Supplemental material (online)

	Movie Part 1		Movie Part 2	
	AN	FN(P2=>P1)	AN	FN(P1=>P2)
Number of significant correlations				
Whole brain	19776	24899	20435	25670
% increase with functional registration				
Whole brain	25.9% ± 2.4%		25.6% ± 2.8%	

Table S1. Number of cortical nodes with significant between-subject correlations ($r > 0.10$, $p < 0.01$ after correction of df for temporal autocorrelation) for time series obtained while subjects watched one-half of *Raiders of the Lost Ark* after anatomical normalization (AN) and after functional normalization based on the other half of the movie (FN(P1=>P2) and FN(P2=>P1). The change in the number of significant correlations also is shown as a percent increase.

	Movie Part 1		Movie Part 2	
	AN	FN(P2=>P1)	AN	FN(P1=>P2)
Proportion of cortical voxels with significant between-subject correlations				
Whole brain	24.2%	29.4%	25.2%	30.4%
% increase with functional registration				
Whole brain	21.5% ± 2.1%		20.6% ± 2.0%	

Table S2. Proportion of cortical voxels with significant between-subject correlations ($r > 0.10$, $p < 0.01$ after correction of df for temporal autocorrelation) of time series obtained while subjects watched one-half of *Raiders of the Lost Ark* after anatomical normalization (AN) and after functional normalization based on the other half of the movie (FN(P1=>P2) and FN(P2=>P1). The change in the proportion of voxels with significant correlations also is shown as a percent increase. Data from the warped cortical surfaces were resampled into the voxels in the original three-dimensional brain image volumes by averaging correlations for all nodes that intersected with each voxel. Cortical voxels were those that intersected with at least one node in the cortex model.

	TN	AN	FN(P2=>P1)
<u>Movie Part 2</u>			
Significant correlations	17323	20435	23041
% increase with registration		17.6% ± 8.0%	32.6% ± 3.5%

Table S3. Number of cortical nodes with significant between-subject correlations ($r > 0.10$, $p < 0.01$ after correction of df for temporal autocorrelation) for time series obtained while subjects watched the second half of *Raiders of the Lost Ark* after Talairach normalization (TN), as implemented in Freesurfer, after anatomical normalization based on cortical curvature (AN), which uses Talairach normalization as its initialization point, and after functional normalization, using the same Talairach normalization as the initialization point. As in the previous functional normalization that used the curvature-based normalization as the initialization point (Table S1), functional normalizations are fully cross-validated by applying the warp based on the second half of the movie to the time-series data from the first half of the movie (FN(P2=>P1). The change in the number of significant correlations also is shown as a percent increase for both anatomic curvature-based normalizationa and function-based normalization relative to Talairach normalization.

	Face and object perception experiment		
	AN	FN(P2=>face/obj)	FN(P1=>face/obj)
Number of significant correlations			
Whole brain	6779	8005	7925
Ventral temporal cortex	1330	1538	1539
% increase with functional registration			
Whole brain		18.1% ± 3.1%	16.9% ± 3.8%
Ventral temporal cortex		15.6% ± 1.2%	15.7% ± 2.9%

Table S3. Number of cortical nodes with significant between-subject correlations ($r > 0.10$, $p < 0.01$ after correction of df for temporal autocorrelation) for time series obtained while subjects viewed still images of faces and objects after anatomical normalization (AN) and after functional normalization based on the two parts of the movie (FN(P1=>face/obj) and FN(P2=>face/obj). The change in the number of significant correlations also is shown as a percent increase.

	Face and object perception experiment		
	AN	FN(P2=>face/obj)	FN(P1=>face/obj)
Number of significant t-tests			
Whole brain	3980	4527	4550
Ventral temporal cortex	631	838	826
% increase with functional registration			
Whole brain		13.7%	14.3 %
Ventral temporal cortex		32.8%	30.9%

Table S4. Number of cortical nodes with significant t-tests for the contrast faces versus objects ($|t| > 2.36$, $p < 0.01$) anatomical normalization (AN) and after functional normalization based on the two parts of the movie (FN(P1=>face/obj) and FN(P2=>face/obj). The change in the number of significant t-tests also is shown as a percent increase.

	Movie Part 1		Movie Part 2	
	AN	FN(F/O=>P1)	AN	FN(F/O=>P2)
Number of significant correlations				
Whole brain	19776	20936	20435	21569
Ventral temporal	2004	2210	1848	1986
% increase with functional registration				
Whole brain		5.9 ± 1.1%		5.5% ± 0.8%
Ventral temporal		10.3% ± 2.2%		10.4% ± 3.2%

Table S5. Number of cortical nodes with significant between-subject correlations ($r > 0.10$, $p < 0.01$ after correction of df for temporal autocorrelation) for time series obtained while subjects watched one-half of *Raiders of the Lost Ark* after anatomical normalization (AN) and after functional normalization based on time series from the face and object perception experiment (FN(F/O=>P1) and FN(F/O=>P2). The change in the number of significant correlations also is shown as a percent increase.

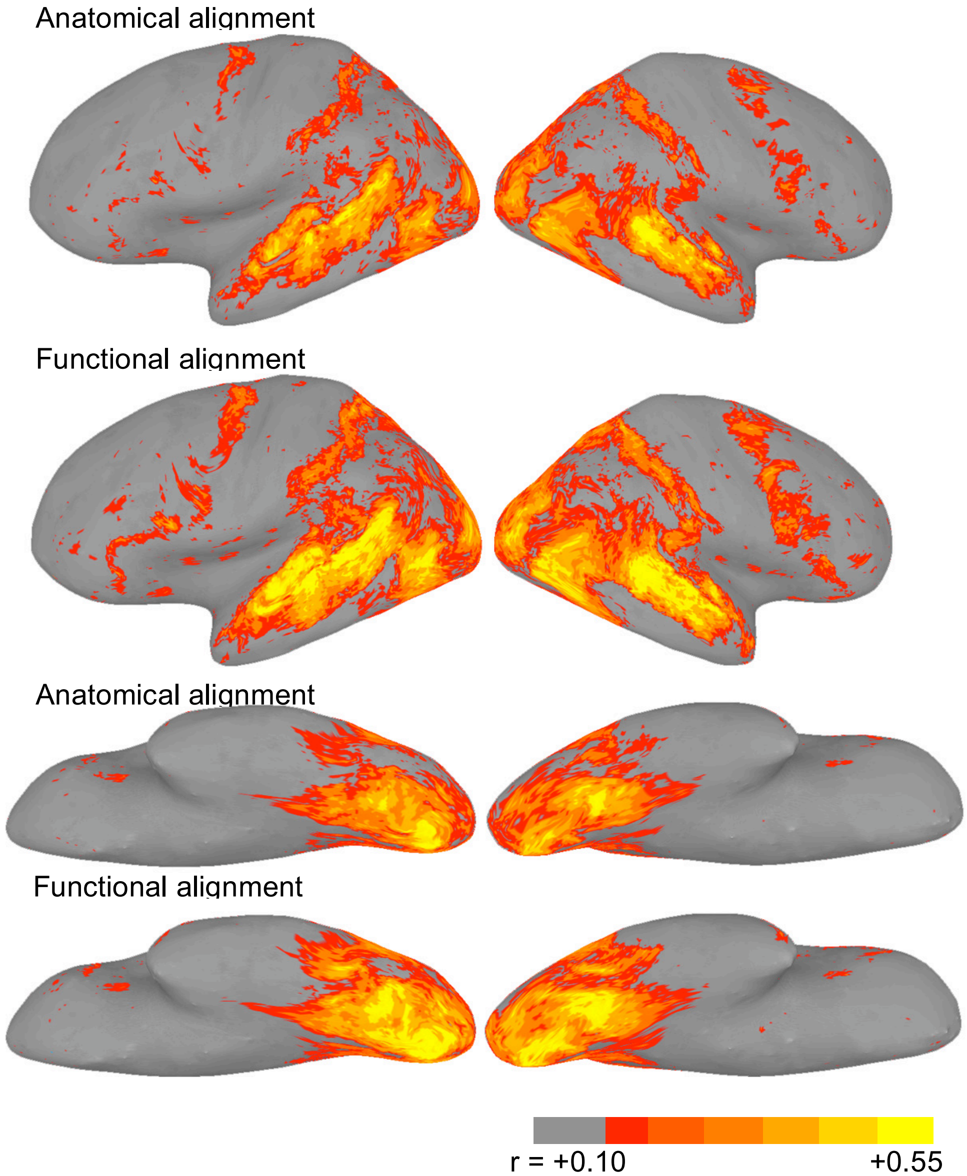

Figure S1. Generalization to the second half of the movie – lateral and ventral views. The upper images in each section show the mean correlation of each subject with the other nine subjects for corresponding nodes after anatomical cortical registration.. The lower images in each section show mean correlations after applying the warps to these nodes that maximized functional similarity in the first half of the movie (cross-validation test). Correlations less than +0.10 ($p < 0.01$) are not shown.

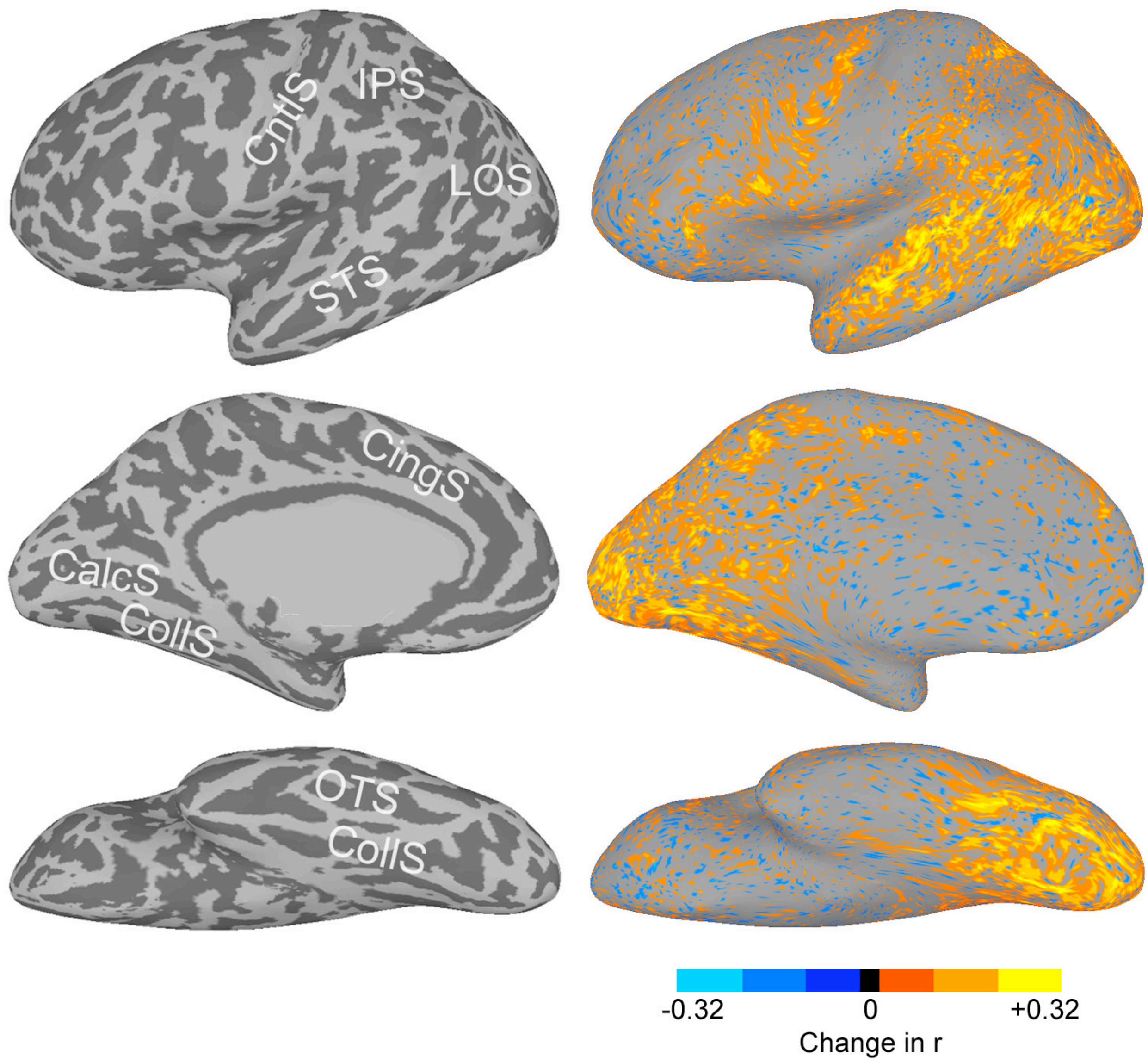

Figure S2. Plot of changes in correlation in the left hemisphere that resulted by functionally aligning the data from part 1 of the movie based on a warp derived from data from part 2 of the movie. Only changes in correlation of ±0.03 are shown in color. Note that increases in correlation are found in the same occipital, temporal, parietal, and premotor cortices that showed significant between-subject correlations after anatomical or functional alignment (Figures 2 and S1). Areas that did not show between-subject correlations, such as primary sensorimotor and prefrontal cortices also did not changes in correlation with functional alignment.

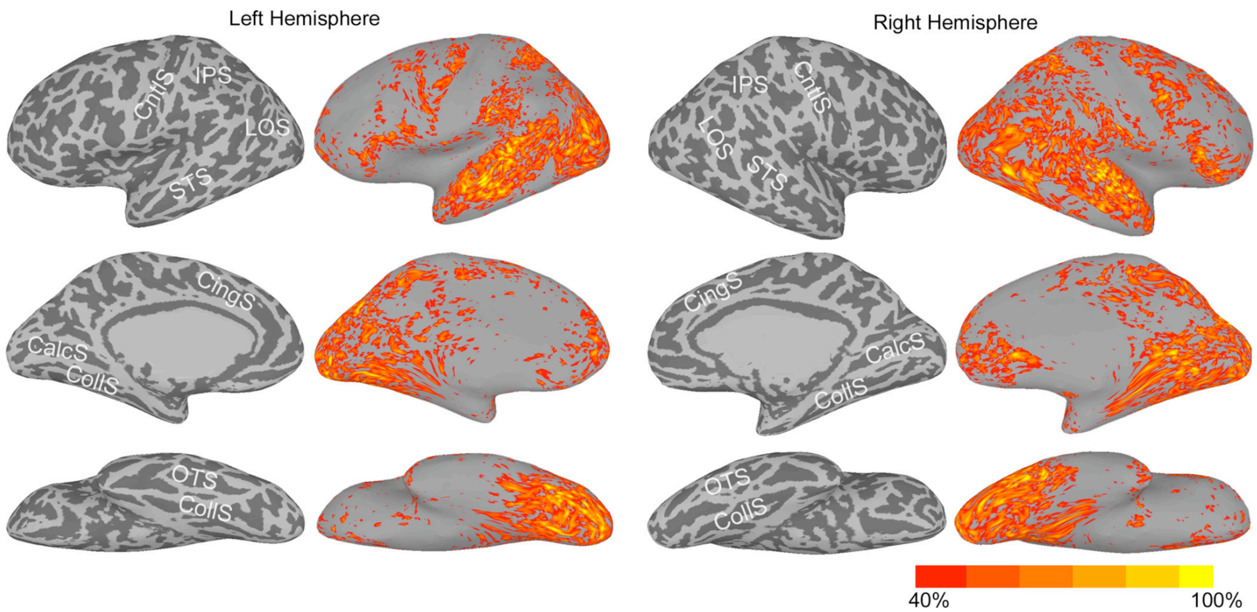

Figure S3. Mean absolute value of expansion or compression of cortex that resulted from functionally aligning data. Note that the greatest expansion and contraction is seen in the cortices that show the largest increases in between-subject correlation with functional alignment (Figures 1, S1, and S2).

S1 Energy terms

Correlation energy term

Let $\bar{s}_i^v = \bar{t}_i^v - \mu_i^v$, where μ_i^v is the mean value of the time-series. Then the alignment measure (between subjects *i* and *j)* can be written as:

$$E_c(i,j) = \sum_v \hat{r}(\bar{t}_i^v, \bar{t}_j^v) = \sum_v \frac{<\bar{s}_i^v, \bar{s}_j^v>}{|\bar{s}_i^v||\bar{s}_j^v|},$$

where $\hat{r}$ is the sample correlation, $<.,.>$ is the inner product and $|.|$ denotes the magnitude of a vector.

Folding penalty term

Let A_{uvw} denote the oriented area of the mesh triangle Δ that consists of mesh nodes *u*, *v* and *w* (*u*> *v* > *w*); $\bar{x}_j^{uv} = \bar{x}_j^v - \bar{x}_j^u$ is the vector pointing from node *u* to node *v,* and $\bar{n}_j^u = \frac{\bar{x}_j^u}{|\bar{x}_j^u|}$ is the surface normal at node *u.* Let's define the oriented area as:

$$A_j^\Delta = A_j^{uvw} = \bar{x}_j^{uv} \times \bar{x}_j^{uv} \cdot \frac{\bar{n}_j^u}{2}.$$

Let A_{j0}^Δ denote the oriented area of triangle Δ in subject *j's* regularized mesh (i.e., at time = 0). Similar to Fischl et al (1999b), we define the folding penalty term as:

$$E_f = \frac{1}{3}\sum_v \sum_{\Delta \in T_v} (A_j^\Delta - A_{j0}^\Delta)^2 I(A_j^\Delta, A_{j0}^\Delta),$$

where $I(A,B)$ is equal to 1 if both arguments are the same sign, 0 otherwise. In other words, if a mesh triangle is folded, the penalty is proportional to the difference between the current area and original area. Otherwise, it is zero. We used a folding penalty term of 30.

Metric distortion penalty term

Let $d_{vu}^{j}(t)$ denote the Euclidean distance between two mesh nodes *u* and *v* on subject *j* at iteration *t.* Note that $t = 0$ corresponds to the original regular mesh. Then the metric distortion penalty is defined as:

$$E_m = \frac{1}{2}\sum_{v}\sum_{u \in N_v}(d_{vu}^{j}(t) - d_0)^2 .$$

We used a metric distortion penalty term of 30.

S2 Renormalizing the Warps in Group-wise Registration

Let $\overline{x}_j^v$ denote the spatial location of node *v* in subject *j.* At anatomical alignment (i.e. before we run our functional registration), each node *v* has the same coordinate value $\overline{x}_0^v$. However, after each pair-wise functional registration of a subject *j* with its corresponding template, $\overline{x}_j^v$ is typically changed. Notice that one can apply a common invertible spatial transformation $\Phi(.)$ to *all* the subjects without altering the correspondence between subjects. In an effort to remove this ambiguity, we impose the additional constraint that the average spatial location across all *N* subjects at each cortical node is zero, i.e., $\frac{1}{N}\sum_{j-1}^{N}\overline{x}_j^v = \overline{x}_0^v$, for each v, where *N* is the number of subjects. An efficient, though suboptimal, method to satisfy this constraint is to subtract off the average node displacement from each subject's displacement warp after each pair-wise registration. In this framework, the spatial location of node *v* in subject *j* is modified to $\overline{x}_j^v - \overline{W}^v$, where the correction $\overline{W}^v$ is given by $\overline{W}^v = \frac{1}{N}\sum_{j=1}^{N}(\overline{x}_j^v - \overline{x}_0^v)$.