Differences in Gray Matter between Musicians and Nonmusicians

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ABSTRACT: **Voxel-based morphometry is used to examine differences in cerebral morphology between musicians and nonmusicians. Principal results show differences in gray matter concentration in the right auditory cortex.**

KEYWORDS: **auditory cortex; musicians; VBM**

INTRODUCTION

There exists a controversial literature regarding gross morphological differences in the brain structure of musicians as compared to nonmusicians. Several authors have shown changes in diverse cerebral regions associated with musical training, notably in the motor and auditory cortices (e.g., Refs. 1 and 2), but these have not always been consistent across studies. Here we present new data bearing on such differences with the use of voxel-based morphometry (VBM) of magnetic resonance images (MRIs).

METHODS

Subject groups were made up of both males and females, 51 nonmusicians and 43 musicians (10 years or more of musical experience, 22 with absolute pitch). T1 MRIs were linearly registered to the symmetric MNI152 template with a 12-parameter cost-minimization fit[3] and then RF inhomogeneity corrected[4] (FIG. 1a) and tissue classified (FIG. 1b).[5] The gray matter class was extracted and blurred using an 8-mm Gaussian kernel (FIG. 1c). Musician and nonmusician images were then contrasted and evaluated according to the general linear model and random field theory correction for multiple comparisons.[6]

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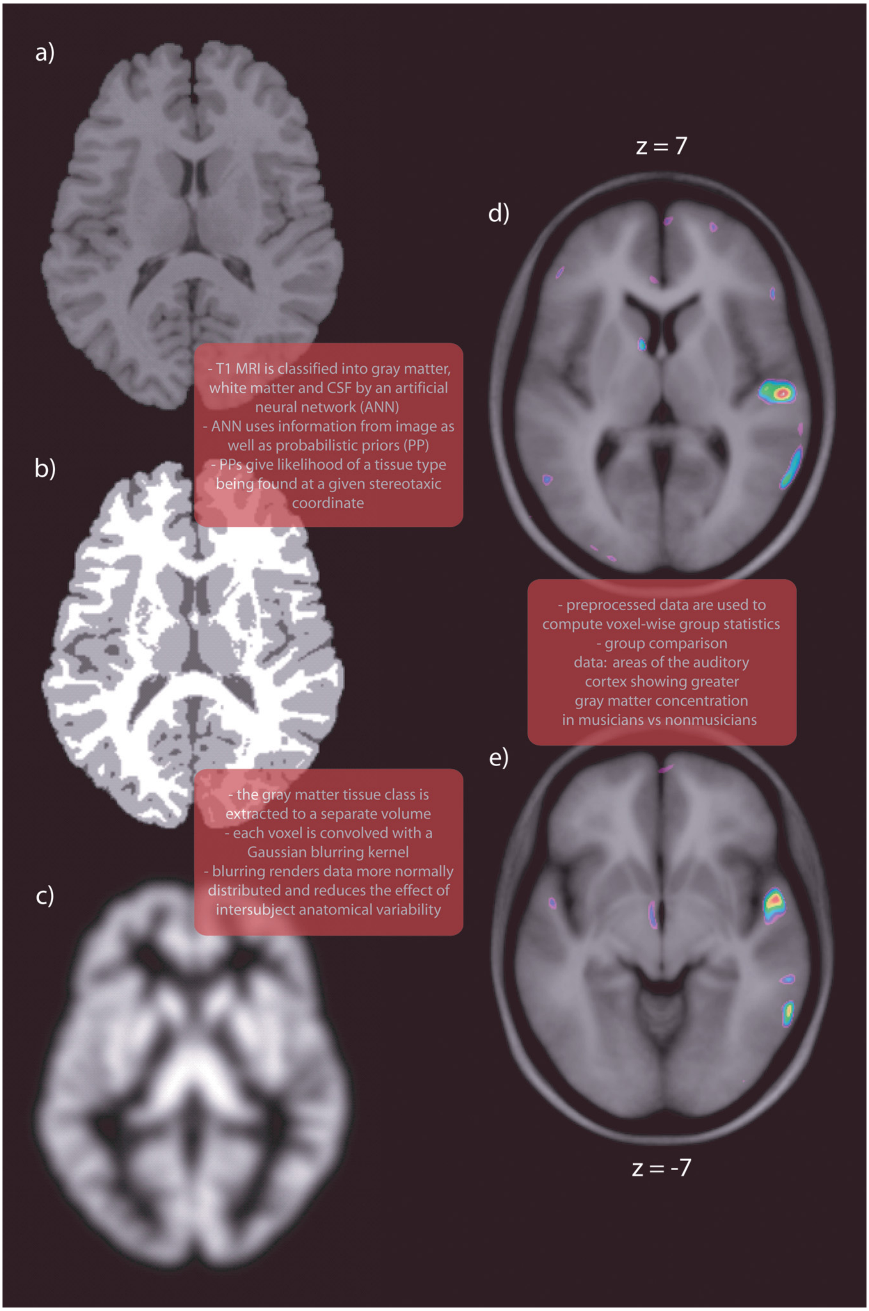

FIGURE 1. Illustration of methods and main VBM results in the right auditory cortex.

RESULTS AND DISCUSSION

The main result is a greater gray matter (GM) concentration in musicians as compared to nonmusicians in the right lateral surface of the superior temporal gyrus, posterior to Heschl's gyrus (planum temporale or caudal-lateral auditory belt cortex, FIG. 1d). A region of interest was defined using this *t*-statistic peak for the purpose of extracting GM values for each subject. A plot of these values by group (musicians with absolute pitch, musicians with relative pitch, and nonmusicians) shows that absolute pitch and relative pitch musicians did not differ from one another in GM concentration in this region, although both differed from nonmusicians (FIG. 2).

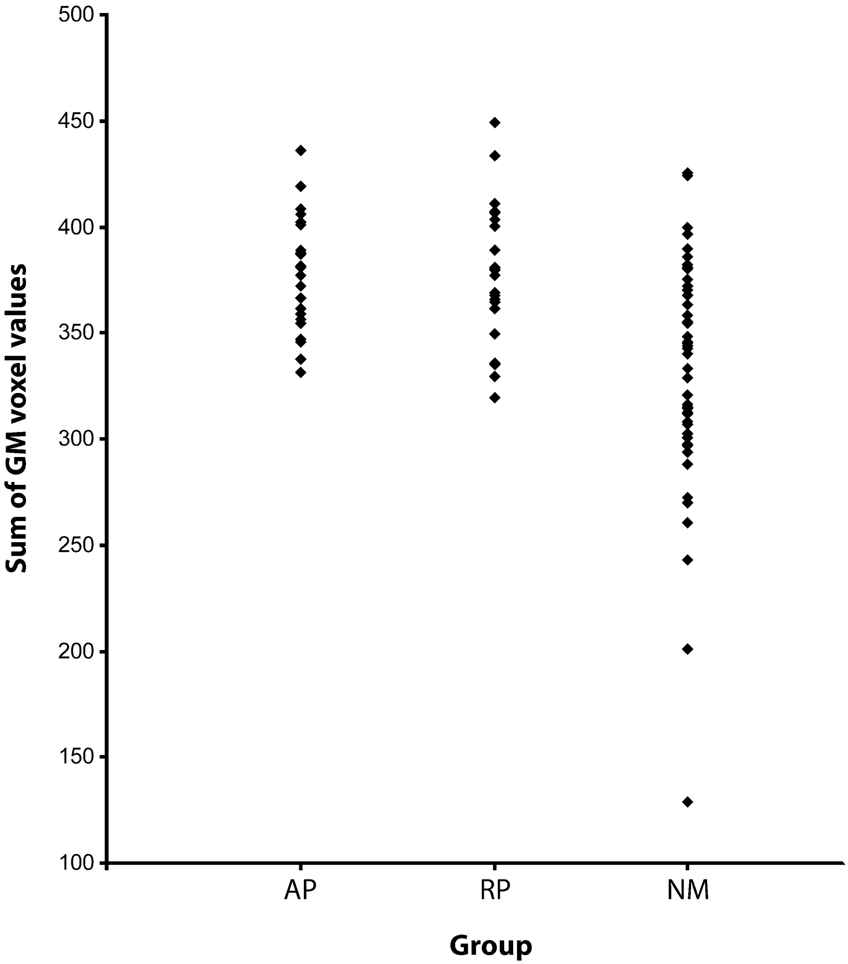

FIGURE 2. The *t*-statistic peak illustrated in FIG. 1d is used to define a region of interest from which the GM values are plotted for absolute pitch (AP), relative pitch (RP), and nonmusician (NM) subject groups separately.

Another peak of greater GM concentration in musicians lies anterior to Heschl's gyrus in the planum polare (FIG. 1e).

VBM results derived from images that are linearly transformed to a stereotaxic space concurrently communicate information about size, position, and morphology. We must therefore be cautious in our interpretation. These and adjacent areas of the superior temporal gyrus have been previously implicated in a number of functional imaging studies, as well as in older brain-lesion studies, as being important for the processing of pitch (see Ref. 7 for a review). They have also been implicated as differential morphological markers in volumetric studies using manual segmentation (e.g., Ref. 8 and 9), and neurophysiological data indicate neuronal pitch sensitivity in an analogous region of the marmoset monkey brain.[10] VBM is a data-driven technique that does not rely upon apriori definitions of anatomical circumscription and, in this way, is free from systematic errors that can arise from such definitions. Our results suggest an experience-dependent difference between musicians and nonmusicians in areas of the right hemisphere known to be important in pitch processing and that seem to preferentially subserve spectral and pitch resolution. However, this anatomical effect seems unrelated to absolute pitch, which may depend more on interactions between pitch-sensitive regions and the dorsolateral frontal cortex.[11]

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[Competing interests: The authors declare that they have no competing financial interests.]

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