Description of fMRI preprocessing

fMRI data were first processed to minimise motion related artifacts[1]. A 3D volume consisting of the average intensity at each voxel over the whole experiment was calculated and used as a template. The 3D image volume at each time point was then realigned to this template by computing the combination of rotations (around the x y and z axes) and translations (in x y and z) that maximised the correlation between the image intensities of the volume in question and the template (rigid body registration). Following realignment, data were then smoothed using a Gaussian filter (FWHM, 7.2mm) to improve the signal to noise characteristics of the images. A FWHM of 7.2 mm was used because the voxel distributions are 3 mm. 7.2 mm thus approximates to a nearest neighbour Gaussian smoothing filter and so allows for the effects of a unit voxel displacement during normalization.

Further data analysis includes slice timing correction and the residual effects of motion are regressed out from the time series (using the estimated motion parameters) before fitting a GLM.

One subject was excluded because of non-compliance and high motion within the scanner.

Linear correlation between motion and brain activation

In order to further assess whether subtle, non-significant differences in motion could have affected the analysis, we tested whether motion parameters were correlated with any of the activation differences we observed between groups. For this purpose, we conducted a voxel-wide regression analysis of motion against brain activation (ie SSQ ratio) during the sustained attention task (8s vs 0.5s contrast), using the estimated maximum displacement motion parameters for x,y and z for each subject.

We only found two small linear correlations between brain activation and maximum displacement motion (see Supplementary Fig S6) in a cluster in the occipital lobe and in the right DLPFC. None of the clusters coincided with any of the areas found to differ between groups in either activation or age-correlation in our original analyses. Therefore, this provides further evidence that there was no significant movement-related effect underlying the group differences in either activation or age correlations.

Reference

1. Bullmore, E.T., Brammer, M. J., Rabe-Hesketh, S., Curtis, V., Morris, R. G., Williams, S. C. R., Sharma, T. and McGuire, P. K. (1999a) Methods for diagnosis and treatment of stimulus-correlated motion in generic brain activation studies using fMRI. Human Brain Mapping 7, 38-48.

TABLE S1. Subject Measures of Performance

Performance Measure	Delay (Secs)	Controls N = 44		ASD N = 46		Combined Group (Controls + ASD) N = 90	
		Mean	± SD	Mean	± SD	Mean	± SD
Mean reaction time (RT) (ms)	0.5s	285.83	± 43.83	313.99	± 80.81	300.22	± 66.56
	2s	363.11	± 36.06	406.51	± 54.98	385.29	± 51.31
	5s	357.48	± 48.14	403.70	± 65.39	381.10	± 61.82
	8s	363.11	± 53.33	409.90	± 65.21	387.02	± 63.85
Intrasubject variability (SD) of RT (ms)	0.5	60.78	± 28.26	84.05	± 42.79	72.67	± 38.05
	2s	58.35	± 25.45	77.55	± 41.79	68.16	± 35.90
	5s	47.06	± 22.20	70.41	± 35.76	58.99	± 31.98
	8s	55.01	± 26.99	70.60	± 38.20	62.98	± 33.93
Omission errors	0.5s	2.11	± 8.85	2.83	± 7.52	2.47	± 8.16
	2s	0.23	± 0.86	0.24	± 0.947	0.23	± 0.90
	5s	0.27	± 0.997	0.24	± 0.673	0.25	± 0.84
	8s	0.30	± 1.112	0.15	± 0.666	0.22	± 0.91
Premature responses	0.5s	4.66	± 12.01	11.93	± 28.02	8.37	± 21.91
	2s	3.25	± 4.35	4.61	± 5.94	3.94	± 5.24
	5s	2.93	± 4.92	4.07	± 4.73	3.51	± 4.83
	8s	3.09	± 4.49	5.63	± 11.82	4.38	± 9.05
Abbreviations: Secs: seconds; SD: standard deviation; ASD: Autism Spectrum Disorder; RT: mean reaction time; ms: milliseconds.							

TABLE S2. Subject Movement

Movement Measure (mm)	Controls N = 44 Mean ± SD		ASD N = 46 Mean ± SD	
Maximum displacement (mm)	0.20	0.196	2.12	10.06
Mimimum displacement (mm)	0.0002	0.000	0.002	0.012
Median displacement (mm)	0.028	0.020	0.05	0.10
Abbreviations: SD: standard deviation; ASD: Autism Spectrum Disorder				

FIGURE S1. Schematic representation of the Sustained Attention Task (SAT). Subjects are required to press a right-hand button as soon as they see a timer appear on the screen counting seconds. The counter appears after either predictable short delays of 0.5s in blocks of 3-5 stimuli, or after unpredictable long delays of 2s, 5s or 8s, pseudorandomly interspersed into the blocks of 0.5s delays. The long second delays have a progressively higher load on sustained attention than the short 0.5s delays that are typically anticipated and have a higher load on sensorimotor synchronisation.

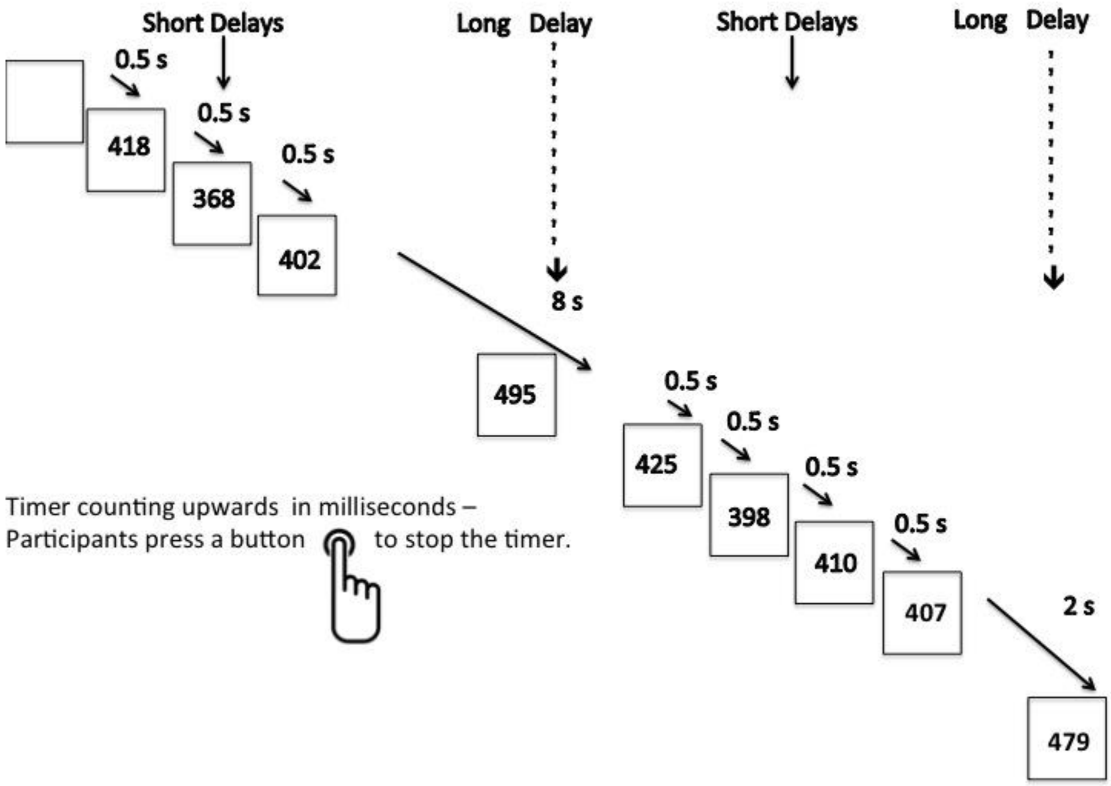


FIGURE S2. A. Horizontal sections showing brain activation within controls for each delay of 2, 5 and 8 seconds (each contrasted with the 0.5s delay). **B**. Horizontal sections showing brain activation within individuals with ASD for each delay of 2, 5 and 8 seconds (each contrasted with the 0.5s delay). Tailarach z-coordinates are indicated for slice distance (in mm) from the intercommissural line. The right hemisphere corresponds to the right side of the image.

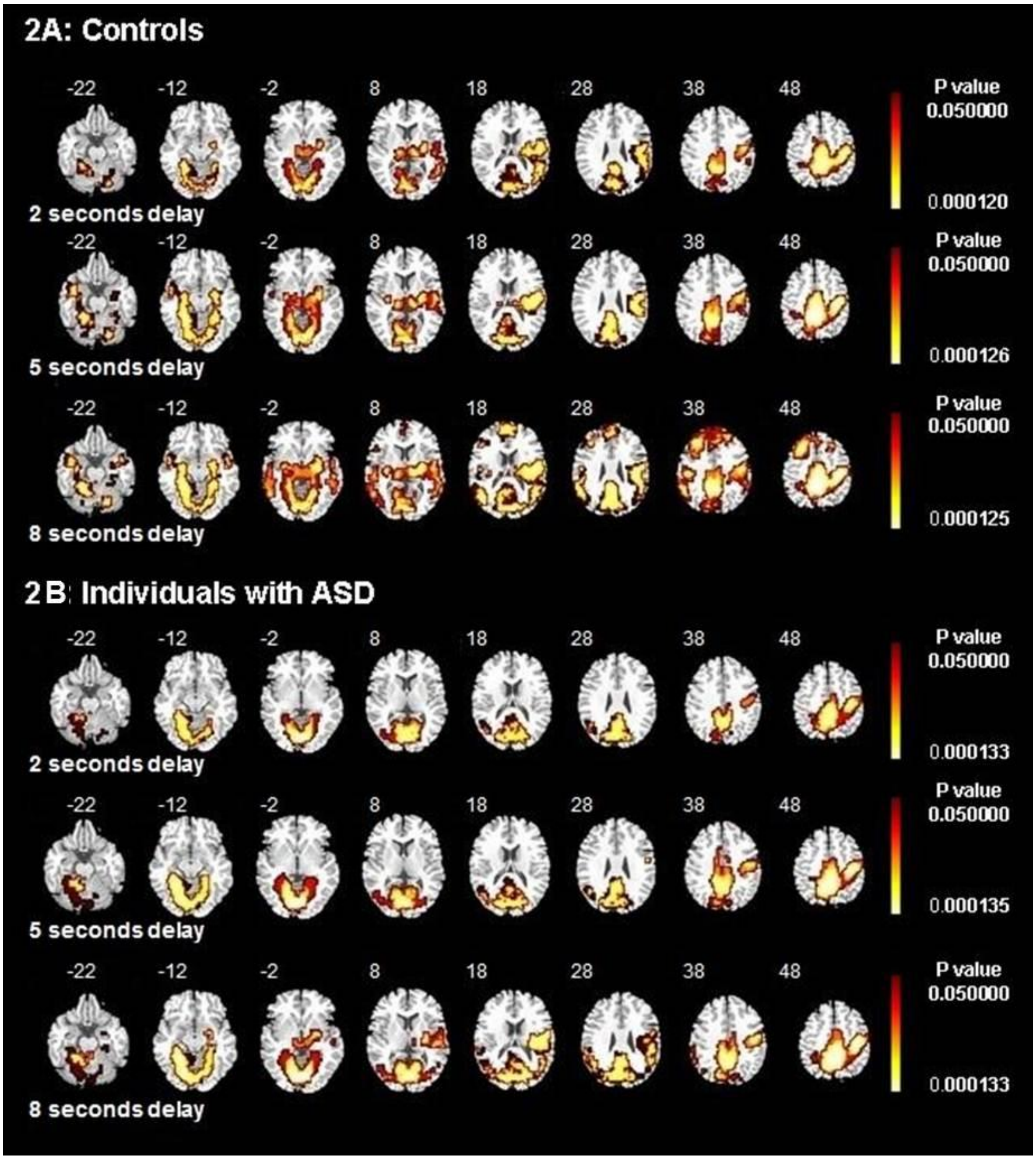
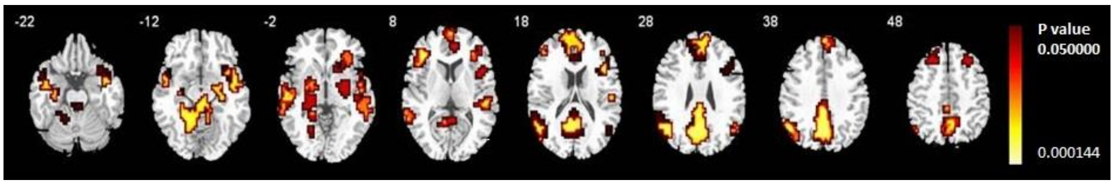


FIGURE S3. A. Horizontal sections showing whole-brain correlations between age and brain activation in controls for the 8s delay contrasted with the 0.5s delay. **B.** Horizontal sections showing whole-brain correlations between age and brain activation in individuals with ASD for the 8s delay contrasted with the 0.5s delay. Tailarach z-coordinates are indicated for slice distance (in mm) from the intercommissural line. The right hemisphere corresponds to the right side of the image.

A: Controls



B: Individuals with ASD

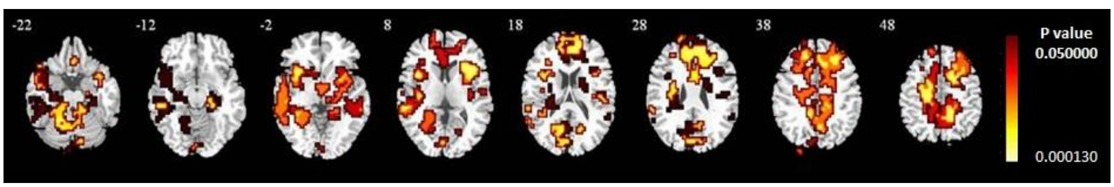


FIGURE S4. Horizontal sections showing ANOVA group differences effect in brain activation between performance-matched subgroups of typically developing controls and individuals with ASD (N = 78) in the Sustained Attention Task independent of delay (i.e. 2s, 5s, 8s, each contrasted with the 0.5s delay period). Activation clusters in yellow indicate regions where individuals with ASD had significantly reduced activation relative to controls. No areas were increased in individuals with ASD relative to controls. Tailarach z-coordinates are indicated for slice distance (in mm) from the intercommissural line. The right hemisphere corresponds to the right side of the image.

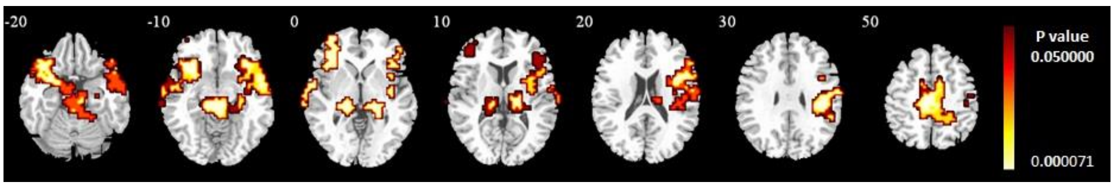


FIGURE S5. Horizontal sections showing group differences in whole brain correlations between brain activation and age for the longest delay of 8 seconds contrasted with the 0.5 second delay between performance-matched subgroups of typically developing controls and individuals with ASD (N = 78). All activation clusters shown in orange are regions where controls showed progressively increased activation with increasing age relative to individuals with ASD, who showed no age significant correlations in these regions. Tailarach z-coordinates are indicated for slice distance (in mm) from the intercommissural line. The right hemisphere corresponds to the right side of the image.

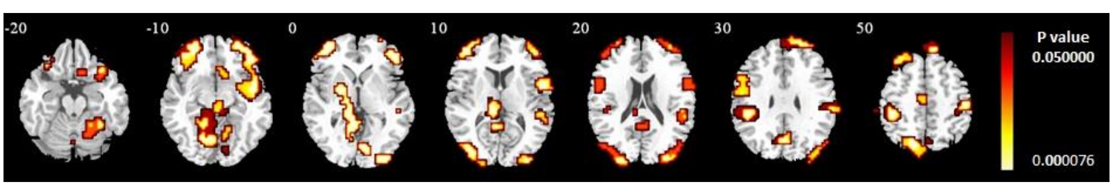


FIGURE S6. Whole brain correlations between brain activation and motion. Horizontal sections showing whole brain correlations between maximum displacement in the x,y,z dimension and brain activation for the longest delay of 8 seconds contrasted with the 0.5 second delay. All activation clusters shown in orange are regions where activation was significantly correlated with motion. Tailarach z-coordinates are indicated for slice distance (in mm) from the intercommissural line. The right hemisphere corresponds to the right side of the image.