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Technical Note

Pitch discrimination abilities in classical Arab-music listeners

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ABSTRACT

The current experiment examined pitch discrimination thresholds in listeners of classical Arab music, and listeners of Western popular music. Classical Arab music is characterized by modes (“Maqamat”, plural of “Maqam” in Arabic language) of which the smallest interval is a quarter tone. In contrast, the smallest interval in Western music is a semitone. We hypothesized that daily exposure to a musical style involving minuscule pitch differences may have a positive effect on pitch discrimination abilities. Results demonstrate superior pitch discrimination abilities in the classical Arab music listeners. These results indicate that musical cultures may differ in their influence on perceptual abilities, depending on their basic acoustic characteristics.

1. Introduction

Ethnic musical styles may vary in many parameters, such as rhythmic patterns and characteristic timbre (i.e., musical instruments and their typical combinations). One of the central identifiers of musical cultures is the method according to which the octave is divided into smaller intervals. The resulting tones are the nucleus of the musical culture. From this nucleus, melodies and harmonies are constructed [14]. In Western music, for example, the octave is divided into 12 intervals (termed *semitones*). In contrast, in Arab music (excluding Northern African music), the tones forming the musical language result from dividing the octave into 24 quarter tones [4,26,27]. Western music is based on scales and modes consisting of 7 tones separated by intervals which are multiplications of semitones. Arab music is also based on a scale system called “maqam” [44]. The maqamat (plural of “maqam”) consist of a great variety of intervals between adjacent notes [6,8,21,27,42,45]. These intervals include multiples of semitones, as well as quarter tones and microtones (intervals smaller than quarter tones), such as in the *Rast*, *Bayat*, *Sikah*, *Saba*, *SikahBaladi* maqamat. Furthermore, melodic progressions in Arab music are normally successive and stepwise in nature [20]; Scott Lloyd [29,33,35]. Therefore, they are characterized by the same intervals as in the maqam.

Exposure to western musical culture has induced major modifications on popular Arab music [1,2,15]. In popular Arab music, some western instruments, such as the synthesizer, electric guitar, drums, are added or replace authentic Arab instruments, such as the “nay”, “oud”, and “riqq” [15,38]. Generally speaking, in Arab popular music the rhythmic-melodic and textual structure is less sophisticated and complicated than in Arab classical music (which has other different names such as: *art*/*traditional*/*genuine music*) [2]. In the vast majority of cases, popular Arab music utilizes simple, short and binary rhythmic patterns (2/4; 4/4), and maqamat with “western character”, which have no quarter tones and microtones [10,44], such as *Nahawand* (minor); *Ajam* (major); and *Kurd* (Phregyan). In contrast, classical Arab music utilizes much longer and sophisticated rhythmic modes (*mawazin*), and m*aqamat* which include quarter tones and micro tones, for example: *Rast*, *Bayat*, *Saba*, *Huzam* etc. [2,5,10,27,28,37].

Israel is an interesting example for a multi-culture society, characterized by a diversity of musical styles [18]. One of the most striking contrasts exists between the Western musical tradition, characterizing most of the European Jewish descendants, and the Arab classical-music culture, characterizing some of the Palestinian Arabs living in the State of Israel. Hence, these distinct populations differ in their exposure to miniscule pitch differences. While Classical Arab-music listeners are exposed to musical intervals smaller

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than semitones from a very early age (through different mass media, cantillation of the Qur'an and eastern church music, and various types of social-musical events), the Jewish population in Israel is usually exposed to Western-Music intervals, of which the smallest interval is a semitone. It is possible that these differences in acoustic surroundings have induced differentiated auditory perceptual abilities in these distinct populations.

This conjecture is supported by the results of prior studies, indicating that musicians possess superior pitch discrimination abilities, compared with the general population [9,22,40]. Furthermore, classical musicians perform better than Rock musicians [22], showing a linkage between musical-style of preference and pitch discrimination abilities.

Based on this evidence, the current study examined whether a similar effect can be observed in Arab-music listeners, who, through the exposure to smaller pitch differences than Western-music listeners, may have developed superior pitch discrimination abilities.

In order to examine this hypothesis, the current study examined pitch discrimination abilities in two groups of participants: a Western music group which included Israeli Jews whose preferred musical style is Western popular music, and a group of Israeli Palestinian Arabs, whose preferred musical style is classical Arab music. These participants were chosen after careful selection (employing a detailed questionnaire), meant to ensure that their preferred musical style is indeed classical (in contrast to "popular").

2. Method

2.1. Participants

Two groups of 15 participants each took part in the experiment. All participants underwent hearing screening at 0.5–4 kHz and demonstrated bilateral pure-tone air-conduction thresholds within normal limits (<15 dBHL) [3]. No participant had more than 1 year of experience in playing a musical instrument, nor previous experience in psychoacoustic testing. All participants signed a consent form prior to the beginning of the experiment. The first group (8 men and 7 women, native Arabic speakers), 22–29 years of age (M = 24.2, SD = 1.67) were regular listeners to classical Arab music (CAM), according to criteria described below. The second group (8 men and 7 women, native Hebrew speakers), 22–30 years of age, (M = 24.9, SD = 2.0), were listeners to western music (WM) with a stated preference for pop/rock genres. None of them listened regularly to classical Arab music, popular Arab music, nor the somewhat related "Mediterranean music."

2.1.1. Inclusion criteria for the CAM group

A detailed questionnaire in Arabic (the translated questionnaire is presented in Appendix A) was composed by an experienced musician proficient in the tradition of classical Arab music. To ensure its validity, the questions assessed the acquaintance of the participants with specific performers rather than relying on their own definition of classical Arab music. Thirty-two potential participants in the CAM group filled the questionnaire, all of them native Arabic speakers of Arab ethnicity. Out of these, 15 fulfilled the criterion of listening to classical Arab music for more than 80% of their total daily listening time. These were designated as the CAM group.

2.2. Tasks

Participants performed two psychoacoustic threshold tasks, repeating each task three times consecutively. No feedback was given, except in the training sessions. The tasks were implemented as a graphic user interface (GUI) programmed in MATLAB and involved using a mouse to press the appropriate button in the GUI. The thresholds in all tasks were obtained using a two-down, one-up adaptive staircase procedure, converging at a performance level of 70.7% [24]. The initial frequency difference between the tones was 200 Hz, with an initial step size of 40 Hz. The step size was divided by 2 after each reversal, until a final step size of 1 Hz was reached. Assessment terminated after 10 reversals with the final step size. Thresholds were calculated using the arithmetic mean of the last 8 reversals. All stimuli were 300 ms in duration, (including 25-ms rise and fall ramps) with a 500-ms inter-stimulus gap. The sound level was adjusted for each participant, according to his or her individual comfort.

All tests were preceded by a training session, in which participants had to achieve five subsequent successes in order to begin the experiment (binomial calculation yields a probability of p = .03 for obtaining five consecutive correct answers by chance). This was performed in order to ensure that participants fully understood the procedure, thus reducing the possible influence of procedural factors, related to the task. The stimuli in the training session employed a single easy-to detect frequency interval of 200 Hz between the reference tone and the test tone. The employment of a supra-threshold frequency difference in the training session was meant to ensure that the training process only clarified the operation of the task's interface and that the threshold obtained reflected primarily untrained auditory perceptual abilities. Each psychoacoustic task consisted of three threshold assessments.

The following psychoacoustic tasks were employed:

2.2.1. Two-tone discrimination task (2TDT)

Two constant frequency pure tones (PT) were presented on each trial. One of the tones was a 1-kHz PT, and the other had a larger frequency value (i.e., higher in pitch). Participants had to indicate the tone that was higher.

2.2.2. Oddball paradigm task (OPT)

A three-interval two alternative forced choice paradigm was employed. A fixed reference PT of 1 kHz was followed by two other tones, one of which was a repetition of the reference and the other was higher in pitch. Participants had to indicate which tone (second or third) was different from the reference tone.

3. Results

3.1. Descriptive statistics

Means and standard deviations are summarized in Table 1 and Fig. 1. These are presented both in Hz and log Hz. It is common practice to analyze psychoacoustic thresholds in the logarithmic domain [11,12,19,30]. This derives from the nature of pitch perception, which is logarithmic [32].

3.2. Group comparison

ANOVA-with-repeated-measures was conducted for each of the tasks (OPT and 2TDT) in which Repetition (first to third) was defined as the within-subject (repeated) factor and Group (CAM and WM) was the between-subject factor. Results are presented below, separately for each task.

3.2.1. OPT

A significant main effect was found for Repetition [$F_{(2,27)}$ = 40.174, p < 0.001]. This indicates that the gradual improvement in thresholds shown in Fig. 1 was significant. A highly