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Note

Music training and mental imagery ability

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Abstract

Neuroimaging studies have suggested that the auditory cortex is involved in music processing as well as in auditory imagery. We hypothesized that music training may be associated with improved auditory imagery ability. In this study, performance of musically trained and musically naive subjects was compared on: (1) a musical mental imagery task (in which subjects had to mentally compare pitches of notes corresponding to lyrics taken from familiar songs); (2) a non-musical auditory imagery task (in which subjects had to mentally compare the acoustic characteristics of everyday sounds); and (3) a comparable measure of visual imagery (in which subjects had to mentally compare visual forms of objects). The musically trained group did not only perform better on the musical imagery task, but also outperformed musically naive subjects on the non-musical auditory imagery task. In contrast, the two groups did not differ on the visual imagery task. This finding is discussed in relation to theoretical proposals about music processing and brain activity.

Keywords: Music; Imagery; Temporal lobes

1. Introduction

Musical mental imagery, or the ability to 'hear' melodic sound-sequences with the 'mind's ear' in the absence of external stimulation, plays an important role in musical performance [2]. Musicians often rely on musical imagery to guide their performance and to memorize or compose new music. Moreover, the ability to read written music silently is an acquired skill that often involves mental imagery. Halpern [4] devised a task aimed at measuring mental scanning in auditory imagery for songs, modeled on the visual scanning study by Kosslyn et al. [6]. Subjects were asked to mentally compare pitches of notes corresponding to lyrics taken from familiar songs (e.g. 'The Star Spangled Banner'). Results showed that reaction times increased as a function of the distance between two beats and as a function of the starting point of the earlier lyric [4], and thus provided evidence that auditory imagery is not only a strong subjective experience, but, analogous to visual imagery, can be quantified to a certain extent.

It has been suggested that music training and listening to music may have beneficial effects on other cognitive processes. For example, Rauscher et al. [12] reported that college students who listened to the first 10 min of Mozart's Sonata for Two Piano's in D Major (K.448) subsequently scored significantly higher on a spatial–temporal task than after listening to 10 min of progressive relaxation instructions or after 10 min of silence (although this effect has not always been replicated for other cognitive tasks, [15]). Indeed, evidence has also been provided that music training may improve pre-school children's spatial–temporal reasoning [14].

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The putative effects of music training on cognitive performance may not be limited to spatial–temporal tasks, however. Chan et al. [1] recently reported higher verbal but not visual memory performance in subjects with at least 6 years of music training before the age of 12 compared to a control group without music training. These authors argued that the improved verbal memory in musically trained subjects may be due to a larger planum temporale in the left hemisphere relative to the right hemisphere in musicians, as has been shown in previous MRI-studies [17]. However, there is no evidence of involvement of the planum temporale in memory processing [18] and in a recent review on structure and function of the planum temporale [18] it is concluded that 'the functional significance of asymmetrical planum temporale remains obscure' (p. 41).

A more straightforward approach would be to predict which cognitive processes may be enhanced in musically trained individuals compared to non-trained individuals by taking into account the neural structures activated in music processing. Two studies using positron emission tomography (PET) have been reported [5,20], in which basically the same auditory cortical areas (in the temporal lobes, bilateral) were activated during musical imagery and musical perception, and it has been proposed that these areas are involved in auditory imagery in general [20]. A related finding was recently reported in an fMRI-study of vivid auditory imagery associated with auditory hallucinations in patients with schizophrenia, which activated sensory auditory cortex [3]. In the present study we compared performance of subjects with and without music training on tasks of musical auditory imagery, non-musical auditory imagery and visual imagery. If music training leads to more proficient processing of mental images in auditory cortical areas, better performance of musically trained subjects on musical imagery may well extend to non-musical auditory imagery. This is not a trivial prediction, as there is evidence that music (the domain in which the training occurs) concerns a very specific type of auditory information processing and representation, that may dissociate with other types of auditory information [11]. According to our hypothesis, musically trained subjects will not perform better on a visual object imagery task compared to subjects without musical training, as visual imagery activates different cortical areas [7].

2. Method

2.1. Subjects

A total of 35 college students from Utrecht University participated in the study. Subjects were assigned to either a 'musically-trained' group (15 subjects) or a 'non-trained' group (20 subjects). Subjects in the musical group had to: (1) actively play a musical instrument at the moment of testing; and (2) have received at least 2 years of formal music training. The two groups differed significantly ($P < 0.01$) in number of years of music training (musicians 5.4; non-musicians 1.5). The two groups did not differ in terms of age (musicians 22.5 years; non-musicians group 21.1 years; $t = 1.25$) or number of years of education (musicians 16.3; non-musicians 16.0; $t = 0.49$). The male/female ratio was 6/9 in the trained group and 5/15 in the non-trained group.

2.2. Measures

2.2.1. Musical auditory imagery task

Musical imagery was assessed with a pitch comparison task (based on the task described by Halpern [4]) that consisted of a perception and an imagery condition and required subjects to compare the pitches of notes corresponding to song lyrics.

Subjects viewed the lyrics from the first phrase of a familiar Dutch song on a screen and were asked to decide whether, of two highlighted lyrics which appeared in uppercase letters, the pitch of the second lyric was higher or lower than that of the first lyric. An English-language example of a song-line would be 'OH say can you SEE', taken from the American national anthem. Lyric refers here to a monosyllabic word, or one syllable of a two-syllabic word. Subjects responded by means of a key-press and were asked to respond as fast as possible. In the perceptual condition, subjects were actually presented with the song, which was played on a tape-recorder, and thus viewed the lyrics and heard the song at the same time. The imagery condition was identical, with the exception that the song was not presented, and subjects had to rely on their musical imagery in order to be able to perform the task correctly. The task consisted of 31 trials, divided over five well-known Dutch songs. Number of correct responses and reaction times were recorded.

2.2.2. Non-musical auditory imagery task

This task was modeled on the visual imagery object comparison task developed by Mehta et al. [9], described below. The task concerned a quantitative comparison between imagery and perception of acoustic characteristics of common sounds. A triad of common sounds was presented, and subjects had to indicate the most deviant item in terms of acoustic characteristics. In the perceptual condition, the sounds were actually presented (with use of a personal computer), whereas in the imagery condition the names of the sounds were read from cards, which required subjects to form mental images in order to be able to make a correct judgement. An example of a sound triad that was presented is 'crying baby', 'laughing baby' and 'meow-