Supplemental Information
Supplemental data related to main text Results

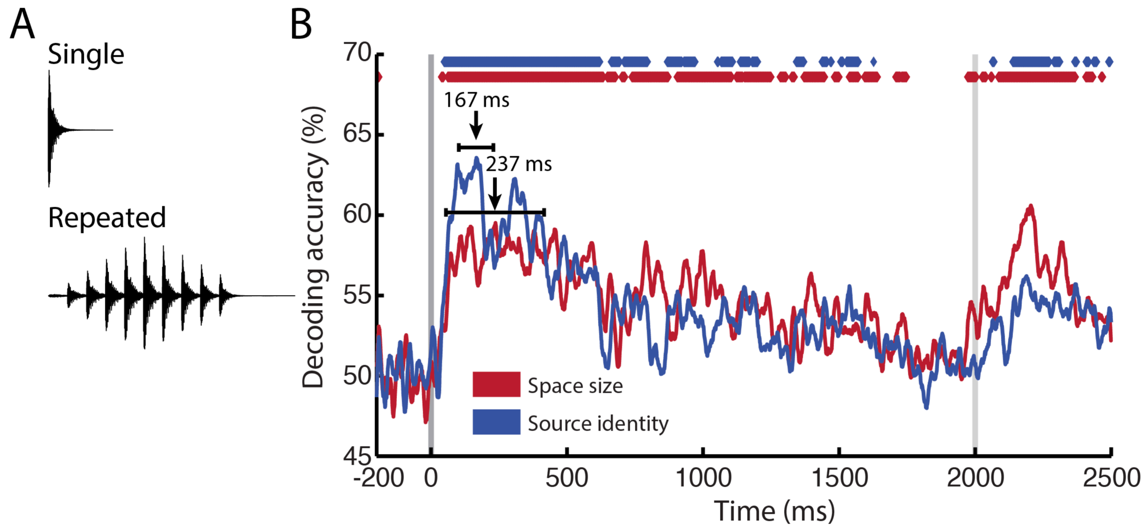

Figure S1, related to Fig. 2. Space size and sound source decoding with repetition-window stimuli. A. Representative waveforms of single and repeated stimuli. Repeated stimuli are produced by concatenation of anechoic stimuli, RIR convolution with the resulting train, and linear amplitude ramping. **B.** Decoding results showing source (blue) and space (red) decoding. Sound-source classification peaked at 167 ±64 ms, while space size classification peaked at 237 ±180 ms. Color-coded marks above time courses indicate significant time points ($p<0.05$, FDR corrected); latency error bars indicate one standard deviation computed by bootstrapping the participant pool. Gray vertical lines indicate stimulus onset and approximate offset.

Supplemental experimental procedures

To examine the temporal dynamics of space size and source identity representations at longer temporal scales exceeding single-stimulus durations, we recorded MEG data while participants (N=16) listened to stimuli comprising the same impact sounds as in the main experiment, repeated ten times at 200 ms intervals, and then convolved with the same RIRs that produced the spatial stimulus conditions for the main experiment. The 2 s waveform was then linearly ramped up for 1 s and down for 1 s to avoid strong attacks at the beginning of the stimulus (Fig. S1A). Consequently, each stimulus contained its source and spatial information distributed throughout the 2000 ms "repetition window." Figure S1B displays the results of the space size and source analysis for repetition-window stimuli. Sound-source decoding peaked at approximately 167 ± 64 ms, while space size decoding peaked at 237 ± 180 ms. Responses remained significant throughout much of the stimulus duration but peaked early on, despite the amplitude envelope peaking in the middle of the stimulus, 1000 ms post-onset. This dissociation of stimulus amplitude and MEG decoding peaks suggests that the neuromagnetic decoding signal reflects processing not simply locked to the distribution of source and space information throughout the longer stimulus.

Due to the longer stimulus duration, experimental sessions were approximately 10 min. longer than in the main experiment. The MEG time series extracted from the neural data spanned 2701 rather than 1201 time points, from -200 to +2500 ms relative to stimulus onset. All other parameters (organization of stimulus conditions, task, presentation procedure, analysis) remained the same as in the main experiment. Statistical significance was calculated via *t*-test and corrected for multiple comparisons using an FDR of 5%, as in the main experiment. Bootstrapped peak distributions were used to produce error bars in peak latencies. For peak latency calculations, we included only the time during which the stimulus was actively playing, between 0 and 2000 ms.

Supplemental analysis of stimulus properties

To determine the extent to which the MEG signal could be explained by low-level responses to stimulus properties, we generated time-frequency cochleograms from each stimulus using a Matlab-based toolbox [1] that emulates the filtering properties of the human cochlea. Each waveform was standardized to 44100 samples and passed through a gammatone filterbank (64 subbands, center frequencies 20-20,000 Hz), summing the energy within overlapping 20 ms windows in 5 ms steps (Fig. S2A). The resulting cochleograms were then correlated pairwise at each time point, with 64-element pattern vectors comprising the energy per frequency subband in each 5 ms bin. The resulting Pearson correlation coefficients were then subtracted from 1 and averaged to compute the stimulus dissimilarity measure for that time point (Fig. S2B). Repeating this analysis across time points yielded the stimulus-based dissimilarity curve (Fig. S2C). The same analysis, performed on conditions pooled by source identity and space size (analogously to the pooled decoding analysis in Fig. 2), revealed that the peak latencies of the respective source and space dissimilarity curves were significantly mismatched with the MEG decoding peaks (Fig. 2D; $p < .05$ for both source and space via bootstrapping MEG peak latencies). The disparity between MEG decoding and stimulus dissimilarity time courses suggests that the neural signal reflects processing other than the temporal structure of the stimulus.

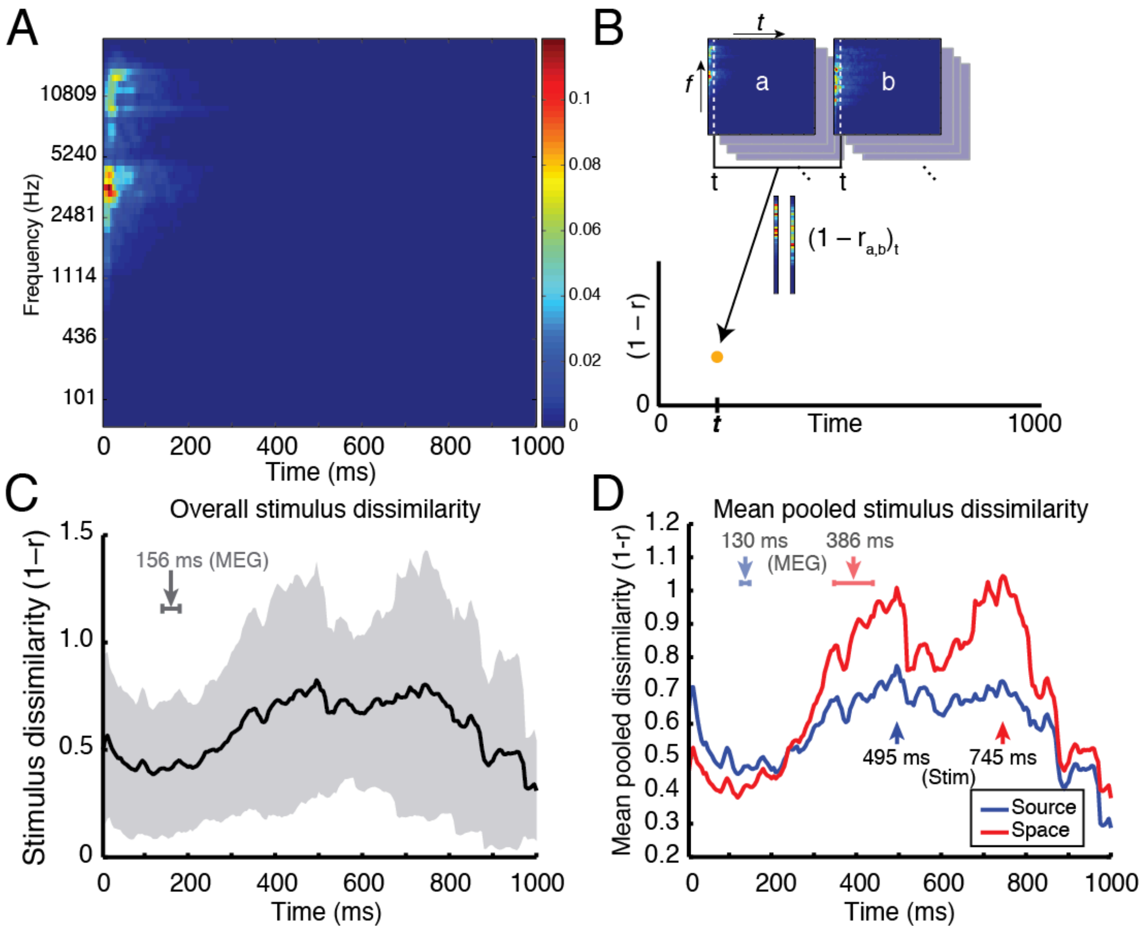

Figure S2, related to Figs. 1, 2. Stimulus dissimilarity analysis. A. Representative frequency-by-time cochleogram of one stimulus, discretized into 200 5-ms bins and 64 frequency subbands. **B.** Dissimilarity procedure: For each pair of stimuli, pattern vectors across frequency subbands were correlated at corresponding time points and subtracted from 1 (*upper panel*). The final dissimilarity value at time *t* is an average of all pairwise correlations at that time point (*lower panel*). **C.** Stimulus dissimilarity across all conditions. Peak MEG dissimilarity measure (i.e. decoding accuracy; see Fig. 1) is shown for reference. **D.** Pooled dissimilarity across space size and source identity. Pairwise correlations were performed and averaged analogously to pooled decoding analysis. MEG pooled decoding peaks for source identity and space size are shown for reference; corresponding stimulus dissimilarity peaks were significantly offset ($p < .05$ for both source identity and space size).

Sample stimuli

Sample stimuli are described here and will be made available for download.

Filename	Stimulus Condition	Sound Source	Source Description	Space Size	Space Description	Approx. Volume (m^3)	RT60 (sec)
stim1.wav	1	1	Hand pat	1	Small (kitchen)	50	.25
stim2.wav	2	1	Hand pat	2	Medium (hallway)	130	.51

stim3.wav	3	1	Hand pat	3	Large (gym)	600	.68
stim4.wav	4	2	Pole tap	1	Small (kitchen)	50	.25
stim5.wav	5	2	Pole tap	2	Medium (hallway)	130	.51
stim6.wav	6	2	Pole tap	3	Large (gym)	600	.68
stim7.wav	7	3	Ball bounce	1	Small (kitchen)	50	.25
stim8.wav	8	3	Ball bounce	2	Medium (hallway)	130	.51
stim9.wav	9	3	Ball bounce	3	Large (gym)	600	.68

Table S1. Experimental stimuli. Representative stimuli from the main experiment are labeled conditions 1–3.

Supplemental References

[1] Ellis DPW. Gammatone-like spectrograms 2009. http://www.ee.columbia.edu/~dpwe/resources/matlab/gammatonegram/ (accessed June 5, 2016).