Effects of Familiarity, Key Membership, and Interval Size on Perceiving Wrong Notes in Melodies

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OVERVIEW

This study investigated the role of familiarity of tunes and musical expertise in the perception of wrong notes in melodies. The wrong notes were either in the musical key (scale) of the melody, or not, and were 1 or 2 semitones removed from the original right note. This study was designed to test two theories of perception and memory for melodies:

- According to the "contour + successive intervals" theory, a melody is encoded and remembered as a sequence of pitch intervals from one note to the next. For example, Trainor, McDonald, & Alain (2002) say, "Melodic information is thought to be encoded in the brain in two different 'relative pitch' forms, a domain-general contour code (up/down pattern of pitch changes) and music-specific interval code (exact pitch distances between notes)." And Trehub & Hannon (2006) say, "Adults' ability to recognize or reproduce familiar tunes necessarily depends on their encoding of finer pitch relations, specifically, intervals, or precise pitch distances between successive tones."
- According to the "contour + scale" theory (Dowling, 1978), the contour provides the pattern of ups and downs, but the precise pitch distances are provided by an overlearned scale (embodying the tonal hierarchy) that is common to numerous melodies in the same mode.
- There is considerable converging evidence in favor of the latter theory (Dowling, Kwak, & Andrews, 1995), including (a) that intervals are more easily remembered with reference to a familiar melody than vice versa, (b) that the functions of pitches in a tonal hierarchy are specified in terms of scale degrees and not intervals, and (c) that melodies can still be recognized when the sequence of successive intervals from note to note has been destroyed by octave scrambling or by temporally interleaving distractor notes.
- Here, we test these theories directly by introducing wrong notes into familiar melodies. If the successive intervals theory is correct, then greater changes in the interval pattern—that is, greater pitch distances between the wrong note and the original right note—should produce more accurate and faster responses than smaller changes. If the contour + scale theory is correct, then responses to out-of-key wrong notes should be more accurate and faster than responses to in-key wrong notes, regardless of changes in the interval pattern.
- A pilot study led us to suspect that highly familiar melodies ("Mary Had a Little Lamb," "Happy Birthday") might lead to different patterns of responses than moderately familiar melodies ("Auld Lang Syne," "Over the Rainbow"). It might be that the highly familiar melodies serve as prototypes, so that the scale is remembered with reference to them, rather than vice versa. Hence it might happen that key membership would be less important in determining responses, and changes in intervals relatively more important.

PARTICIPANTS

Familiar Melodies

N = 30; age range = 18 to 33 years

N = 16; musical training = more than 5 years

N = 14; musical training = less than 5 years, most had 0 years

Unfamiliar Melodies

N = 57; age range = 18 to 75 years

N = 30; musical training = more than 5 years

N = 27; musical training = less than 5 years , most had 0 years

STIMULI

Stimuli were generated on MATLAB 2009a:

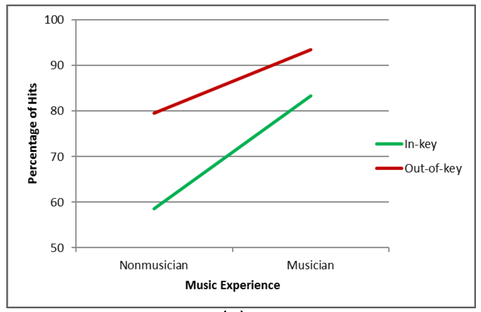
(a) 11 "highly" familiar songs (familiarity ratings: 92% or higher)

(b) 21 "moderately" familiar songs (familiarity ratings: 44 - 91%)

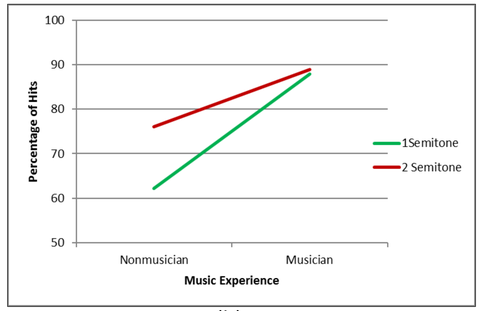
(c) 32 unfamiliar folk songs (Bronson, 1976)

RESULTS

Figure 1. "Highly" familiar melodies. (a, b)—Hits. (c, d)—Response time (ms) for accurate responses. "Moderately" familiar melodies. (e, f)—Hits. (g)—Response time (ms) for accurate responses. Unfamiliar melodies. (h)—Response time (ms) for accurate responses.



(a)



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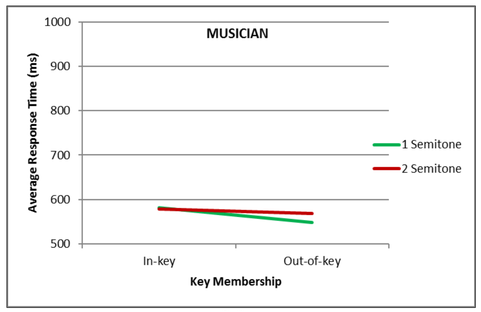

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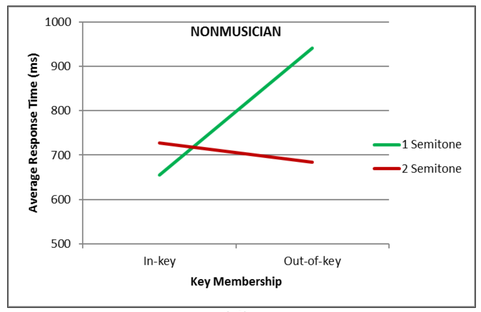

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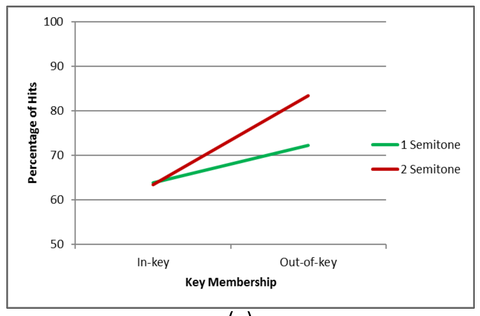
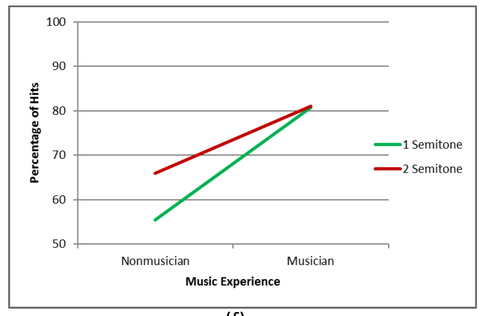


(e)



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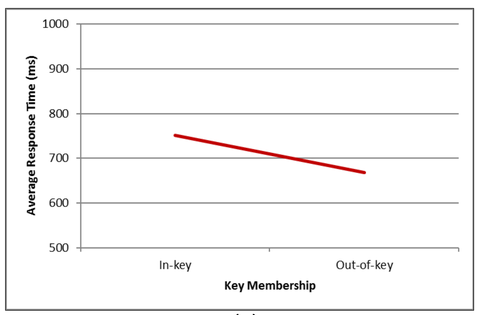
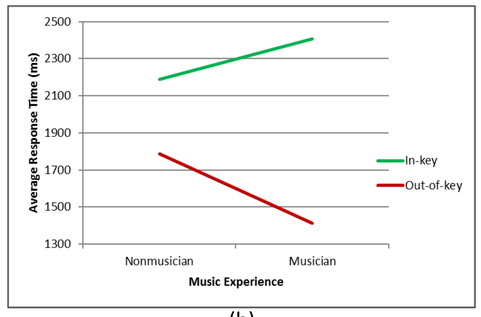


(g)



(h)

TASK

Participants heard 32 familiar and 32 unfamiliar melodies which were repeated twice. Each melody had one wrong note that was either in- or out-of-key, 1 or 2 semitones away, and up or down from the original note. Participants pressed the spacebar when they heard a wrong note.

RESULTS

For both hits and response time, we performed a 2 Music Experience x 2 Key Membership x 2 Interval Size mixed design ANOVA separately for each of the 3 familiarity conditions.

Overall, musicians generally responded with greater speed and accuracy than nonmusicians.

"Highly" familiar melodies:

- Out-of-key notes were better detected by both groups, whereas more distant wrong notes were better detected by nonmusicians, but not by musicians (Figures 1a, 1b).
- Nonmusicians, however, were not faster in responding to out-of-key wrong notes, whereas musicians were faster with both in- and out-of-key notes (Figures 1c vs. 1d).

"Moderately" familiar melodies:

- Both groups were more accurate and faster in responding to out-of-key wrong notes (Figures 1e, 1f, 1g).
- Nonmusicians, but not musicians, responded more accurately to more distant wrong notes (Figure 1f).
- Both groups were most accurate with out-of-key wrong notes 2 semitones away from the original note.

Unfamiliar melodies:

- Detection of wrong notes was very poor (~10% hits).
- The interaction of Music Experience x Key Membership x Interval Size approached significance, and neither group found out-of-key wrong notes easier to detect.
- However, both groups were faster at responding to them (Figure 1h).

DISCUSSION AND SUMMARY

- The results for musicians definitely favor the "contour + scale" theory. For them, but not for nonmusicians, key membership was generally a determining factor for speed and accuracy of responses, and interval size much less so. This was even true for the highly familiar melodies, where we had expected that interval size might play a stronger role even for these participants.
- The "contour + intervals" theory does better at characterizing the responses of nonmusicians, who generally responded more accurately and quickly to the more distant wrong notes. However, even the nonmusicians responded with greater speed and accuracy to out-of-key notes, with few exceptions (notably in the highly familiar melodies).

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