Supplemental Figures and Tables

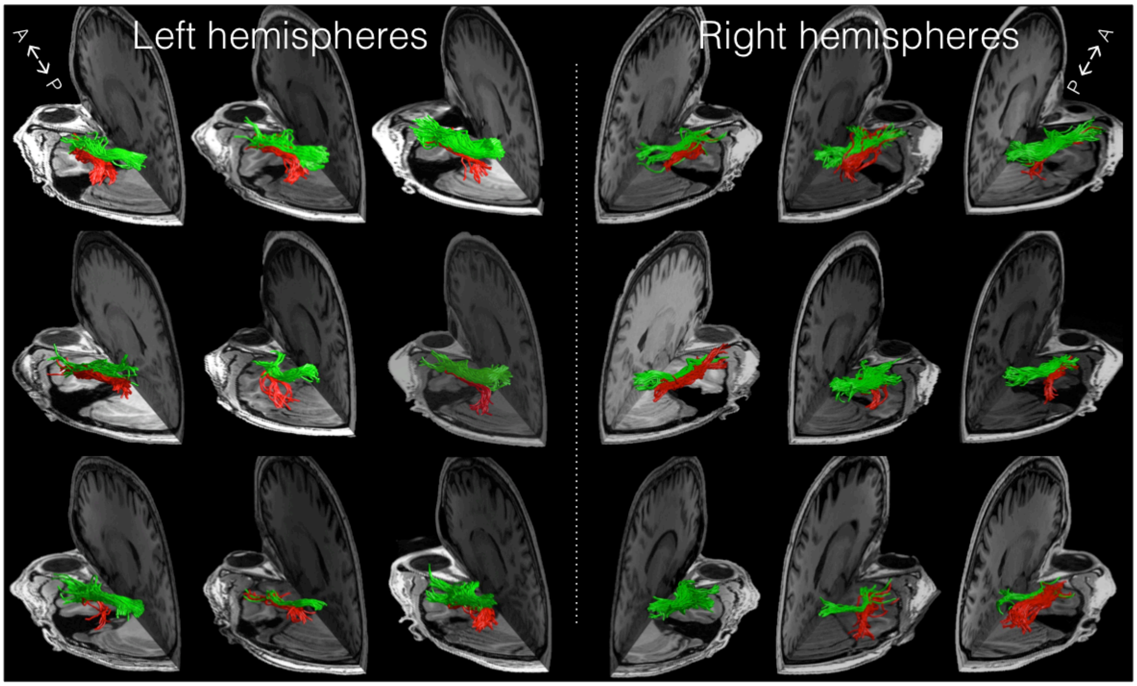

Figure S1: Functionally-defined white matter tracts mFus-fibers (red) and CoS-fibers (green) for the 9 additional typical adults scanned with an updated diffusion-weighted sequence, related to Figure 3. The left half are FDWM tracts in each subject's left hemisphere, the right half show the right hemisphere tracts. All tracts were successfully extracted in each hemisphere except for one subject whose especially deep and thin fusiform gyrus did not enable white matter voxels to be distinguished from cortex within 6mm of the center of the mFus-faces fROI in the right hemisphere.

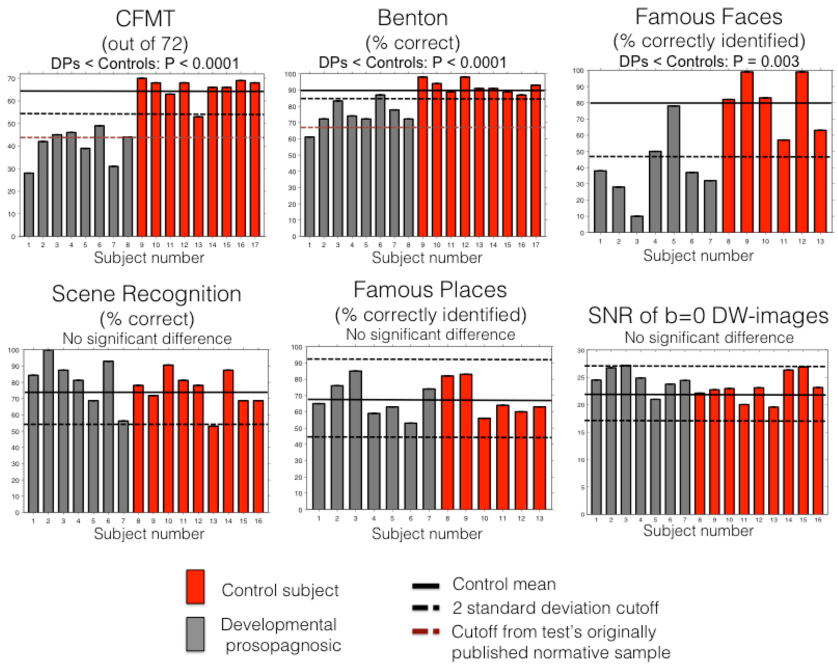

Figure S2: Behavior and signal-to-noise ratio (SNR) of typical adults and DP subjects, related to Figure 6. Scores of DP subjects (gray bars) are compared to those of typical adults (red bars), with the mean of the typical adults shown in a solid black line. Dotted black lines indicate the 2 standard deviation (STD) cut-off determined from the typical adults. In the Cambridge face memory task (CFMT), all DP scores were 2 STDs lower from the typical adults' mean and this difference is statistically significant ($t(14)=6.9$, $p<0.0001$). For comparison purposes, the red dotted line indicates the original cut-off point from Duchaine & Nakayama 2006b used to diagnose 6 adults with DP from a control population of 50 typical adults. Notably, many of our DP subjects fall below this original cut-off as well. Similarly for performance on the Benton test, many of the DP subjects were 2 STDs below the typical adult mean, and as a group scored significantly lower than typical adults ($t(14)=5.52, p<0.0001$). Many of the DPs, however, were above the Benton's cut-off definition for "severely impaired" face recognition, indicated here by the red dotted line. Duchaine & Nakayama 2006b discuss the general ability of DP adults to pass the Benton test, which is why we used the CFMT to diagnose subjects with DP, and used the Benton as a test of general face-processing ability. For scene recognition, all DP subjects were well above the 2 STD cut-off, with no significant difference between groups ($t(14)=1.5, p=0.16$). DP subjects were also impaired on a standard test of identifying famous faces ($t(11) = 3.81$, $p = 0.003$), but were similar to controls in identifying famous places ($t(11) = 0.02$, $p =0.98$). Lastly, there was no significant difference in the SNR of the non-diffusion-weighted images across subject groups ($t(14)=0.82, p=0.42$).

FDWM-Behavior Correlations

Benton

		Left CoS	Left mFus	Right CoS	Right mFus	Left ILF	Right ILF
Local WM	Typical adults	R = -0.07 P = 0.79	R = 0.27 P = 0.26	R = -0.09 P = 0.72	**R = 0.7** **P < 0.0017**	*n/a*	*n/a*
	DPs	R =-0.34 P = 0.39	R = 0.21 P = 0.61	R = -0.02 P = 0.95	R = -0.51 P = 0.21	*n/a*	*n/a*
Whole Bundle	Typical adults	R = -0.12 P = 0.63	R = 0.28 P = 0.25	R = -0.10 P = 0.53	R = 0.23 P = 0.37	R = 0.29 P = 0.24	R = 0.13 P = 0.59
	DPs	R = -0.37 P = 0.42	R = 0.17 P = 0.69	R = -0.04 P = 0.93	R = -0.08 P = 0.86	R = 0.22 P = 0.60	R = 0.02 P = 0.96

Place Recognition

		Left CoS	Left mFus	Right CoS	Right mFus	Left ILF	Right ILF
Local WM	Typical adults	**R = -0.75** **P < 0.0004**	R = -0.3 P=0.24	R=-0.37 P=0.14	R = -0.19 P = 0.41	*n/a*	*n/a*
	DPs	R = 0.1 P = 0.82	R=-0.1 P = 0.84	R=-0.3 P=0.51	R = 0.12 P = 0.79	*n/a*	*n/a*
Whole Bundle	Typical adults	**R = -0.67** **P = 0.003**	R = -0.42 P = 0.10	R = -0.65 P = 0.004	R = -0.25 P = 0.50	R = -0.49 P = 0.04	R = -0.58 P = 0.02
	DPs	R = -0.36 P = 0.24	R = -0.60 P = 0.11	R = -0.44 P = 0.32	R = -0.15 P = 0.73	R = -0.71 P = 0.07	R = -0.69 P = 0.08

Table S1: Correlations between FA values of FDWM and behavioral scores, related to Figures 5 and 7. Local WM correlations: correlation between average FA in FDWM voxels located within a 10mm expanse centered on the fROI sphere defining either mFus-fibers or CoS-fibers and %-correct scores on the Benton Facial Recognition Test, or an Old/New Scene Recognition test, respectively. Whole Bundle correlations: correlation between FA was averaged over the entire FDWM tract and the same behavioral scores. This analysis was done for the entire mFus-fibers, CoS-fibers, and the inferior longitudinal fasciculus (ILF). Significant correlations (passing a Bonferroni-corrected threshold of .05/16 = 0.003125) are bolded. Correlations were done separately across all 18 typical adults, and all 8 DP adults.

Movie S1: MFus-fibers and CoS-fibers and their spatial relationship to the ILF, related to Figures 3 and 4. This movie illustrates that mFus-fibers (red) and CoS-fibers (green) have a lateral-medial relationship, and are largely ventral to the inferior longitudinal fasciculus. While primarily parallel in nature, mFus-fibers and CoS-fibers are especially divergent in their posterior extents to one another and to the ILF. All pathways tended to converge in the anterior temporal lobe.

Supplemental Experimental Procedures

Behavioral Testing

Subjects underwent behavioral testing outside the scanner by completing the Benton Facial Recognition Test (Benton et al., 1983), an old/new scene recognition memory test (Golarai et al., 2010), and the Cambridge Face Recognition Test (Duchaine and Nakayama, 2006).

Benton Test of Face Recognition: Given previous findings linking Benton performance with the size of the FFA (Golarai et al., 2010) and the causal role of the FFA in the perception of faces (Parvizi et al., 2012), we used the Benton Test of Face Recognition (Benton et al., 1983) to assess an individual's ability to perceive face identity. Accuracy performance was defined:

$$accuracy = 100\frac{correct\ identification}{total\ number\ of\ identifications}$$

Old/New Scene Recognition Test: We used a standard old-new recognition task employing indoor and outdoor scenes, as described in a previous publication (Golarai et al., 2010). Accuracy was calculated as $accuracy = 100\frac{number\ correct\ items}{total\ number\ of\ items}$

One of the DP subjects was unable to complete the scene recognition task, and one control subject was excluded from this test due to familiarity with the stimuli. Thus, correlations between scene recognition scores and FA were performed with the remaining 7/8 DPs and 17/18 typical adult subjects. Right mFus-fibers could not be defined in one typical adult subject due to anatomical constraints (deep and thin fusiform gyrus in which white matter was partially-volumed with gray matter, **Supplementary Figure 1**). Thus correlations between FA in the right mFus-fibers and behavior used 8/8 DPs and 17/18 typical adults.

Cambridge Face Recognition Test: (Duchaine and Nakayama, 2006) was used to identify subjects with typical face recognition vs. those who had deficits. DPs scored significantly worse on this task ($P<0.001$) compared to controls (**Supplementary Figure 2**). DPs and a subset of typical adults participated in additional testing to validate that DPs are impaired in additional face tasks such as famous faces recognition but not impaired in visual recognition in general (**Supplementary Figure 2**).

Additional Behavioral Testing for DPs: DP subjects were further characterized as impaired through interviews assessing the social impact of their deficit in daily life, and only included if their face recognition impairments impacted their life recently and frequently. DP subjects were also significantly impaired on a Famous Face Test ($p<0.05$) and an Old-New face recognition test ($p<0.05$) compared to typical adults (**Supplementary Figure 2**).

fMRI

Localizer Experiment: During fMRI, subjects viewed gray-scale images each of indoor and outdoor scenes, child and adult faces, abstract sculptures, cars, and scrambled images (randomly scrambled objects into 225 8x8 pixels squares). Stimuli were presented in 12s blocks alternating with 12s of fixation. Conditions appeared in random order. Subjects were asked to fixate on the crosshair centered on each image and to press a button whenever an image repeated (one-back task). Subjects participated in 2 runs of this experiment using different stimuli where each condition was repeated twice in a run.

Data analysis: fMRI was preprocessed and analyzed using mrVISTA (http://white.stanford.edu/newlm/index.php/Software). Data were motion corrected and each voxel's data was fit with a general linear model (GLM) as in our previous publications (Golarai et al., 2010; Weiner and Grill-Spector, 2010). There was no spatial smoothing and data was analyzed in the native space of each subject's brain.

Definition of functional regions of interest (fROIs): fROIs were defined in each subject's brain and restricted to the gray matter. Face-selective mFus-faces/FFA-2 was defined as a region in the lateral fusiform gyrus, straddling the MFS that responded more strongly to images of faces than objects & places, $p<10^{-3}$, voxel level. Place-selective CoS-places/PPA was defined as the cluster of voxels in the collateral sulcus that responded more strongly to images of places than objects & faces, $p<10^{-3}$, voxel level. Because the posterior boundary of CoS-places/PPA was variable across subjects, and to use similarly sized face and place-fROIs across subjects, place-selective voxels along the CoS that extended beyond the posterior-most point of the mFus-faces/FFA-2 fROI were excluded.

Author Contributions: JG analyzed both fMRI and DWI data and wrote the manuscript; FP contributed to DWI data analysis, implementation of LiFE, and writing the manuscript; NW collected behavioral, DWI, and fMRI data for DP subjects, contributed to analysis of DP's behavioral & fMRI data, and contributed to writing the manuscript; GG contributed to the design of these experiments, collection of DWI, fMRI, and behavioral data in typical adults and fMRI data analysis in typical adults; AL collected behavioral, DTI, and fMRI data on typical adults, segmented the brains and contributed to analysis of behavioral data; SP collected behavioral and fMRI data for DP subjects and analyzed the behavioral data; JY contributed to the design of the experiment and DWI data collection; KGS contributed to the design of these experiments, data analysis, and writing the manuscript.

Supplemental References

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