

Influences of Tone-Colour on Musical Memory



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Introduction

Perception of Nonadjacent Keys

- Modulation, which occurs throughout Western tonal-harmonic music, results in temporally nonadjacent keys
- Musical surface features, such as melody and rhythm, assist with key memorization
- Aspects of timbre (e.g., number of harmonics and amplitude envelopes) contribute to the encoding of music, and may thus influence memory of nonadjacent keys

Research Question

- **Do components of timbre influence memory recognition within a nonadjacent-key paradigm?**

Methods

Experiment 1: Timbre Assessment

- Rate 3 timbres for “naturalness”
 - **IVs:** *Synthetic vs. Subtractive vs. Sampled Timbre*
 - **DV:** *Naturalness*

Experiment 2: Timbre Naturalism

- Rate closing probe cadence for goodness-of-completion (e.g., Fig. 1)
 - **IVs:** *Nonadjacent Timbre Matching*
 - **DV:** *Probe Goodness-of-Completion*

Experiment 3: Timbre Composition

- Influence of timbre components on nonadjacent-key perception
 - **IV1:** *Tonic vs. Non-Tonic Key Relationship*
 - **IV2:** *Dynamic (AE_{Dyn}) vs. Flat (AE_{Flat}) Amplitude Envelopes*
 - **IV3:** *Single (H_1) vs. Multiple (H_9) Harmonics*
 - **IV4:** *Timbral-Component Matching ($H_{Same}-AE_{Same}$; $H_{Same}-AE_{Diff}$; $H_{Diff}-AE_{Same}$; $H_{Diff}-AE_{Diff}$)*
 - **DV:** *Probe Goodness-of-Completion*

Fig. 1: Example of tonic nonadjacent stimuli used in Exp. 2 and 3: C major—D major—C major (probe cadence). Keys modulated bidirectionally 1–2 semitones between stimuli sections.

| Nonadjacent Key: C(0) | Intervening Key: D(+2) | Probe Key: C(0) |
|-----------------------|------------------------|-----------------|
| | | |

Audio 1: Exp. 1 stimulus of Fig. 1 Probe as *Sampled* Timbre



Audio 2: Exp. 2 stimulus of Fig. 1 Probe as *Non-Tonic**, $H_{Same}-AE_{Diff}$



Audio 3: Exp. 3 stimulus of Fig. 1 as *Tonic*, $H_{Same}-AE_{Diff}$



Results

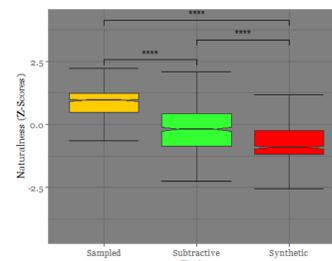


Figure 3: Exp. 1 normalized ratings of naturalness across three timbres.

Figure 4: Exp. 2 normalized goodness-of-completion ratings normalized and compared between probe timbres.

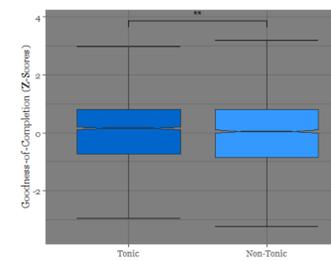
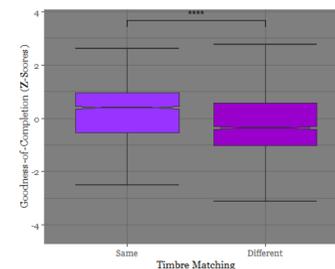
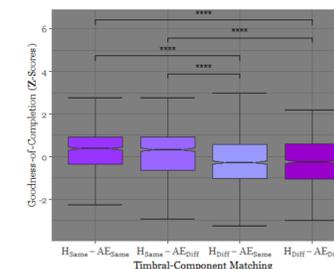


Figure 5: Exp. 3 normalized goodness-of-completion ratings relative to their tonic-key relationship.

Figure 6: Exp. 3 normalized goodness-of-completion ratings compared across timbre matching conditions.



Experiment 1: Assessment

- *Timbre Naturalness:* $F_{2,64} = 776.23, p < .0001, \omega^2p = .068$ (Fig. 3)

Experiment 2: Naturalism

- *Timbre Matching:* $F_{1,60} = 121.8, p < .0001, \omega^2p = .039$ (Fig. 4)

Experiment 3: Composition

- *Tonic-Key Relationship:* $F_{1,33} = 7.85, p = .005, \omega^2p = .002$ (Fig. 5)
- *Probe Timbre:* $F_{3,33} = 27.00, p < .0001, \omega^2p = .018$
- *Timbral-Component Matching:* $F_{3,33} = 77.50, p < .0001, \omega^2p = .051$ (Fig. 6)

Discussion

Experiment 1: Timbre Assessment

- Stimuli easily distinguishable based on naturalness

Experiment 2: Timbre Naturalism

- Significant effect of timbre matching between nonadjacent key and probe cadence, consistent with hypothesis that memory for timbre persists across keys and distinct timbral transformations

Experiment 3: Timbre Composition

- Significant effect of H matching on goodness-of-completion but not AE matching
- Significant effect of *Tonic-Key Relationship*, suggesting memory for key within small timbral transformations

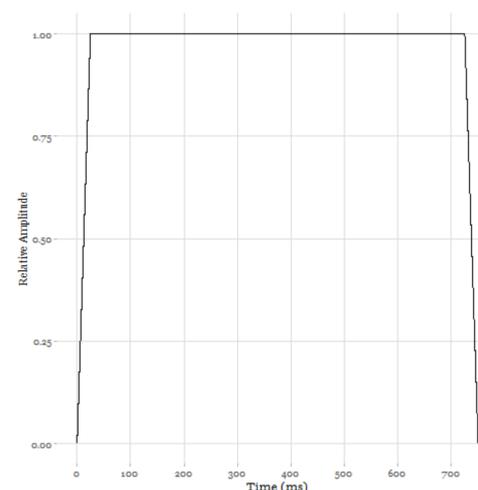


Fig. 2A, 2B, 2C, 2D, and 2E: Waveforms for all AE and H stimulus combinations presented in Exp. 3:

H_1-AE_{Flat} (2A); H_9-AE_{Flat} (2B); H_5-AE_{Int} (2C); H_9-AE_{Dyn} (2D); H_1-AE_{Dyn} (2E).

References

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²Spyra, J., Stodolak, M., & Woolhouse, M. (2019). Events versus time in the perception of nonadjacent key relationships. *Musicae Scientiae*, 102986491986746.

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Thanks

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