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The Effect of Tonal Context on Short-Term Memory for Pitch

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ABSTRACT

Background and Aims

This paper presents an experimental investigation into how the tonal interpretation of a pitch affects its retention in short-term memory. The hypothesis that a clear tonal context facilitates the retention of pitches over longer time-spans as compared to tonally ambiguous or atonal contexts has been examined before in previous work (Cuddy, Cohen, & Mewhort, 1981; Cuddy, Cohen, & Miller, 1979; Dewar, Cuddy, & Mewhort, 1977; Krumhansl, 1979). We present two experiments that aim to partly replicate previous findings while controlling for additional parameters. In contrast to the conclusions drawn from previous experiments, we postulate that it is impossible to conclude that tonal context aids pitch memory because subjects are in actuality responding to the tonal fitness of a probe tone, as described by Krumhansl and Kessler (1982), and are not actually executing a pitch recall task.

As in the case of Krumhansl's (1979) studies, we use Deutsch's (1972) experimental paradigm for our experiment. The task involves comparing a probe tone to a target that is separated by interference tones. We experimentally manipulated the degree of tonality of the interference tones and the scale degrees of the target and probe, while fixing factors such as the time interval between target and probe, and the overall pitch register. Beyond experimental design considerations, the way we analyse and interpret our data is significantly different from prior work.

Method

A preliminary study (Experiment 1) was conducted to provide a quantitative measure of a pitch sequence's degree of tonality. The stimuli were 60 seven-note melodic sequences representing candidate stimuli to be used in the main pitch memory experiment. These stimuli conformed to Deutsch's specifications (same inter-onset intervals between notes, no pitch repetitions), and only excluded a final comparison tone that was to be added later in Experiment 2. Moreover, each sequence was specifically designed to sound either very tonal, or tonally ambiguous, or atonal.

Thirty-four musically trained subjects, were asked to rate (1) how tonal each sequence sounded as a whole, (2) how tonal the first half of the sequence sounded, and (3) how tonal the second half sounded. Subjects responded to each question by selecting a value ranging from 1 to 5, where "1 = not tonal, 5 = clearly tonal."

These sequences were then used in the main pitch memory experiment (Experiment 2), in which the first pitch of each sequence was considered the target tone. For each sequence, three possible stimuli were created, each with a different appended comparison tones: one identical to the target, one a semitone above the target, and one a semitone below the target. Subjects were asked to indicate whether the comparison tone and target tone were the same or different. Each stimulus was presented twice over the course of the experiment. The 48 participants were a different population from Experiment 1; mean number of years of training on a primary instrument was 9.9 (SD = 5.5) and overall self-ranked musical training level was 3.4 out of 5 (SD = 1.1).

Results

Based on the tonality ratings from Experiment 1, each trial was put in one of four tonality categories. The "Most Tonal" group consisted of all trials containing sequences that had an average overall tonality rating of 4.0 or higher (9 sequences), "Mid Tonal" consisted of sequences with tonality ratings between 3.5 and 3.9 (26 sequences), "Low Tonal" consisted of sequences with ratings between 3.0 and 3.4 (17 sequences), and "Atonal" consisted of sequences rated 3.0 or lower (8 sequences). Logistic regression was performed on each of these groups with average melodic interval size, overall mean tonality rating, first half tonality rating, second half tonality rating, and Krumhansl-Kessler key-profile (KK-profile) values of both the target and comparison tones as predictors.

The regression results were highly similar for the three tonal groups: the only significant predictor of task accuracy was the KK-profile value of the comparison tone. The results for the Atonal sequences were significantly different from the other groups; the primary predictor in this case was the overall tonality rating followed by the KK-profile values of the target tone (positive association) and comparison tone (negative association). However, given the lack of clear tonal contexts, the KK-profile values in the Atonal case arguably make little sense as predictors; these values were calculated with respect to the KK-profile of the key that correlated the highest with the pitches in the sequence preceding the comparison tone, and those correlations were quite low for the most part.

Conclusions

The results of this study indicate that the strong correlation between tonal contexts and accuracy in pitch memory tasks are misleading. As in previous studies, there was a strong correlation between the response accuracy—percent correct for all stimuli containing the same context sequences—in the data discussed here and the overall tonality ratings for those sequences, r (Pearson's) = .68, $p < 0.001$, df = 58. However, further analysis reveals that the primary predictor of task accuracy was the KK-profile value of the comparison tone. It is of course the case that using KK-profile values as predictors assumes some minimally tonal context to begin with, but a closer look at stimuli with strong tonal ratings but large error rates (i.e., cases where the comparison tones are different from the target but fit well in the tonal context) shows that this confound is particularly acute when the fitness value of the incorrect comparison pitch is very high. Future experimental designs must address this problem in order to identify the

precise mental representations and mechanisms through which tonal context may indeed aid pitch memory recall.

Keywords

Pitch perception, short-term memory, tonality.

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