Supplementary Methods

Subjects

Fifteen subjects between the ages of 23 and 33 (6 male, 9 female, mean age = 27) were recruited from the local Dartmouth community. Subjects reported no significant abnormal neurological history and all had normal or corrected-to-normal visual acuity. Subjects were paid for their participation and gave informed consent in accordance with the guidelines set by the Committee for the Protection of Human Subjects at Dartmouth College.

Materials

Prior to functional scanning, each subject listened to segments of more than 150 songs and rated each one on how familiar the song was to the subject (1-5 scale, 5=familiar). This provided a basis for identifying songs that were 'familiar' (M=4.7) and 'unknown' (M=1.1) on a subject-by-subject basis. Twenty familiar and twenty unknown songs were chosen for each subject. Half of the familiar and unknown songs chosen for each subject contained lyrics; the remaining half were instrumental songs without lyrics. Notably, any song could occur in the familiar category for one subject and the unknown category for another subject, thus controlling for stimulus differences between categories.

Unique soundtracks for each subject were prepared digitally using Audacity 1.2.1 software (http://audacity.sourceforge.net). Soundtracks were comprised of a series of one-minute song segments. Within each song segment, 2-5s snippets of music were extracted and replaced with gaps of silence (Figure S1).

As such, each song segment consisted of 45s of music and 15s of silence. Each soundtrack contained an equal number (10) of familiar songs with lyrics, unknown songs with lyrics, familiar instrumentals, and unknown instrumentals. Soundtracks were presented using an Apple iPod (Apple, Cupertino, CA). Subjects listened to the soundtracks through pneumatic headphones (ER-30, Etymotic Research) at about 90 dB SPL. All subjects reported being able to clearly discern the music from the background scanner noise. Task instructions were to fixate a centrally-presented cross-hair and passively listen to the soundtrack. Subjects were not explicitly told that the study was interested in auditory imagery. To subjects, the audio presentation of the soundtrack appeared to be choppy and cut-out at various, random gaps.

Functional imaging

Anatomical and functional whole-brain imaging was performed on a 1.5 T GE Signa Scanner (General Electric Medical Systems, Milwaukee, WS). Anatomical images were acquired using a high-resolution 3-D spoiled gradient recovery sequence (SPGR; 124 sagittal slices, TE = 6 ms, TR = 25 ms, flip angle = 25°, 1 x 1 x 1.2 mm voxels). Functional images were collected in six functional runs using a gradient spin-echo, echoplanar sequence sensitive to blood-oxygen level-dependent contrast (T2*) (20 slices per whole-brain volume, 3.75-mm in-plane resolution, 5.5-mm thickness, 1-mm skip, TR = 2000 ms, T2* evolution time = 35 ms, flip angle = 90°).

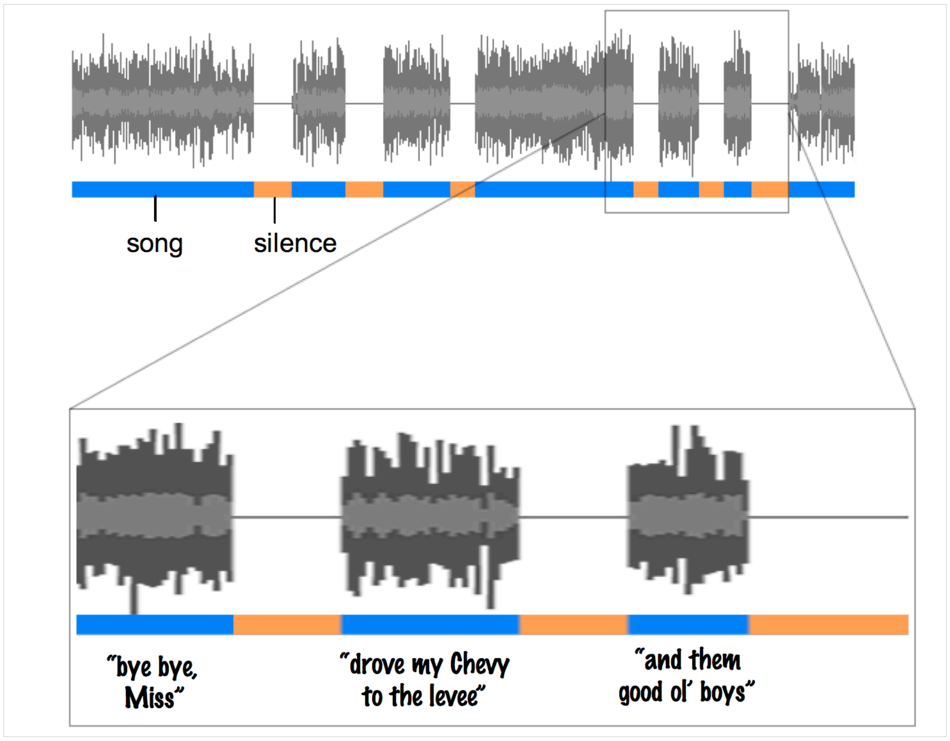

Figure S1. Sample edited segment of song with lyrics ("American Pie" by Don McLean) showing musical portions (blue) and gaps of silence (orange).

Data analysis

fMRI data were analyzed using the general linear model for event-related designs in SPM99 (Wellcome Department of Cognitive Neurology, London, UK). For each functional run, data were preprocessed to remove sources of noise and artifact. Functional data were corrected for differences in acquisition time between slices for each whole-brain volume, realigned within and across runs to correct for head movement, and coregistered with each participant's anatomical data. Functional data were then transformed into a standard anatomical space (2-mm isotropic voxels) based on the ICBM 152 brain template (Montreal Neurological Institute) which approximates Talairach and Tournoux (S1) atlas space. Normalized data were then spatially smoothed (6 mm full-width-at-half-maximum [FWHM]) using a Gaussian kernel. Analyses took place at two levels: formation of statistical images; and regional analysis of hemodynamic responses.

For each participant, a general linear model, incorporating task effects and covariates of no interest (a session mean, a linear trend, and six movement parameters derived from realignment corrections) was used to compute parameter estimates (β) and t-contrast images (containing weighted parameter estimates) for each comparison at each voxel. These individual contrast images were used in a hypothesis-driven region-of-interest analysis focusing on auditory cortex.

To quantify signal change in auditory cortex in an unbiased manner, spherical regions-of-interest (6-mm radius) were defined in primary auditory cortex (PAC) based on (S2) and in auditory association cortex (BA 22) based on (S3). For each participant, parameter estimates of signal change for gaps in familiar instrumentals, unknown instrumentals, familiar songs with lyrics, and unknown songs with lyrics were computed across all voxels within each region-of-interest and examined statistically using repeated measures ANOVA. To ensure that the findings observed during silent moments were not simply related to activation differences that were present when subjects were hearing the different types of music, a separate ANOVA was undertaken. When listening to music, activity in auditory association cortex was greater for unknown than familiar songs. Activity in PAC did not differ as function of whether the song was known or unknown (Fig S2).

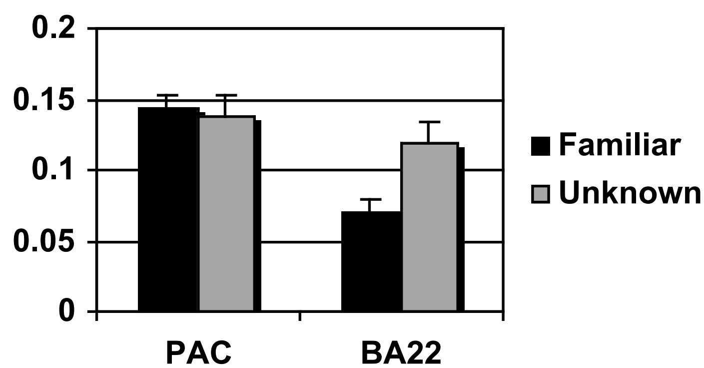

Figure S2. Signal change in PAC and auditory association cortex (BA22) while subjects listened to familiar (black) and unknown songs (gray).

While the current study focused on neural activity in auditory cortex, whole brain imaging was conducted. When gaps in familiar songs were contrasted with gaps in unknown songs, additional activity was observed bilaterally in dorsolateral prefrontal cortex (BA 9) and in the supplementary motor area.

S1. J. Talairach, P. Tournoux, *Co-Planar Stereotaxic Atlas of the Human Brain* (Thieme Medical Publishers, Inc., New York, 1988), pp. 122.

S2. J. Rademacher *et al.*, *Neuroimage* **13**, 669 (2001).

S3. M. E. Wheeler, S. E. Petersen, R. L. Buckner, *Proc Natl Acad Sci U S A* 97, 11125 (2000).