Latent absolute pitch: An ordinary ability?

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ABSTRACT

1. Background
Absolute pitch (AP) is the ability to identify pitches without a reference tone. The related phenomenon of (passive) “absolute tonality” (e.g., Terhardt & Seewann, 1983; Schellenberg & Trehub, 2003) is the ability to discriminate between the original key of a musical piece and exact transpositions of it. Absolute tonality seems to be more widespread than traditionally assumed. Generally, all-or-none models of absolute pitch are increasingly being replaced by a continuum view.

2. Aims
With a new design, Vitouch & Gaugusch (2000) found that high school students (amateur musicians) without AP were significantly able to distinguish an original piece from even a one-semitone transposition. The aim of the present study was an independent, modified and extended replication of this finding.

3. Method
Eighty-three high school students (41 with active piano experience), all non-possessors of AP, listened to the beginning of Beethoven’s “Für Elise”. The piece was presented via headphones on 14 consecutive days (one trial per day), either in the original key (A minor) or as a “digital twin” in Ab minor, in a double-blind design. Pieces were identical except for pitch (MIDI transposition). Subjects had to judge if they heard the original key or not. The 24-hours inter-trial interval served as a rigorous method of memory interference.

4. Results
Students with and without piano playing experience showed significant, and significantly different, recognition scores of 67% (M = 9.3 out of 14, SD = 1.95; effect size delta = 1.2) and 59% (M = 8.2, SD = 2.2; delta = 0.6), respectively. Results were highly convergent with the findings of Vitouch & Gaugusch (2000), with correspondence even at the group-specific effect size level.

5. Conclusions
Our findings are in line with the results of Schellenberg & Trehub (2003). They lend strong support to the view that latent forms of AP are widespread, at least among amateur musicians, and that the rudimentary ability of absolute tonality is modulated by (early?) music experience.

Keywords
Absolute pitch, absolute tonality, key recognition, pitch perception, memory for pitch

INTRODUCTION
Subjects with absolute pitch are able to identify and label isolated pitches (e.g. “c”). In the literature this special performance is given a 1 : 10,000 probability of incidence among non-musicians (Bachem, 1955; Takeuchi & Hulse, 1993; Chin, 2003; Vitouch, 2005). Despite of a long research tradition, issues of genesis and learnability are still unsolved.

Other than normal people and professional or amateur musicians, AP listeners seem to pay less attention to tone height, chords, and intervals but rather to the so-called tone chroma or tone quality which is a special sound characteristic common in all pitches with the same label (e.g. “c”). Thus, for AP listeners the discrimination between the tones “c” and “d” seems less difficult than between “c” and “c1” (one octave above). In research, apart from these typical and therefore largely ignored octave errors, there typically is an error tolerance of one semitone (cf. Abraham, 1901). Due to its supposed rarity, absolute pitch in this perfect form was hypothesized to be an innate ability (Stumpf, 1883). With Meyer’s (1899) impressive study regarding a possible learnability of absolute pitch an intensive debate was initiated between geneticists and proponents of learning
theory. Finally, thanks to recent neuroscientific research (Schlaug et al., 1995a, 1995b, 2001; Preis et al., 1999; Keenan et al., 2001; Ohnishi et al., 2001) the formerly strict borders between the opposed groups are increasingly replaced by mutual concessions.

Despite many typologies regarding assumed subtypes, various grades of accuracy, and potential learnability, impressionistic identification and production abilities remain which cannot be wholly explained by the criteria of absolute pitch or possible related subtypes. One such phenomenon is the so-called (passive) absolute tonality (cf. Vitouch, 2005) denoting the discrimination between a musical composition in the original key and exact transpositions of it (Terhardt & Ward, 1982; Terhardt & Seewann, 1983; Schellenberg & Trehub, 2003).

Based on Terhardt & Seewann (1983), Vitouch & Gaugusch (2000) tested 52 subjects without AP (31 persons with piano experience) using the prelude in C-major from Johann Sebastian Bach’s Well-Tempered Clavier. In a random sequence on 14 consecutive days the composition was presented 7 times each either in the original key (C major) or digitally transposed to C-sharp major. The 24-hours inter-stimulus interval (ISI) served as a rigorous short-term memory interference condition. The presentation in C major and C-sharp major was used to assure the minimal difference in pitch (one semitone) and the maximal difference in tone quality (key-distance effect, cf. Bartlett & Dowling, 1980; Takeuchi & Hulse, 1992; Takeuchi, 1994; van Egmond & Povel, 1994). The results demonstrated significant recognition scores of 59% for the whole sample ($M = 8.2; SD = 1.8$; effect size Cohen’s $d = 0.7$) and of 62% for the group of pianists ($M = 8.68; SD = 1.49; d = 1.13$).

The current research project represents a methodologically re-designed and extended replication study.

**METHOD**

Based on Vitouch & Gaugusch (2000) the following parts of the study design were positively revised:

- Double-blind design
- Usage of a composition which is not in the familiar key of C major
- Balanced sample sizes of pianists and non-pianists

For the purpose of good comparability, another well-known piano composition, Ludwig van Beethoven’s *For Elise* (WoO59), was selected as the musical stimulus. The participants only heard the beginning of the musical piece which was 37 seconds in length. By means of digital MIDI transposition, the piece, which originally is in A minor, was transposed to A-flat minor, creating a “digital twin” only differing in pitch. Thus, in this study there again was a minimal difference in pitch together with a maximal key-distance effect.

At the beginning of the study the ideal sample size of 88 subjects was calculated by means of a power analysis (Erdfelder, Faul, & Buchner, 1996) to guarantee a power of 0.75 at the effect size of Cohen’s $d = 0.5$.

Actually, 83 students (57 female, 26 male) at two Carinthian high schools with a mean age of $M = 16.5$ years could be recruited for participation (motivationally supported by a lottery game for participants). At the beginning of the study, musical experience (singing or instrumental lessons) and music activities (choir, ensembles) were assessed by means of a questionnaire. Among all participants there were 41 persons with and 42 without piano playing experience as well as 16 non-musicians, i.e., persons without any relevant musical knowledge. The participants had an average musical experiences of $M = 7.1$ years, with a range of 0-21 years. The “musicians” and “pianists” had started with their musical education at a mean age of $M = 8.1$ and $M = 8.9$ years, respectively.

In order to guarantee the subjects’ maximal attention, the stimulus was presented in an isolated test atmosphere via portable CD player and closed headphones. In both schools, small and separated rooms were used for testing.

In a random sequence, which was identical for all subjects and created by a third independent person, the students heard the musical piece *For Elise* on 14 consecutive days 7 times each in the original key (A minor) and in the form of an exact digital MIDI transposition (A-flat minor). Just as in Vitouch & Gaugusch (2000) a 24-hours ISI was used to achieve reliable working memory decay.

After each presentation the subjects had to write down their subjective certainty of decision on the response sheet (1 = absolutely confident, 5 = very insecure). Furthermore, they were free to give a written explanation of their decision strategy used in this particular trial.

**RESULTS**

Data analysis was conducted by means SPSS (v12.0). The sample of $N = 83$ subjects demonstrated a recognition performance of 63% ($M = 8.8; SD = 2.12$; effect size Cohen’s $d = 0.83$), which with $t \left(82\right) = 7.55, p = .000 < 0.05$ was significantly above chance level ($7$ correct judgments or $50\%$). In the subgroups of 41 pianists ($67\%; M = 9.3; SD = 1.95; p = .000 < 0.05; d = 1.2$) and 42 non-pianists ($59\%; M = 8.2; SD = 2.2; p = .001 < 0.05; d = 0.6$) we found significant, and significantly different, recognition scores [between-groups $t \left(81\right) = 2.44; p = .017 < 0.05$]. The subgroup of 16 non-musicians showed performance at chance level ($M = 7.2; SD = 2.0; p = .718 > 0.05$).

A significant correlation (Pearson) was evident between the musical experience in years and the recognition score ($r = .243, p = .013$), but there were no substantial correlations regarding the onset of musical education, i.e. the age subjects had started with their music or instrumental lessons ($r = .09, p = 0.28$). Comparing the first (trial 1) with the last trial (trial 14), a significant learning effect was revealed [$t \left(82\right) = 3.37; p = .001 < 0.05$].
The results are highly convergent with the findings of Vitouch & Gaugusch (2000), with correspondence even at the group-specific effect size level. In the pooled sample of 135 subjects (Figure 1), the difference in the recognition performance of pianists ($M = 9.0$ or 64% hits, $SD = 3.2$; Cohens $d = 0.6$) and non-pianists ($M = 8.0$ or 57% hits, $SD = 4.5$; Cohens $d = 0.2$) becomes strongly evident ($t(133) = 3.19$, $p < .002$).

CONCLUSIONS
In both studies (Vitouch & Gaugusch, 2000, and the current sample and design), the tested 135 subjects showed a remarkable recognition performance, which is striking in consideration of the fact that the musical stimuli (original key vs. exact transposition) differed by just one semitone (C major vs. C-sharp major and A minor vs. A-flat minor, respectively). This indeed speaks for “latent absolute pitch” performance similar to what Schellenberg & Trehub (2003) found, and for “absolute tonality” being a phenomenon with AP-like properties at least at the objective performance level.

Between-groups differences in recognition scores (pianists, non-pianists and non-musicians) are supposed to depend on the musical background, which presumably allowed “musicians” to develop and adopt specific listening strategies in order to manage the task. However, the design and the technical properties of the setup grant that such strategies can only exploit pitch information. This leads to the interpretation of absolute key recognition being a latent form of AP modulated by (early?) musical experience.

The non-significant performance of the non-musicians cannot be properly interpreted due to the small sample size ($n = 16$), and therefore leaves the question open if there really is no absolute key recognition or absolute tonality in people without musical experience. Alternatively, their poor recognition scores may be a result of the used musical material, as non-musicians presumably show less interest in classical music compared to musicians and pianists. This question remains to be clarified in a fair comparison with more popular stimuli, such as well-known pop songs (Levitin, 1994) or TV jingles (Schröger, Kaernbach, & Schönewiesner, 2002; Schellenberg & Trehub, 2003).

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REFERENCES


