

Wrong Notes in Melodies: Asymmetries in Detection of Up vs. Down Alterations

W. Jay Dowling & Rachna Raman

Contact: jdowling@utdallas.edu

OVERVIEW

In two experiments we tested listeners' ability to detect wrong notes in familiar melodies. We presented melodies that had been rated familiar (such as *Twinkle, Twinkle Little Star*, *Frère Jacques*, and *The Bear Went Over the Mountain*) in which we introduced a wrong note at an unpredictable place in the middle of the melody. Listeners were to respond as quickly as possible when they heard a wrong note. The wrong notes were either 1 or 2 semitones (ST) from the original target, either in or out of the key of the melody, and were either altered up or down from its original pitch. In general, both distance from the original target and key membership affected detection. Wrong notes were easier to detect when they were further from the target, and when they were out-of-key, with key membership producing much stronger effects (see Figure 1). But in our previous analyses we had not looked at the effects of direction of the change.

Our intuitions suggested that pitch changes in the up direction would be more noticeable than changes down, but the literature suggested that, if anything, down changes would be more noticeable, in line with the results of Neuhoff, Knight, & Wayand (2002). However, other recent research addressing this question with a variety of tasks found no up-down asymmetry in accuracy of response (Neuhoff, Kramer, & Wayand, 2002; Weir, Williamson, & Müllensiefen, 2015).

TASK

In each experiment listeners heard 32 trials, each one consisting of the beginning of a familiar melody. At some point, a wrong note would be introduced, and the listener's task was to press the space bar on the computer as soon as they heard it. If they did not detect a wrong note, they were to press the space bar at the end of the melody in order to proceed to the next trial.

STIMULI

In Experiment 1 the stimuli consisted of the first 10 to 16 notes of 22 melodies that had received the highest familiarity ratings from a different group of listeners, from an initial set of 48 melodies. We introduced a different type of wrong note on each of 32 trials: the wrong note was 1 or 2 ST from the original pitch, was in or out of the key of the melody, and was displaced up or down. Each type of trial occurred equally often.

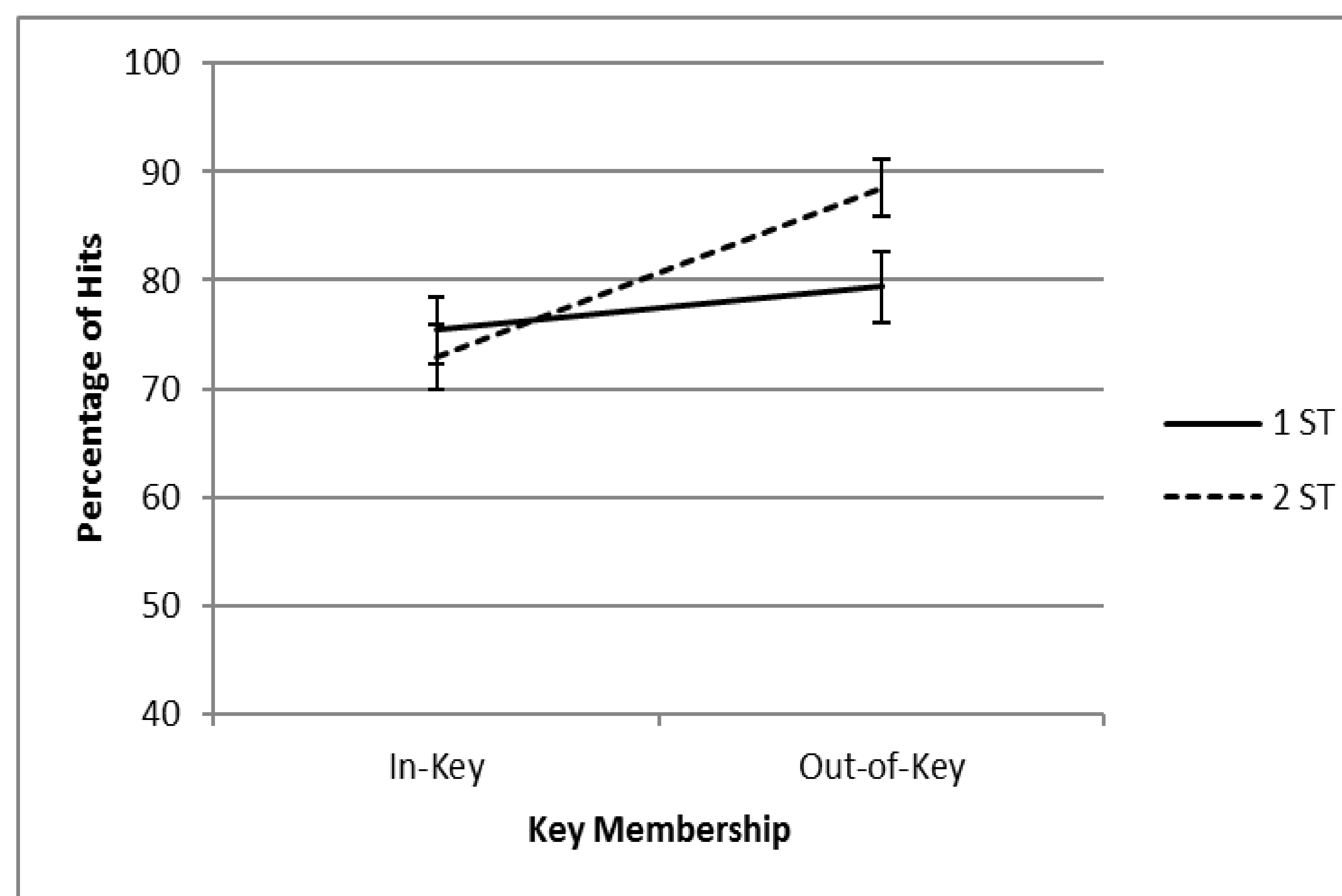
In Experiment 2 the stimuli consisted of the first 18 to 28 notes of 32 melodies selected as described above, but here separated into the 8 most familiar melodies (*Happy Birthday*, *Rudolph the Red-Nosed Reindeer*) and 24 moderately familiar melodies (*On Top of Old Smokey*, *Three Blind Mice*). Wrong notes were introduced into these two sets of melodies as described above. There were 80 trials in Experiment 1 and 64 trials in Experiment 2. A desktop computer presented the stimuli as sine waves over earphones at comfortable levels, and recorded accuracy and the response times of correct responses. To count as a correct detection the response had to occur in a window of 300 to 1500 ms following the occurrence of the wrong note.

PARTICIPANTS

There were 35 listeners in Experiment 1 and 76 listeners in Experiment 2. Listeners had a wide range of musical training, from 0 to 20 years of music lessons or playing in an ensemble, but amount of training had little effect on the results.

FIGURE

Figure 1. Percentage of hits (successful detections) in Experiment 1 for In-Key and Out-of-Key wrong notes that were either 1 ST (solid lines) or 2 ST (dashed lines) from the original target note.



RESULTS

Here we report only the results pertaining to direction of the pitch change of the wrong note. In general, we found descending changes more noticeable than ascending changes, in agreement with the results of Neuhoff, Knight, & Wayand (2002).

In Experiment 1, we ran a 3-way within-groups ANOVA with 2 Key Membership (In vs. Out) x 2 Interval Size (1 vs. 2 ST) x Direction (Up vs. Down) on hits (successful detections) and on response times. Wrong notes below the original correct pitch were detected more often (78%) than those moved up (75%), $F(1,34) = 4.29$, $\eta^2 = .01$, $p < .05$. And with response times the interaction of Key Membership x Pitch Direction was significant, $F(1,34) = 14.63$, $\eta^2 = .03$, $p < .001$, such that for alterations up out-of-key wrong notes were identified faster than in-key.

In Experiment 2, we ran two 4-way ANOVAs with 2 Familiarity Levels x 2 Key Membership (In vs. Out) x 2 Interval Size (1 vs. 2 ST) x 2 Direction (Up vs. Down). For hits, there were several interactions that involved direction: Familiarity x Key Membership x Pitch Direction, $F(1,43) = 9.69$, $\eta^2 = .01$, $p = .003$, Familiarity x Key Membership x Interval Size x Pitch Direction, $F(1,43) = 5.25$, $\eta^2 = .004$, $p = .03$, Familiarity x Interval Size x Pitch Direction, $F(1,43) = 17.69$, $\eta^2 = .02$, $p < .001$, and Interval Size x Pitch Direction, $F(1,43) = 17.69$, $\eta^2 = .02$, $p < .001$. These results indicate that (1) for Highly Familiar melodies, down alterations were better detected than up; (2) pitch direction only affected detection of wrong notes moved 1 ST, where down was better detected than up; (3) however, with Moderately Familiar melodies, the above effect held for 1 ST displacements, but at 2 ST up was better detected than down; (4) and with Highly Familiar melodies, for out-of-key notes were better down, but in Moderately Familiar melodies in-key notes were better detected when moved up.

For response times, there was faster detection of wrong notes moved up, $F(1,43) = 4.90$, $\eta^2 = .008$, $p = .03$, and the interaction of Interval Size x Pitch Direction was significant, $F(1,43) = 6.55$, $\eta^2 = .007$, $p = .01$, where that effect operated mainly for wrong notes moved 1 ST.

REFERENCES

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DISCUSSION

In general, where we found differences due to direction of the pitch change of a wrong note, alterations in the down direction were more easily detected than those in the up direction. This agrees with the results of Neuhoff, Knight, & Wayand (2002).

For response times, there appears to be something like a speed-accuracy trade-off, with responses to the less well detected up alterations faster than for the down, and that especially for the 1 ST alterations.