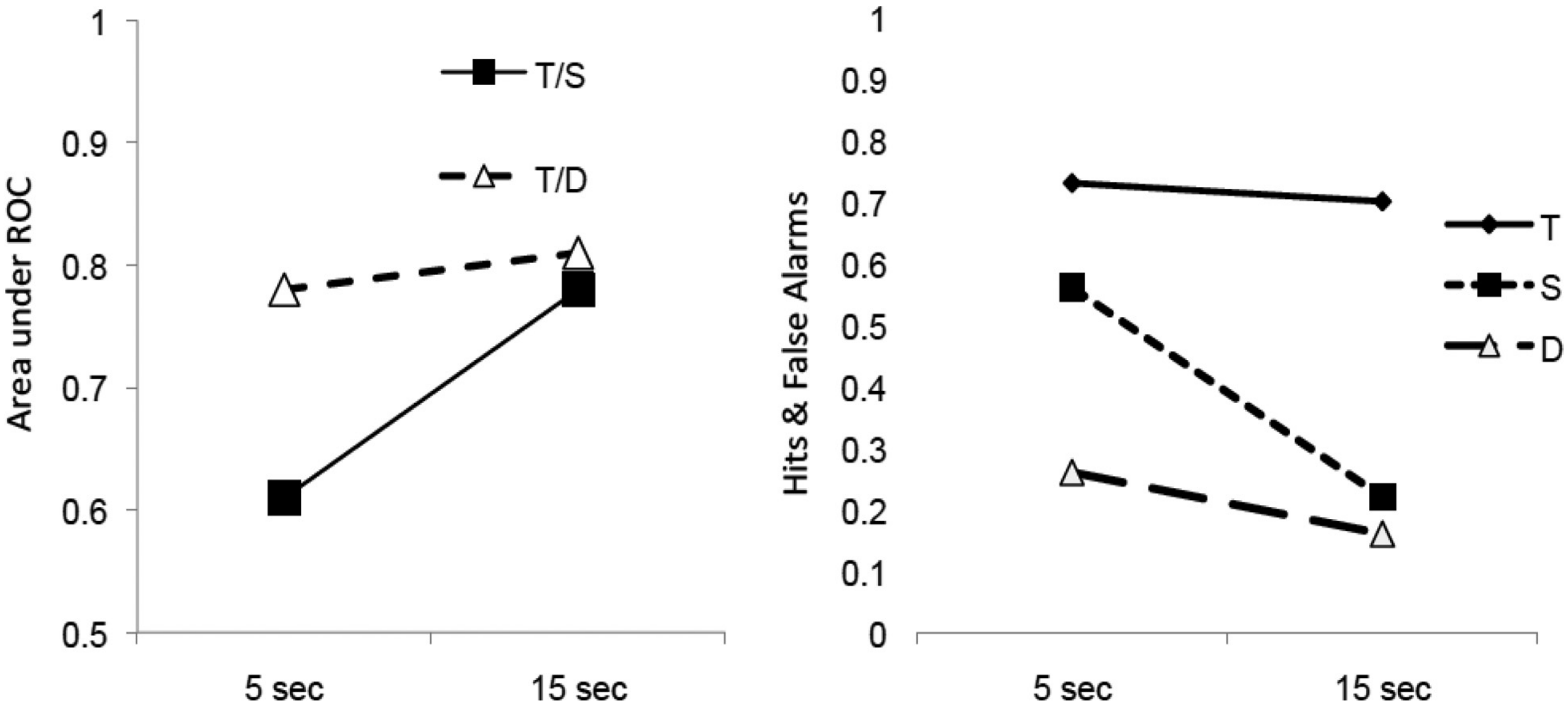
Memory for a new piece

- In the experiment listeners hear the beginning of a classical minuet:

Memory for a new piece

- One of the first two phrases will be tested
- The tests occur after 1 or 3 intervening phrases (2 or 6 measures) – 4-5 vs 12-15 sec
- Test items are **T**argets, **S**imilar lures, or **D**ifferent lures. Similar lures have the same contour as targets, but are attached to the scale at a different pitch level
- Ss respond on 4- or 6-confidence-level scale (sure different to sure same)
- Measure hits & false alarms, and area under the ROC (unbiased estimate of proportion correct where chance is 0.50)

Memory for a new piece

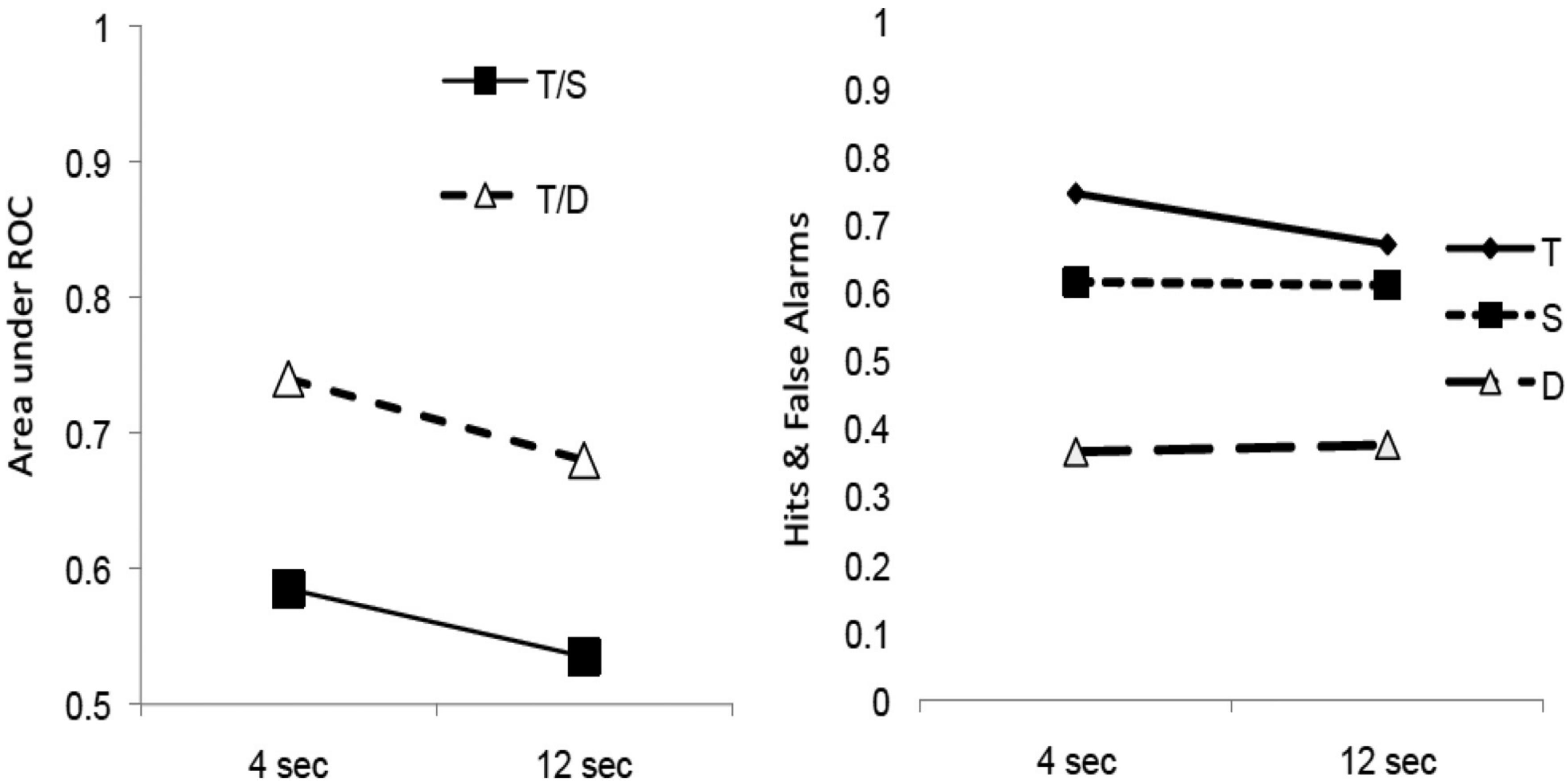


Memory for a new piece

- We theorize that when tested after 5 sec the listener bases their answer on individual features of the phrase such as the melodic-rhythmic contour and the tonal scale
- By 15 sec those individual features have been bound together (into what Treisman would call an “object file”) so that now the listener takes account of where the contour is attached to the scale
- We have replicated this result with popular guitar music as well (Dowling, Magner & Tillmann, 2016)

Memory for a new piece

- When the intervening "filler" material changes timbre, the memory improvement disappears

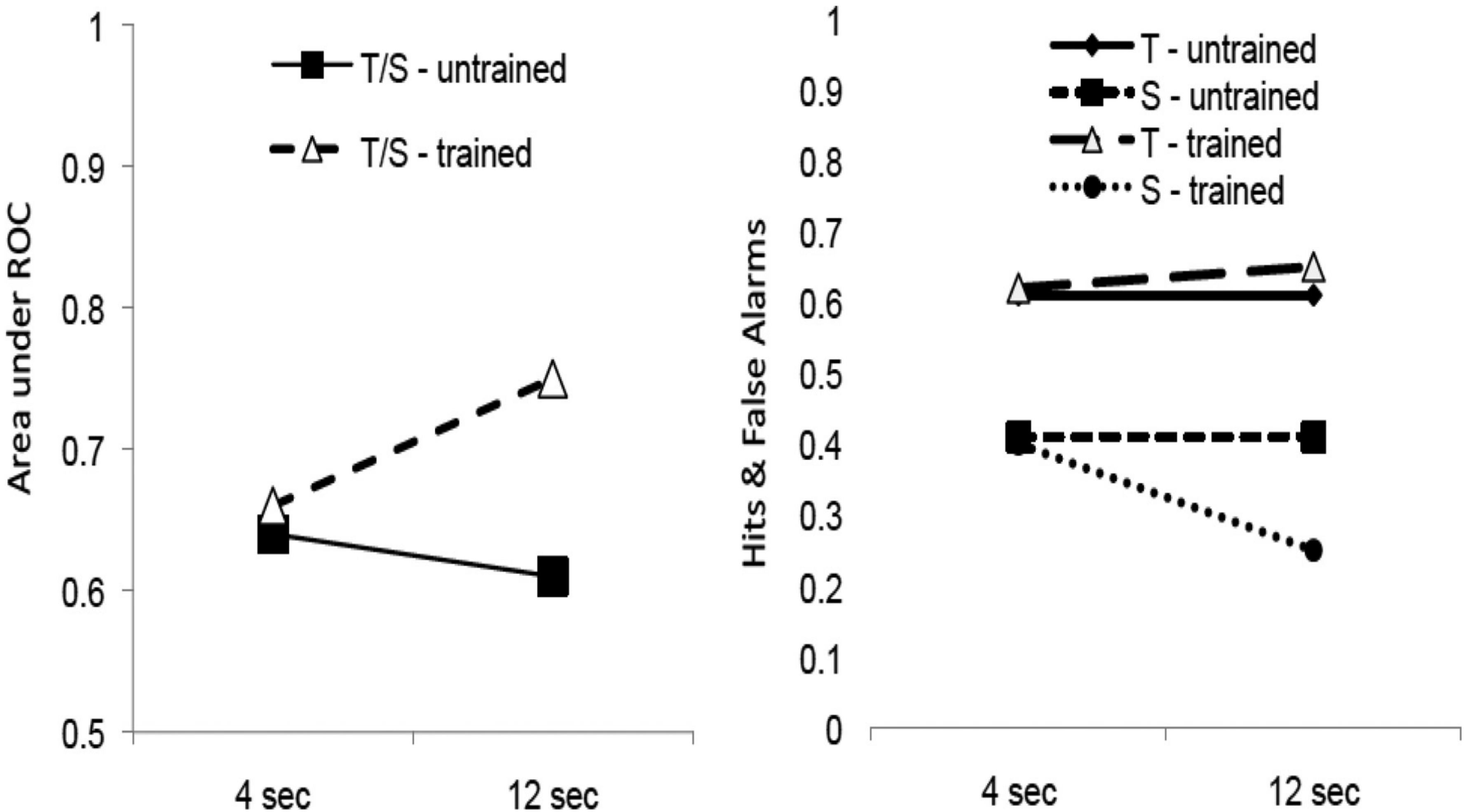


Memory for a new piece

- This is consistent with Gernsbacher's theory of memory for stories, in which, when the topic changes, only the gist of the preceding passage is stored, and the details are lost
- In the first experiment the test items were exactly as the composer wrote them, and so they had other changes besides moving the contour along the scale
- So we constructed **S** lures in which the *only* change was in the pitch level of the contour

Memory for a new piece

- In this case only moderately trained musicians show the effect



Memory for a new piece

- This result is consistent with that of Dowling (1986) who showed that moderately trained musicians encode novel melodies they hear as diatonic scale steps
- In that experiment Ss heard novel melodies presented with a surrounding chordal context which framed the melody as either centered on the 1st degree of the scale (tonic) or the 5th degree (dominant)
- Then memory for the melody was tested a few trials later with either the same or a different context

Fig. 1. Examples of stimuli in Experiment 1: (A) A novel melody introduced with chordal context ending with the tonic (I) chord; (B) a same-context transposition of A; (C) a same-context imitation of A; (D) a different-context transposition of A; (E) a different-context imitation of A. The Roman numerals under the staves indicate the chord labels in the con-

Memory for a new piece

- Untrained Ss were unaffected by the context shift, but moderately trained musicians' performance fell to chance when the context changed – an "encoding specificity" effect

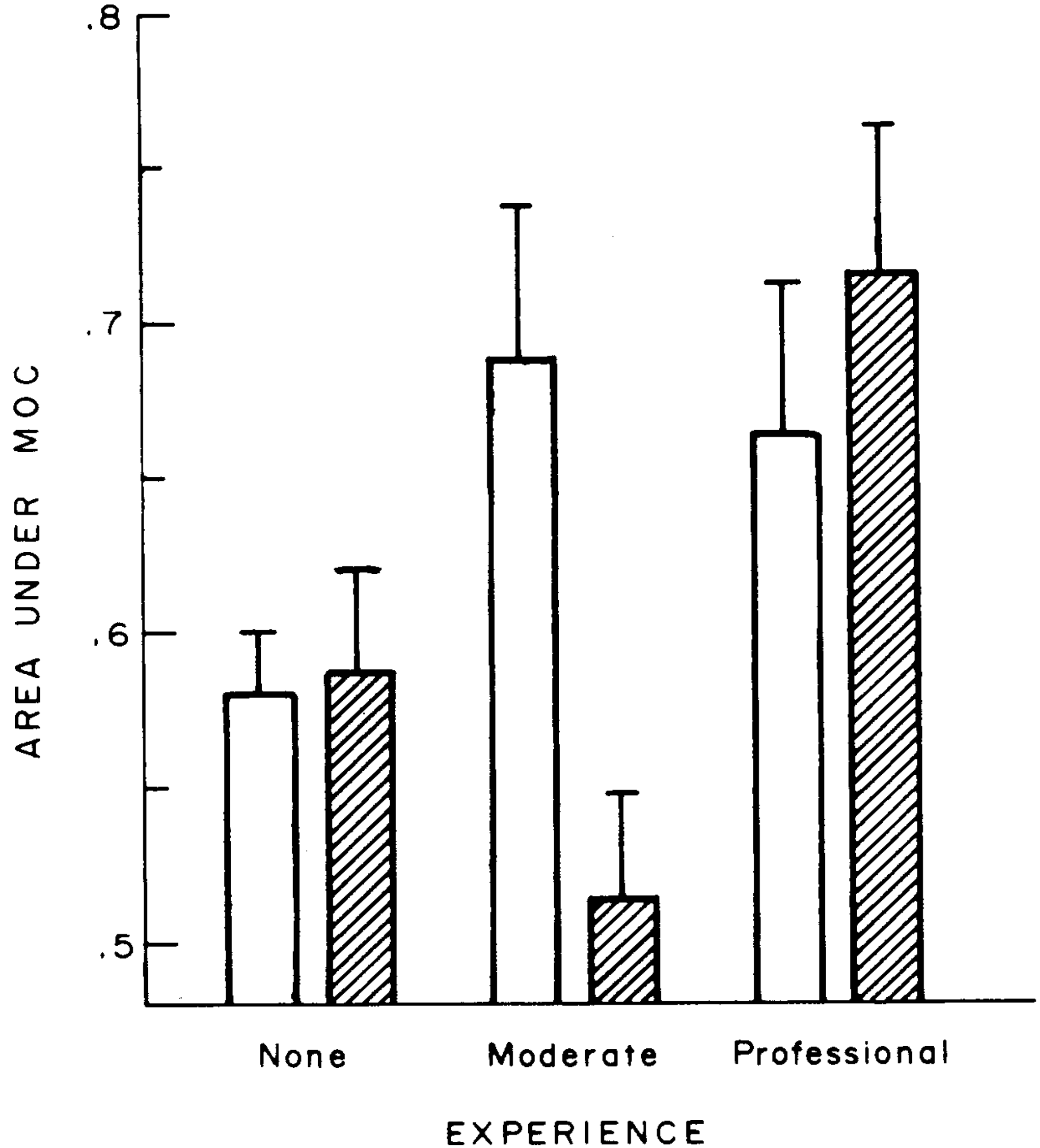


Fig. 3. Areas under the MOC for Experiment 1 with two contexts (same: open bars; different: cross-hatched) at three levels of experience. Chance was .50. (Brackets show standard

Detection of wrong notes in melodies

- These results also converge with recent experiments in which Ss detect wrong notes in melodies
- With familiar melodies both untrained and trained musicians detect out-of-key wrong notes more easily than in-key ones, showing that with those melodies they are relying on the scale structure
- We imagined that with unfamiliar melodies they would still be able to use that structure to detect out-of-key wrong notes

Detection of wrong notes in melodies

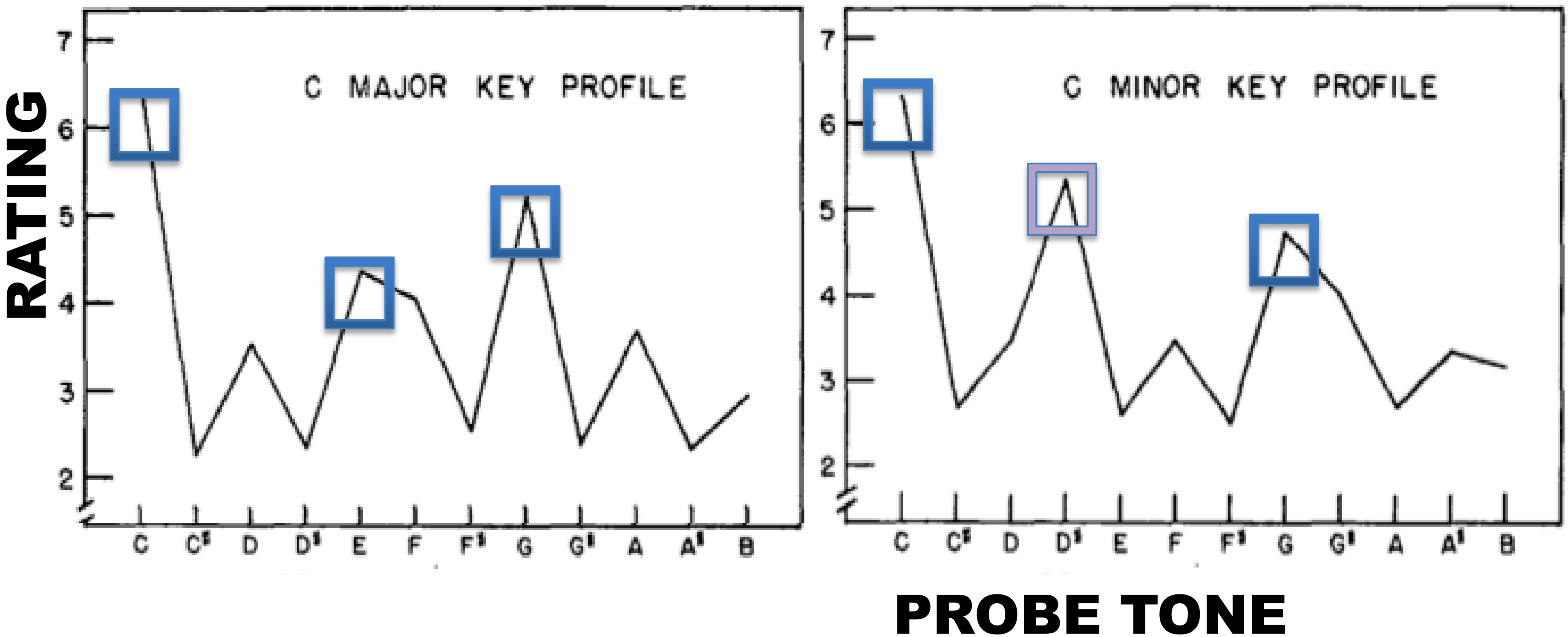
- However, detection was at chance for both groups
- We think that was because even the moderately trained Ss did not have time to start encoding the pitches of the unfamiliar melody as scale steps or not
- We are currently designing an experiment in which we give them more exposure to the melody to facilitate scale-step encoding, which should lead to better out-of-key wrong note detection

Tracking modulations

- Further converging evidence bearing on scale-step encoding by moderately trained musicians comes from studies using Toiviainen & Krumhansl's (2003) continuous probe-tone technique
- Listeners hear a piece of music in one ear and a probe tone (one of the 12 possible semitones) in the other ear. Using a slider on the screen controlled by the mouse they continually rate how well the probe goes with the piece. They do this 12 times – once for each semitone
- Here are some sample profiles:

Two Western Tonal Hierarchies

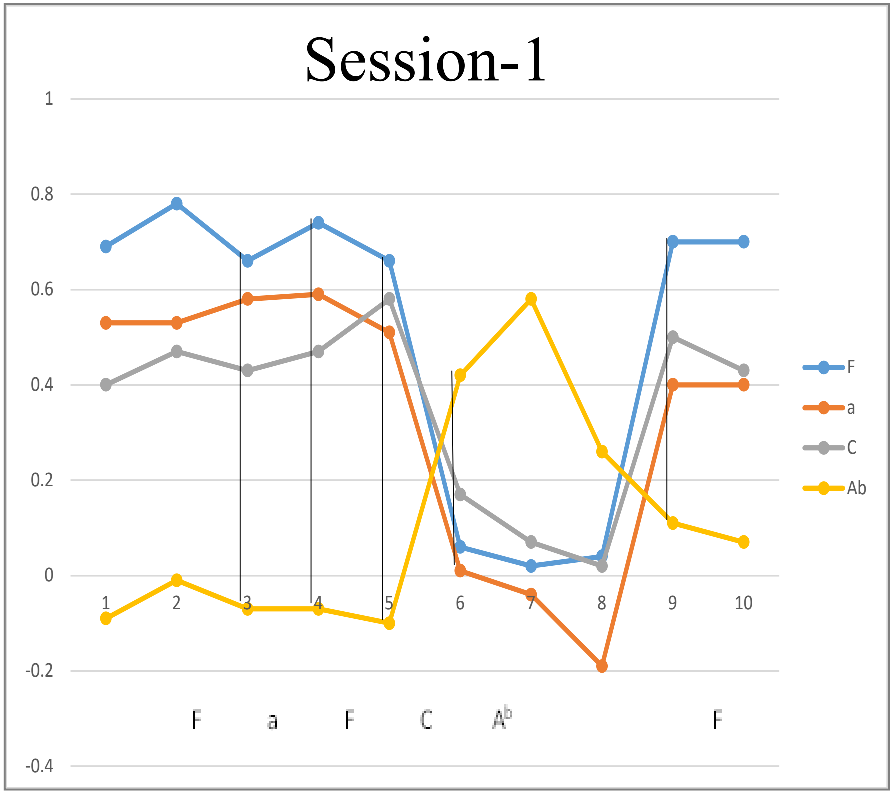
- Krumhansl & Kessler (1982)
- Key profiles
- Notice “in-scale” vs. “out-of-scale” pitches



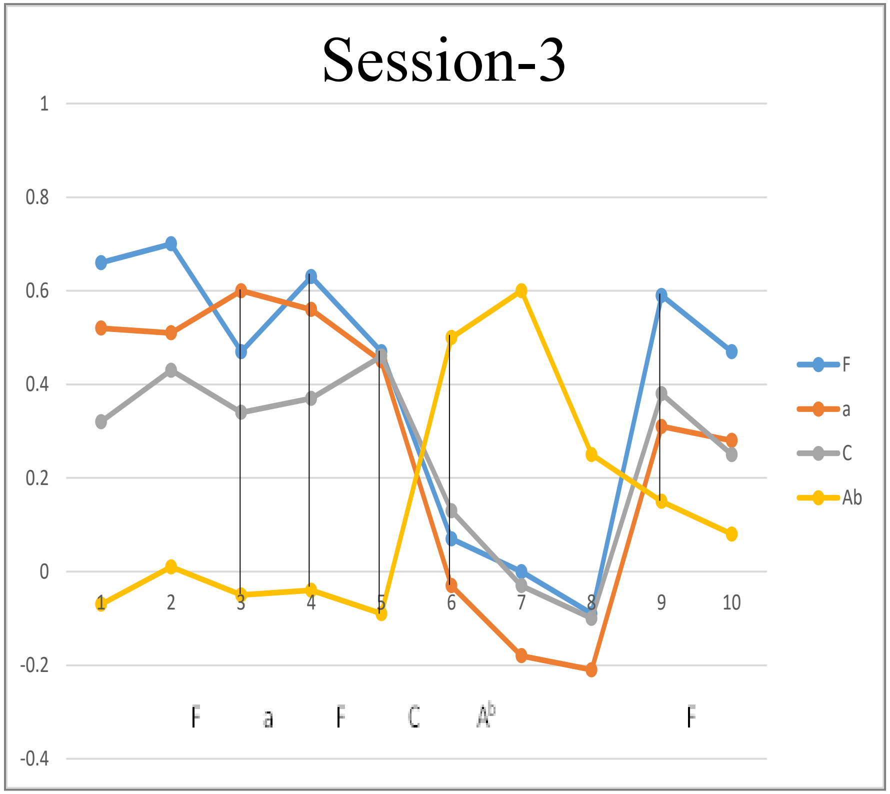
Tracking modulations

- The profile of their ratings at each moment in the piece can be correlated with the standard profiles of the relevant musical keys to give us an indication of what key they are hearing the piece in at each moment
- We can plot those correlations across time to see whether the listeners are tracking the modulations within the piece from key to key
- The figure shows the responses of expert orchestral musicians who learned the finale of Dvorak's "American" string quartet, both the first time they heard it & after learning to play it

Dvorak



Session-1
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1 2 3 4 5 6 7 8 9 10
F a F C Ab F
F
a
C
Ab



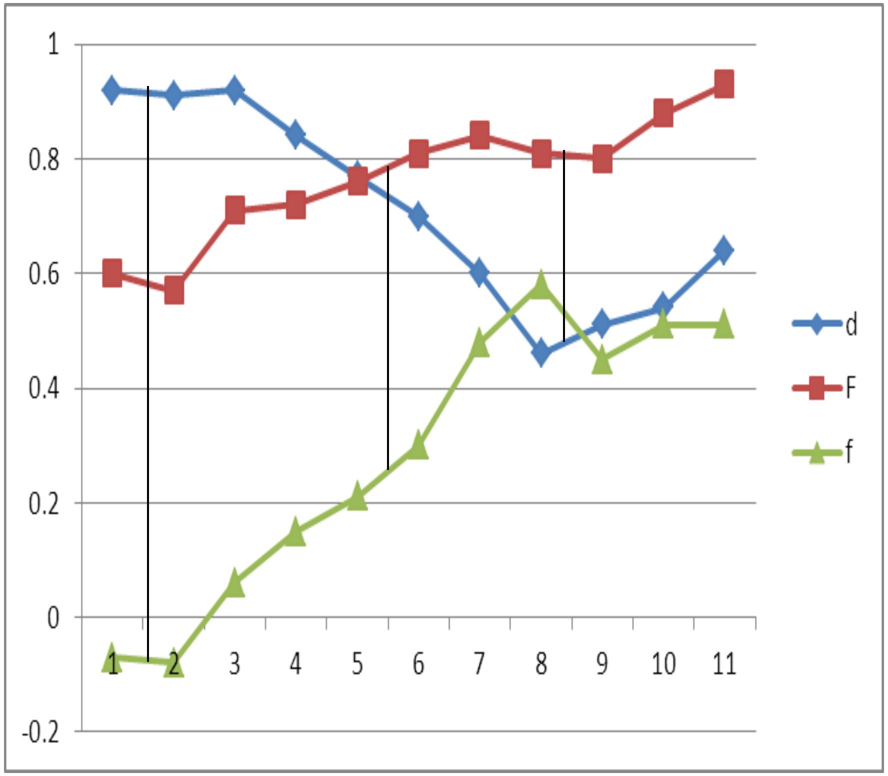
Session-3
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1 2 3 4 5 6 7 8 9 10
F a F C Ab F
F
a
C
Ab

Tracking modulations

- Clearly they grasped the modulation pattern right off
- However, in performing the experiment the first time, they still had to listen to the piece 12 times, and so by the end of the experiment were rather familiar with it.
- Here are profiles from a similar experiment using Haydn's Quartet op. 76 no. 3, looking at the first 3 (out of 12) trials compared with the last 3
- Clearly the first 3 trials are giving us a more sharply differentiated view of the modulation structure

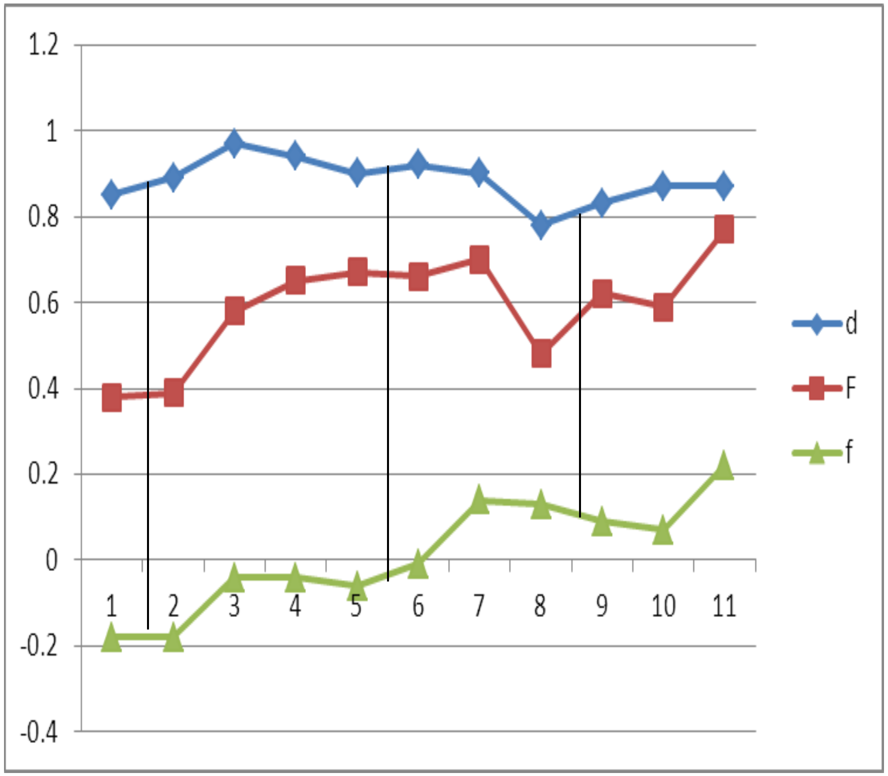
76/2 Musicians

d F f F



trials 1-3

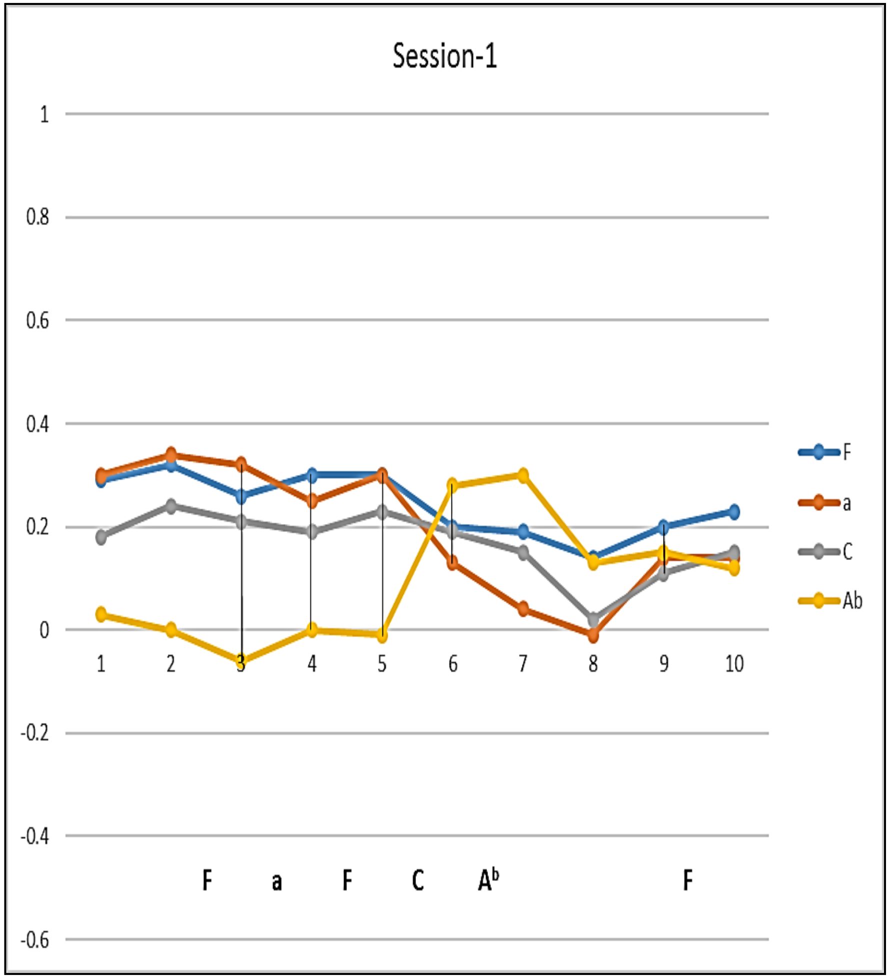
d F f F



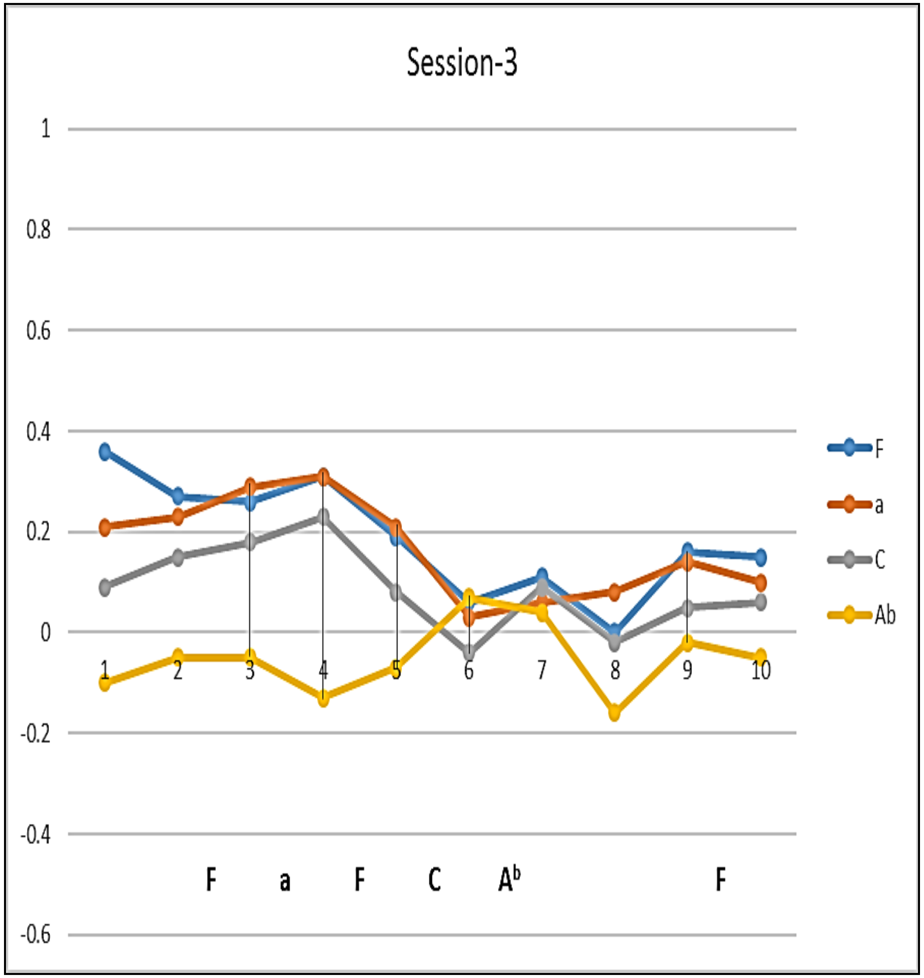
trials 10-12

Tracking modulations

- This suggests that musicians latch onto the pattern of keys in a novel piece very quickly – as soon as they are 10-15 sec into a new key they have got their bearings in it. (The time divisions in the figures are 10 sec)
- This converges with the result that it takes 10-15 sec to attach a melodic shape to the scale
- But note that they are still settling into a new key when they are more than 10 sec into it



Session-1
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1 2 3 4 5 6 7 8 9 10
F a F C A^b F
F
a
C
Ab



Session-3
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1 2 3 4 5 6 7 8 9 10
F a F C A^b F
F
a
C
Ab

Tracking modulations

- And note that the nonmusicians show some sensitivities to the keys, but not nearly so sharply as musicians
- Similar results obtained in our studies of modulation in South Indian (Carnātic) music (Raman & Dowling, 2016)

Conclusions

- Listeners' perceptual systems take 10—15 sec to attach a new melodic shape to a tonal scale framework
- Results of continuous-probe-tone studies show it takes at least 10 sec to settle into a new key
- All this suggests that even though musicians will remember hearing a piece with firmly grounded tonal structure, their actual immediate experience of that piece lacked that structure

Implications

- This is perhaps not so surprising – this is how perception works – it constructs a representation of the real world that is more like the real world than the pattern of excitation of our sense organs (Brunswik)
- And as Leonard Meyer points out, we would not keep finding new structural relationships in our favorite pieces if our memories for them reflected every aspect of their structure – the "imperfection of our memory" allows us to continually experience new and exciting things

Thanks to

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&

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