**Text S1:** Censoring Outlier Brain Volumes

This section defines a testing procedure, first applied by Campbell et al.**45**, that identifies outliers in fMRI data that are potentially caused by abrupt head motion. The algorithm identifies and removes timepoints that are outliers in both the 6 rigid-body motion parameter estimates (MPEs), and in the fMRI data after performing motion correction. For an fMRI data matrix ***X***fmri (with dimensions *V* voxels x *T* timepoints) with a matrix of MPE time-courses ***X***mpe (6 x *T*), a robust procedure for removing spikes is defined as follows:

1. decompose ***X***fmri and ***X***mpe using PCA, and represent the data in PC space coordinates, as ***Q***fmri (with dimensions *T* x *T*) and ***Q***mpe (6 x *T*). This provides an orthonormal basis that maximizes the explained variance in the data, and greatly reduces the dimensionality of fMRI data.
2. For PC-space data-points ***q***t (1 < *t* < *T*), obtain the median coordinate vector ***q***med(t) within a 15-TR time window centered at *t* (e.g. all volumes within the ±7 TR of volume *t*). For volumes at the start (*t*<8) and end (*t*>*T*-7) of the run, this will be less than 15 time-points. Then compute the squared Euclidean distance . This measures the displacement of ***q***t away from surrounding data points; a point ***q***t with larger displacement *d*t is more likely to be an outlier. This procedure is performed for all data points in ***Q***fmri and ***Q***mpe, producing *T*x1 vectors of displacement values ***d***fmri and ***d***mpe, corresponding to timepoints in the fMRI data.
3. For each ***d***, fit a Gamma probability distribution to the data, by computing the maximum likelihood estimates of the distribution parameters. The Gamma model is used, as it forms a flexible distribution over a set of random, strictly positive variables. Then identify timepoints that are outliers at *p*<0.05, for both ***d***fmri and ***d***mpe distributions. These are labeled as motion outliers in the data.
4. Remove any outlier fMRI volumes, and replace them by interpolating voxel values from adjacent volumes, using cubic splines. This controls for potential spikes, while minimizing discontinuities in the fMRI time-courses due to removal of outliers.

This provides an adaptive, statistically-driven procedure, used to remove spikes in fMRI data.