Detection of Wrong Notes in Familiar Melodies that have Out-of-Key Notes in them

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OVERVIEW

Both schematic and veridical knowledge must be involved in detecting wrong notes in familiar melodies. Dowling (1978) proposed that veridical knowledge of melodic contour is combined with schematic knowledge of the tonal scale (tonal hierarchy) in forming a memory representation which can serve in recognition or recall. With familiar melodies listeners also have veridical knowledge of the pitch pattern of the particular melody. When wrong notes are introduced into those melodies, out-of-key wrong notes are noticed more quickly and accurately than in-key wrong notes (APCAM, 2017).

Here we pose the question: What happens when the veridical pitch information in the particular melody differs from the schematic pitch information of the tonal hierarchy? That is, what happens when there are out-of-key notes in the familiar melody? (Schubert's *Ave Maria* is a familiar example.) When they are altered at test, are out-of-key alterations still more noticeable than in-key alterations? Or are in-key alterations more noticeable, presumably because the listener is used to hearing an out-of-key note at that point in the melody?

TASK

We conducted a pilot study in which we familiarized listeners with "naturally occurring" melodies with out-of-key notes in them (such as, *Ave Maria*), and then tested them by introducing alterations of those notes as well as of the in-key notes of the melody. The positions of the out-of-key notes in those melodies were not systematically controlled, however, and the results were complex and uninterpretable. Therefore we constructed 2 sets of melodies in which the out-of-key notes to be familiarized were controlled (Experiments 1A & 1B).

Familiarization: In each version of the experiment, listeners became familiar with the 8 melodies in 4 sessions over a 2-week period, learning to name them in 4 iterations of the list in each session. The familiarization sessions each lasted about 40 min.

Wrong-Note Detection: Following the 4th familiarization session, listeners completed a wrong-note detection task in which they had to respond as soon as they heard a note that was different from the familiarized version. There were 32 trials in which each melody appeared 4 times: once with each of the out-of-key notes altered and once with each of two originally in-key notes altered. This task lasted about 20 min.

STIMULI

Stimuli were recorded using Grand Piano timbre on Cakewalk SONAR, which produced .wav files. We used 16 unfamiliar folk songs (Bronson, 1976): 8 in Experiment A and 8 in Experiment B.

Familiarization: We introduced two out-of-key pitches into each melody, by altering the pitch of a 2nd or 6th scale step by 1 ST up or down. One of the altered notes lay at a corner in the melodic contour, and the other was in the middle of an ascending or descending passage. We chose two similarly positioned in-key notes for subsequent alteration in the test phase. We constructed 2 sets of 8 melodies, with two separated out-of-key notes in each melody. We used these 2 sets to conduct the whole experiment twice (Experiments 1A & 1B).

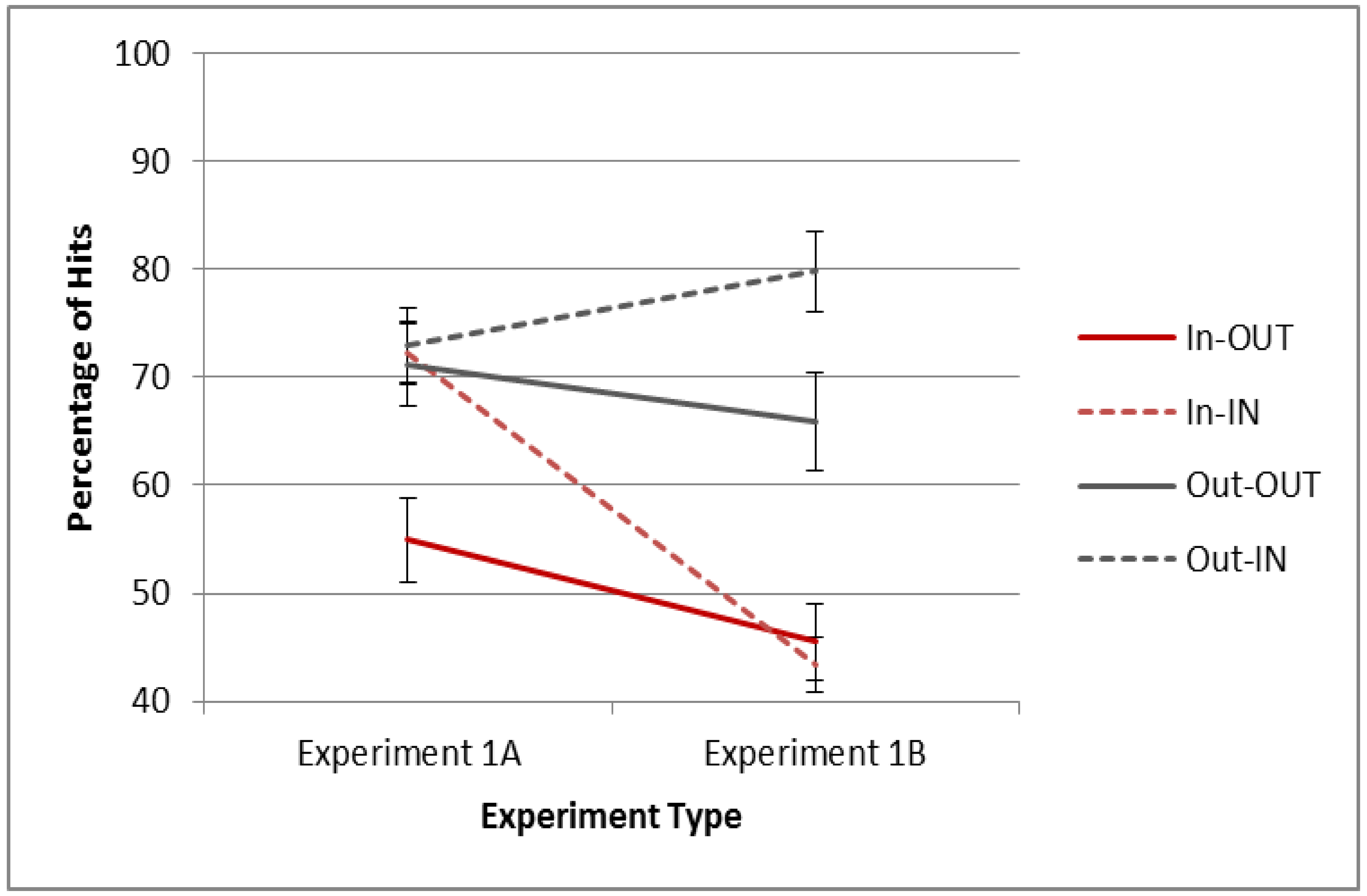
PARTICIPANTS

Experiment 1A: N = 36 (2 dropped); age range = 18 to 26 years
N = 9; musical training = more than 5 years (*M* = 9.56 years)
N = 27; musical training = 0 to 5 years (*M* = 2.30 years)

Experiment 1B: N = 38 (4 dropped); age range = 18 to 39 years
N = 15; musical training = more than 5 years (*M* = 8.53 years)
N = 23; musical training = 0 to 5 years (*M* = 1.48 years)

RESULTS

Figure 1. Percentage of hits (successful detections) in Experiments 1A and 1B for In-Key (red lines) and Out-of-Key (grey lines) wrong notes with originally out-of-key (OUT; solid lines) or in-key (IN; dashed lines) target notes.



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RESULTS

The results of Experiments 1A & 1B differed regarding listeners' responses to alterations of the familiarized in-key notes of the melodies (IN in Figure 1). Experiment 1B replicated the results of our earlier experiments in showing better detection of out-of-key wrong notes, whereas Experiment 1A did not. However, the answer to the principal question we posed concerning the alteration of familiarized out-of-key notes (OUT in Figure 1) was unambiguous: In both experiments out-of-key alterations were much more easily detected (by about 15% points). This result indicates the importance of schematic knowledge of the tonal system in wrong-note detection, even of wrong notes that were never veridically in-key.

Overall, alterations of initially in-key notes (IN) were more easily detected than alterations of initially out-of-key notes (OUT). This also points to the importance of schematic knowledge, since it suggests that the veridical knowledge of the pitches in this familiarized melody was better for the initially in-key notes than for the initially out-of-key notes.

There were results involving musical training: More highly trained musicians performed better overall than the less trained, and this was especially true of the formers' detection of out-of-key notes. This was to be expected, because it shows greater grasp of the tonal hierarchy by the musicians.

DISCUSSION AND SUMMARY

With unfamiliar melodies, it is clear that schematic information alone is only capable of leading to wrong-note detection that is barely better than chance (considering that the listener has a 3-s window to detect a wrong note in a 20-s melody, giving roughly a 14% level of chance detection. Responses are much faster with out-of-key wrong notes, suggesting that the violation of tonal expectations makes the wrong note "pop out." And curiously, responses to 1-semitone deviations are faster than those to 2-semitone deviations. Perhaps the most puzzling result here is the interaction between key membership and distance of deviation for detection accuracy. It may be that when a scale note moves just 1 semitone to another in-key note, the fact that that must involve the scale steps 3 and 4, or 7 and 1 may lead to more obvious changes in the tonal tendencies of the scale steps involved, making the change more obvious than 2-semitone alterations involving scale steps with more similar tendencies. It is also noteworthy that musical training had no effects whatsoever on wrong-note detection with unfamiliar melodies. Whatever schematic knowledge is being used in this task, nonmusicians have it to roughly the same degree as musicians, at least for the levels of training represented here.

With familiar melodies, we found that both key membership and distance of deviation from the original target pitch affected detection accuracy and response time. We found that key membership was especially important for detection accuracy with the highly familiar melodies. This raises the possibility that whereas for moderately familiar melodies the pitch tend to be represented in terms of the scale, for highly familiar melodies the scale may be represented in terms of the melody; that is, these melodies in effect serve to define the scale. This fits with the practice of music students to rely on highly familiar melodies to ensure accuracy in the reproduction of scale intervals.

The more highly trained listeners performed better than the less trained in both detection accuracy and response times. Taken together with the results with unfamiliar melodies, this suggests that the principal differences due to training (at least at the levels represented here) lie not so much in more finely honed schematic knowledge developed by training, but rather in the better-trained listeners' knowledge of a greater range of actual melodies.