Data supplement for Dumornay et al., Racial Disparities in Adversity During Childhood and the False Appearance of Race-Related Differences in Brain Structure. Am J Psychiatry (doi: 10.1176/appi.ajp.21090961)

Supplementary Methods

In the main report, we observed significant race-related differences in gray matter volume of several brain regions and significant differences in assessed dimensions of adversity. We completed a set of follow-up analyses first to determine if the observed race-related differences in gray matter volume were dependent on the anatomical atlas used to define the regions of interest. We therefore completed the initial racial group comparisons using the gray matter volume from regions in the Destrieux atlas (NDA: abcd_mrisdp201). We selected 25 regions that overlapped the prefrontal cortex regions assessed in the main report. Given the main findings, we completed independent samples t-tests to compare gray matter volume (normalized as a proportion of intracranial volume) between Black and White children.

Further, given the hypothesis that adversity and threat-related brain regions are related to PTSD, we performed follow-up analyses to determine if there differences in PTSD symptoms as a function of race or adversity. Posttraumatic stress disorder (PTSD) symptoms were obtained from the full parent-reported K-SADS-5 diagnostic interview (NDA: abcd_ksad01). Twenty-five items assessing present PTSD symptoms were summed to create an index of PTSD symptom severity. The total sum index was compared between Black and White children using independent samples t-tests with corrections for inequality of variance as determined by Levene's test. Multiple linear regression analysis was completed to determine if the adversity metrics were associated with PTSD symptoms. Further, we completed a formal parallel mediation analysis to determine if accounting for differences in adversity attenuated race-related differences in PTSD symptoms.

Finally, we calculated correlations between PTSD symptom severity and gray matter volume of our *a priori* regions of interest using residuals from models that only considered age, gender, scanner, and family-relatedness (i.e., before accounting for adversity) and residuals from models that also included adversity metrics (i.e., after accounting for adversity) to isolate race-related correlations between gray matter volume and PTSD symptom severity.

Given prior work highlighting racial disparities in pollutants and toxin exposure, we also completed additional parallel mediation analyses to see if accounting for differential exposure to toxins in participant's neighborhoods contributed to race-related differences in GMV. Data on average annual levels of fine particulate matter 2.5 (i.e., particles/droplets in the air less than two and a half microns; PM2.5) and nitrogen dioxide (NO2) at ground level from each participant's neighborhoods in a 10x10 km^2 area were taken from the residential history questionnaire. These measures reflect potential exposure to small matter particles associated with deleterious health outcomes. White children resided in neighborhoods with significantly lower PM2.5 [$t(8616) = -23.65$, $p < 0.001$] and NO2 [$t(8616) = -11.42$, $p < 0.001$] than Black children.

Supplementary Results

Consistent with our main findings, we observed significant race-related differences in gray matter volume in overlapping regions on the Destrieux atlas as observed using the Desikan-Killainy atlas (Table S1). Specifically, Destrieux regions such as the cingulate gyrus, superior frontal gyrus, and superior frontal sulcus showed significant race-related differences. In contrast to the Desikan-Killainy atlas, the Destrieux atlas showed significant race-related differences in circular sulcus of the insula but also did not show an effect on long insular gyrus consistent with findings from the Desikan-Killainy atlas. These findings suggest the results from the main analysis

are largely generalizable with the Destrieux atlas highlighting potentially more focal race-related effects.

We further observed that Black children (M = 0.48, SD = 1.50), compared to White children (M = 0.31, SD = 1.07), showed greater severity of PTSD symptoms at the present time [$t(2355) = -4.51$, $p < 0.001$]. Similarly, when removing participants with scores of zero to account for zero inflation, Black children (M = 2.87, SD = 2.58, n = 309), compared to White children (M = 2.04, SD = 2.00, n = 1140) showed greater PTSD symptoms at present [$t(412) = -5.25$, $p < 0.001$]. A linear regression analysis demonstrated that PTSD symptoms were significantly predicted by adversity metrics including income, employment, hardship, conflict and trauma (Table S2). We completed parallel mediation analyses to determine if differences in adversity mediated differences in PTSD symptoms. We observed significant total [*z-stat* = 5.50, $\beta_c = 0.17$, $p < 0.001$], indirect [*z-stat* = 13.32, $\beta_{ab} = 0.26$, $p < 0.001$], and direct [*z-stat* = -2.70, $\beta_{c'} = -0.09$, $p = 0.007$] effects with a percentage mediated of 153%. These findings demonstrate partial, inconsistent mediation of race-related effects on PTSD symptoms in the sample. Inclusion of the pollution measures had minimal impact on the total [*z-stat* = 5.49, $\beta_c = 0.14$, $p < 0.001$], indirect [*z-stat* = 12.18, $\beta_{ab} = 0.22$, $p < 0.001$], and direct [*z-stat* = -2.62, $\beta_{c'} = -0.07$, $p = 0.009$] effects with a percentage mediated of 157%. Finally, we observed small correlations between regional gray matter volume before and after accounting for adversity in the sample (Table S3). Together, these findings suggest that accounting for adversity – in addition to explaining race-related differences in gray matter volume – partially explains differences in childhood posttraumatic symptom expression.

Finally, addition of regional PM2.5 and NO2 exposure levels had a minimal impact on parallel mediation models explaining race-related differences in GMV (Table S4). When including

pollution measures, there was no longer a significant indirect effect of adversity on GMV of the pars triangularis or the frontal pole. However, inclusion of pollution exposure measures led to full mediation of race-related differences of GMV in the superior frontal gyrus. These findings suggest that consideration of pollution exposure in some regions further attenuates, while in other regions does not help to explain, race-related differences in GMV.

Table S1. Race-related differences in gray matter volume (in mm^3) of Destrieux parcellated regions

	White American		Black American			
Region	*M*	*SD*	*M*	*SD*	*t-statistic*	*(p-value)*
Fronto-marginal gyrus and sulcus†	0.178	0.022	0.169	0.020	15.18	<.001§
Transverse frontopolar gyri and sulci†	0.174	0.025	0.166	0.025	12.07	<.001
Anterior part of the cingulate gyrus and sulcus†	0.402	0.039	0.391	0.040	9.31	<.001
Middle-anterior part of the cingulate gyrus and sulcus†	0.240	0.029	0.236	0.030	5.59	<.001
Middle-posterior part of the cingulate gyrus and sulcus†	0.219	0.024	0.213	0.024	9.07	<.001
Opercular part of the inferior frontal gyrus†	0.277	0.033	0.269	0.035	9.01	<.001§
Orbital part of the inferior frontal gyrus†	0.072	0.012	0.069	0.012	7.76	<.001
Triangular part of the inferior frontal gyrus	0.231	0.036	0.234	0.037	-2.18	0.029
Middle frontal gyrus	0.904	0.094	0.899	0.097	2.20	0.028
Superior frontal gyrus†	1.449	0.116	1.412	0.119	10.93	<.001
Long insular gyrus and central sulcus of the insula	0.090	0.011	0.089	0.011	1.95	0.051
Short insular gyri†	0.157	0.016	0.155	0.017	4.57	<.001§
Orbital gyri†	0.535	0.047	0.514	0.048	15.38	<.001
Gyrus rectus	0.158	0.021	0.158	0.021	-0.20	0.839
Subcallosal gyrus	0.049	0.015	0.048	0.015	1.51	0.132
Anterior segment of the circular sulcus of the insula†	0.077	0.011	0.073	0.010	12.49	<.001§
Inferior segment of the circular sulcus of the insula†	0.159	0.018	0.163	0.019	-6.33	<.001§
Superior segment of the circular sulcus of the insula†	0.192	0.019	0.188	0.019	6.04	<.001
Inferior frontal sulcus	0.290	0.040	0.290	0.043	0.51	0.613§
Middle frontal sulcus	0.246	0.039	0.243	0.039	2.72	0.007
Superior frontal sulcus†	0.388	0.052	0.383	0.055	3.07	0.002§
Lateral orbital sulcus†	0.053	0.010	0.054	0.010	-4.16	<.001§
Medial orbital sulcus†	0.090	0.015	0.093	0.016	-5.81	<.001§
Orbital sulci†	0.205	0.023	0.196	0.025	14.04	<.001§
Suborbital sulcus	0.063	0.012	0.063	0.012	0.66	0.512

Notes. †Symbol indicates the t-test result was significant after Bonferroni Correction (0.05/25 = 0.002). §Levene's test is significant ($p < .05$), suggesting a violation of the equal variance assumption. N_{WA} = 6,727; N_{BA} = 1,510, total *df* = 8235. GMV of these regions were normalized as a proportion of estimated intracranial volume [(region volume/intracranial volume) x 100] and averaged across left and right hemispheres.

Table S2. Summary of linear regression analysis predicting PTSD symptom severity

Predictor	β	*t-statistic*	*p*
Parental employment	-0.03	-2.63	0.01
Parental education	0.01	0.52	0.60
Family income	-0.06	-4.13	< 0.001
Material hardship	0.10	8.46	< 0.001
Family conflict	0.04	3.58	< 0.001
Neighborhood disadvantage	-0.00	-0.09	0.93
Trauma history	0.26	23.61	< 0.001

Notes. N = 7,623. Participant's adversity exposure was significantly associated with their PTSD symptom severity, $F(7, 7623) = 132.06$, $p < 0.001$, $R^2 = 0.11$. PTSD symptom severity is an index created by summing twenty-five items assessing present PTSD symptoms from the full parent-reported K-SADS-5 diagnostic interview (NDA: abcd_ksad01).

Table S3. Correlations between PTSD symptom severity and GMV

	PTSD Symptom Severity			
	Before		After	
Region	*r-value*	*p-value*	*r-value*	*p-value*
Caudal anterior cingulate cortex	**-0.03**	**0.004**	-0.02	0.169
Caudal middle frontal gyrus	-0.01	0.203	0.01	0.546
Lateral orbitofrontal cortex	-0.02	0.142	-0.01	0.571
Medial orbitofrontal cortex	0.01	0.678	-0.00	0.751
Pars opercularis	-0.00	0.996	0.01	0.370
Pars triangularis	0.01	0.233	-0.00	0.803
Pars orbitalis	-0.00	0.893	-0.00	0.805
Rostral anterior cingulate cortex	-0.02	0.108	-0.01	0.376
Rostral middle frontal gyrus	-0.02	0.126	-0.02	0.151
Superior frontal gyrus	**-0.02**	**0.033**	**-0.03**	**0.030**
Frontal pole	-0.01	0.291	-0.01	0.607
Insula	-0.00	0.748	-0.01	0.318
Hippocampus	-0.01	0.476	-0.00	0.758
Amygdala	-0.00	0.930	0.01	0.566

Note: Bold values indicate $p<0.05$. "Before" indicates gray matter volume (GMV) estimated from residuals of linear mixed effects models that included age, gender, scanner, and family relatedness. "After" indicates GMV estimated from residuals of linear mixed effects models that included additional terms for adversity metrics noted in the main text.

Table S4. Summary of parallel mediation analyses of race-related effects on GMV accounting for adversity when including measures of pollution

Brain Region	Total Effect (c)	*p*-value	Total Indirect Effect (ab)	*p*-value	Direct Effect (c')	*p*-value	Percentage Mediated
Caudal anterior cingulate cortex[+]	-0.17	< .001	-0.04	0.015	-0.13	< .001	25.44%
Caudal middle frontal gyrus[+]	-0.29	< .001	-0.12	< .001	-0.17	< .001	40.89%
Lateral orbitofrontal cortex[+]	-0.45	< .001	-0.07	< .001	-0.37	< .001	16.37%
Medial orbitofrontal cortex	-0.03	0.333	-0.03	0.091	0.00	0.937	-
Pars opercularis	-0.31	< .001	0.00	0.873	-0.31	< .001	0.96%
Pars triangularis	0.13	< .001	0.03	0.164	0.11	0.001	18.94%
Pars orbitalis[+]	-0.19	< .001	-0.07	< .001	-0.13	< .001	33.85%
Rostral anterior cingulate cortex	-0.29	< .001	-0.03	0.056	-0.26	< .001	11.68%
Rostral middle frontal gyrus	0.02	0.597	-0.13	< .001	0.15	< .001	-
Superior frontal gyrus[+]	-0.20	< .001	-0.13	< .001	-0.07	0.050	66.50%
Frontal pole	-0.19	< .001	-0.04	0.051	-0.15	< .001	18.52%
Insula	0.05	0.115	0.01	0.79	0.04	0.233	-
Hippocampus	-0.12	< .001	-0.01	0.59	-0.11	0.001	8.55%
Amygdala	-0.14	< .001	-0.01	0.592	-0.13	< .001	7.41%

Note: Gray matter volume (GMV) estimated from residuals of linear mixed effects models that included age, gender, scanner, and family relatedness (i.e., the isolated race-related effect). Percentage mediated is calculated by ab/c * 100. [+]Symbol indicates model met criteria for partial or full mediation. Percentage mediated omitted for regions in which no significant total effect was observed.

Figure S1. Alternative view of race-related differences in regional gray matter volume. Paneled view for each region included in analysis of gray matter volume (y-axis) compared between White American (green) and Black American (orange) children (x-axis). Plots show the distribution of values for each group. Plots inside distributions represent boxplots for each group by brain region.