Supplementary Material to “Functional brain abnormalities associated with comorbid anxiety in autism spectrum disorder,” James Bartolotti, John A. Sweeney, and Matthew W. Mosconi

**Participants.**

Table S1.Subject IDs by Group from the ABIDE database (fcon\_1000.projects.nitrc.org/indi/abide/)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Group | Site | Sub\_ID | Group | Site | Sub\_ID | Group | Site | Sub\_ID | Group | Site | Sub\_ID |
| ASD+Anx | EMC | 29873 | ASD-NoAnx | NYU1 | 50985 | Control | KKI | 29350 | Control | NYU1 | 51075 |
| ASD+Anx | EMC | 29889 | ASD-NoAnx | NYU1 | 50991 | Control | KKI | 29354 | Control | NYU1 | 51078 |
| ASD+Anx | IP | 29606 | ASD-NoAnx | NYU1 | 50992 | Control | KKI | 29355 | Control | NYU1 | 51079 |
| ASD+Anx | KKI | 29283 | ASD-NoAnx | NYU1 | 50994 | Control | KKI | 29356 | Control | NYU1 | 51081 |
| ASD+Anx | KKI | 29287 | ASD-NoAnx | NYU1 | 50996 | Control | KKI | 29357 | Control | NYU1 | 51083 |
| ASD+Anx | KKI | 29376 | ASD-NoAnx | NYU1 | 51002 | Control | KKI | 29359 | Control | NYU1 | 51085 |
| ASD+Anx | KKI | 29415 | ASD-NoAnx | NYU1 | 51007 | Control | KKI | 29365 | Control | NYU1 | 51086 |
| ASD+Anx | KKI | 29458 | ASD-NoAnx | NYU1 | 51008 | Control | KKI | 29373 | Control | NYU1 | 51087 |
| ASD+Anx | NYU1 | 29194 | ASD-NoAnx | NYU1 | 51009 | Control | KKI | 29374 | Control | NYU1 | 51088 |
| ASD+Anx | NYU1 | 29217 | ASD-NoAnx | NYU1 | 51011 | Control | KKI | 29380 | Control | NYU1 | 51090 |
| ASD+Anx | NYU1 | 50974 | ASD-NoAnx | NYU1 | 51012 | Control | KKI | 29382 | Control | NYU1 | 51093 |
| ASD+Anx | NYU1 | 50984 | ASD-NoAnx | NYU1 | 51014 | Control | KKI | 29383 | Control | NYU1 | 51094 |
| ASD+Anx | NYU1 | 50987 | ASD-NoAnx | NYU2 | 29150 | Control | KKI | 29395 | Control | NYU1 | 51096 |
| ASD+Anx | NYU1 | 50995 | ASD-NoAnx | NYU2 | 29154 | Control | KKI | 29399 | Control | NYU1 | 51097 |
| ASD+Anx | NYU1 | 51001 | ASD-NoAnx | NYU2 | 29155 | Control | KKI | 29443 | Control | NYU1 | 51099 |
| ASD+Anx | NYU1 | 51003 | ASD-NoAnx | NYU2 | 29156 | Control | KKI | 29446 | Control | NYU1 | 51100 |
| ASD+Anx | NYU1 | 51026 | ASD-NoAnx | NYU2 | 29159 | Control | KKI | 29451 | Control | NYU1 | 51101 |
| ASD+Anx | NYU1 | 51033 | ASD-NoAnx | NYU2 | 29163 | Control | KKI | 29454 | Control | NYU1 | 51102 |
| ASD+Anx | NYU1 | 51035 | ASD-NoAnx | NYU2 | 29167 | Control | KKI | 29455 | Control | NYU1 | 51104 |
| ASD+Anx | NYU2 | 29157 | ASD-NoAnx | NYU2 | 29170 | Control | KKI | 29460 | Control | NYU1 | 51105 |
| ASD+Anx | NYU2 | 29160 | ASD-NoAnx | NYU2 | 29171 | Control | KKI | 29471 | Control | NYU1 | 51106 |
| ASD+Anx | NYU2 | 29165 | ASD-NoAnx | NYU2 | 29174 | Control | KKI | 29472 | Control | NYU1 | 51107 |
| ASD+Anx | OHSU | 28939 | ASD-NoAnx | OHSU | 28924 | Control | KKI | 29478 | Control | NYU1 | 51108 |
| ASD+Anx | OHSU | 28942 | ASD-NoAnx | OHSU | 28926 | Control | NYU1 | 29225 | Control | NYU1 | 51109 |
| ASD+Anx | OHSU | 28966 | ASD-NoAnx | OHSU | 28933 | Control | NYU1 | 29226 | Control | NYU1 | 51111 |
| ASD-NoAnx | EMC | 29865 | ASD-NoAnx | OHSU | 28936 | Control | NYU1 | 29227 | Control | NYU1 | 51120 |
| ASD-NoAnx | EMC | 29868 | ASD-NoAnx | OHSU | 28937 | Control | NYU1 | 29229 | Control | NYU1 | 51121 |
| ASD-NoAnx | EMC | 29869 | ASD-NoAnx | OHSU | 28940 | Control | NYU1 | 29230 | Control | NYU1 | 51122 |
| ASD-NoAnx | EMC | 29876 | ASD-NoAnx | OHSU | 28958 | Control | NYU1 | 29232 | Control | NYU1 | 51123 |
| ASD-NoAnx | EMC | 29890 | ASD-NoAnx | OHSU | 28963 | Control | NYU1 | 29235 | Control | NYU1 | 51124 |
| ASD-NoAnx | IP | 29584 | ASD-NoAnx | OHSU | 28964 | Control | NYU1 | 29236 | Control | NYU1 | 51125 |
| ASD-NoAnx | IP | 29603 | ASD-NoAnx | OHSU | 28968 | Control | NYU1 | 29237 | Control | NYU1 | 51126 |
| ASD-NoAnx | IP | 29619 | ASD-NoAnx | OHSU | 28982 | Control | NYU1 | 29238 | Control | NYU1 | 51129 |
| ASD-NoAnx | IP | 29623 | ASD-NoAnx | OHSU | 28986 | Control | NYU1 | 29239 | Control | OHSU | 28944 |
| ASD-NoAnx | IP | 29629 | ASD-NoAnx | OHSU | 28995 | Control | NYU1 | 29240 | Control | OHSU | 28947 |
| ASD-NoAnx | KKI | 29285 | Control | EMC | 29896 | Control | NYU1 | 29241 | Control | OHSU | 28951 |
| ASD-NoAnx | KKI | 50798 | Control | EMC | 29901 | Control | NYU1 | 29243 | Control | OHSU | 28953 |
| ASD-NoAnx | NYU1 | 29178 | Control | EMC | 29904 | Control | NYU1 | 29245 | Control | OHSU | 28960 |
| ASD-NoAnx | NYU1 | 29179 | Control | EMC | 29905 | Control | NYU1 | 29246 | Control | OHSU | 28961 |
| ASD-NoAnx | NYU1 | 29183 | Control | EMC | 29908 | Control | NYU1 | 29250 | Control | OHSU | 28969 |
| ASD-NoAnx | NYU1 | 29186 | Control | EMC | 29909 | Control | NYU1 | 29251 | Control | OHSU | 28970 |
| ASD-NoAnx | NYU1 | 29187 | Control | EMC | 29912 | Control | NYU1 | 29254 | Control | OHSU | 28973 |
| ASD-NoAnx | NYU1 | 29191 | Control | EMC | 29916 | Control | NYU1 | 51036 | Control | OHSU | 28978 |
| ASD-NoAnx | NYU1 | 29200 | Control | IP | 29596 | Control | NYU1 | 51040 | Control | OHSU | 28979 |
| ASD-NoAnx | NYU1 | 29202 | Control | IP | 29620 | Control | NYU1 | 51041 | Control | OHSU | 28980 |
| ASD-NoAnx | NYU1 | 29207 | Control | IP | 29632 | Control | NYU1 | 51042 | Control | OHSU | 28981 |
| ASD-NoAnx | NYU1 | 29213 | Control | KKI | 29305 | Control | NYU1 | 51045 | Control | OHSU | 28993 |
| ASD-NoAnx | NYU1 | 29214 | Control | KKI | 29316 | Control | NYU1 | 51046 | Control | OHSU | 28996 |
| ASD-NoAnx | NYU1 | 29224 | Control | KKI | 29317 | Control | NYU1 | 51049 | Control | OHSU | 28999 |
| ASD-NoAnx | NYU1 | 50956 | Control | KKI | 29320 | Control | NYU1 | 51050 | Control | OHSU | 29000 |
| ASD-NoAnx | NYU1 | 50957 | Control | KKI | 29323 | Control | NYU1 | 51056 | Control | OHSU | 29001 |
| ASD-NoAnx | NYU1 | 50958 | Control | KKI | 29324 | Control | NYU1 | 51064 | Control | OHSU | 29003 |
| ASD-NoAnx | NYU1 | 50964 | Control | KKI | 29325 | Control | NYU1 | 51065 | Control | OHSU | 30158 |
| ASD-NoAnx | NYU1 | 50969 | Control | KKI | 29328 | Control | NYU1 | 51069 | Control | OHSU | 30159 |
| ASD-NoAnx | NYU1 | 50976 | Control | KKI | 29332 | Control | NYU1 | 51070 | Control | OHSU | 30160 |
| ASD-NoAnx | NYU1 | 50981 | Control | KKI | 29335 | Control | NYU1 | 51071 | Control | OHSU | 30162 |
| ASD-NoAnx | NYU1 | 50982 | Control | KKI | 29340 | Control | NYU1 | 51072 | Control | OHSU | 30164 |
| ASD-NoAnx | NYU1 | 50983 | Control | KKI | 29345 | Control | NYU1 | 51073 | Control | OHSU | 30167 |

Table S2. Multi-site scanner and sequence parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Site | Scanner | T1 Sequence Parameters | EPI BOLD Sequence Parameters |
| EMC | GE 3TMR750 | TE = 4.24 ms, TR = 10.27 ms, TI = 350 ms,flip angle =16°, No. Slices = 186,voxel size = 0.9×0.9×0.9 mm | TE = 30 ms, TR = 2000 ms, flip angle = 85°, No. Volumes = 160, No. Slices = 37, duration 5:20,voxel size = 3.6×3.6×4.0 mm |
| IP | Philips 1.5TAchieva | TE = 5.6 ms, TR = 25 ms, TI = NA,flip angle = 30°, No. Slices = 170,voxel size = 1.0×1.0×1.0 mm | TE = 45 ms, TR = 2700 ms, flip angle = 90°, No. Volumes = 85, No. Slices = 32, duration 7:55,voxel size = 3.6×3.6×4.0 mm |
| KKI  | Philips 3TAchieva | TE = min, TR = min, TI = 1000 ms,flip angle = 8°, No. Slices = 200,voxel size = 1.0×1.0×1.0 mm | TE = 30 ms, TR = 2500 ms, flip angle = 75°, No. Volumes = 156, No. Slices = 47, duration 6:40,voxel size = 3.0×3.0×3.0 mm |
| NYU1 | Siemens 3TMagnetom Allegra | TE = 3.25 ms, TR = 2530 ms, TI = 1100 ms,flip angle = 7°, No. Slices = 128,voxel size = 1.3×1.0×1.3 mm | TE = 15 ms, TR = 2000 ms, flip angle = 90°, No. Volumes = 180, No. Slices = 33, duration 6:00voxel size = 3.0×3.0×4.0 mm |
| NYU2 | Siemens 3TMagnetom Allegra | TE = 3.25 ms, TR = 2530 ms, TI = 1100 ms,flip angle = 7°, No. Slices = 128,voxel size = 1.3×1.0×1.3 mm | TE = 15 ms, TR = 2000 ms, flip angle = 82°, No. Volumes = 180, No. Slices = 34, duration 6:00,voxel size = 3.0×3.0×3.0 mm |
| OHSU | Siemens 3TMagnetom TIM Trio | TE = 3.58 ms, TR = 2300 ms, TI = 900 ms,flip angle = 10°, No. Slices = 160,voxel size = 1.0×1.0×1.1 mm | TE = 30 ms, TR = 2500 ms, flip angle = 90°, No. Volumes = 120, No. Slices = 36, duration 5:07,voxel size = 3.8×3.8×3.8 mm |

Note: EMC = Erasmus University Medical Center Rotterdam, IP = Institut Pasteur, KKI = Kennedy Krieger Institute, NYU = New York University Langone Medical Center, OHSU = Oregon Health and Science University

**Region of Interest (ROI) definitions.**

Left and right amygdala ROIs were defined using the probabilistic, cytoarchitectonic, Juelich histological atlas (Amunts et al., 2005) using a 50% probability threshold in standard space, inclusive of Basolateral, Centromedial, and Superficial amygdala nuclei.

Craddock 200: ROIs from the Craddock 200 atlas corresponding to anatomical regions of interest are outlined in table SX. Rostral anterior cingulate was defined by combining distinct ROIs for left and right rACC. A single ROI, number 47, which included both left head of the caudate and left nucleus accumbens, was divided into two ROIs at Z = 0. This division corresponds to the dividing line between right head of the caudate and right nucleus accumbens ROIs in the Craddock 200 atlas.

Table S3. Anterior cingulate, medial prefrontal cortex, and basal ganglia ROIs.

|  |  |
| --- | --- |
| Anatomical label | Craddock 200 ROI number |
| dmPFC | 91 |
| dACC | 40 |
| rACC | 5 (left) + 22 (right) |
| sgACC | 160 |
| vmPFC | 51 |
| Left Caudate (head) | 47, Z >= 0 |
| Right Caudate (head) | 135 |
| Left Nucleus Accumbens | 47, Z < 0 |
| Right Nucleus Accumbens | 15 |
| Left Putamen | 67 |
| Right Putamen | 178 |

**Timecourse correlations.**

Pearson’s correlation coefficients between left/right amygdala and target ROIs (i.e., medial PFC and basal ganglia) were normalized using the Fisher’s R to Z transform, and converted to Z-scores by dividing by the square root of the variance, computed as $1/\sqrt{n-3}$, where *n* is the degrees of freedom. The degrees of freedom were corrected for autocorrelation in the BOLD signal by applying Bartlett’s theorem (Jenkins & Watts, 1968) as implemented by Afyouni (Afyouni et al., 2019). For each participant, the Bartlett Correction Factor (BCF), representing the integral across time of the square of the autocorrelation function (Fox et al., 2005; Van Dijk et al., 2010), was calculated for each voxel timecourse. The voxel BCFs were then averaged to yield a whole-brain correction factor. The effective degrees of freedom were obtained by dividing the number of time points by the whole-brain BCF.

**Results.**

**Table S4. Amygdala – ACC/mPFC connectivity**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **dACC** | **dmPFC** | **rACC** | **sgACC** | **vmPFC** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | -0.95 | -1.13-0.77 | **<.001** | -0.03 | -0.220.17 | .789 | -0.02 | -0.210.17 | .852 | 0.58 | 0.350.80 | **<.001** | 0.69 | 0.480.91 | **<.001** |
| TD vs ASDNo+ASDAnx | -0.27 | -0.550.01 | .058 | 0.00 | -0.300.31 | .981 | -0.24 | -0.530.05 | .108 | 0.01 | -0.330.35 | .967 | 0.13 | -0.210.47 | .449 |
| ASDNo vs ASDAnx | -0.82 | -1.22-0.42 | **<.001** | -0.25 | -0.690.19 | .266 | -0.67 | -1.09-0.25 | **.002** | -0.22 | -0.710.27 | .389 | 0.14 | -0.340.63 | .565 |
| Hemisphere | -0.00 | -0.130.12 | .944 | -0.06 | -0.190.08 | .412 | -0.09 | -0.220.05 | .205 | -0.35 | -0.50-0.19 | **<.001** | -0.22 | -0.36-0.08 | **.002** |
| Age | -2.18 | -4.20-0.16 | **.035** | -1.09 | -3.301.13 | .337 | -2.82 | -4.94-0.70 | **.010** | -3.44 | -5.92-0.96 | **.007** | -1.28 | -3.721.16 | .306 |
| Age2 | 0.98 | -0.962.92 | .323 | -0.89 | -3.021.23 | .411 | 1.37 | -0.673.40 | .190 | 3.97 | 1.596.36 | **.001** | 1.65 | -0.704.00 | .169 |
| Mean FD | 0.19 | 0.070.31 | **.003** | -0.00 | -0.140.13 | .992 | 0.06 | -0.070.19 | .344 | -0.21 | -0.36-0.06 | **.008** | -0.21 | -0.36-0.07 | **.005** |
| Site EMC | -0.05 | -0.510.42 | .851 | -0.32 | -0.840.19 | .217 | -0.49 | -0.980.01 | .054 | -0.15 | -0.730.43 | .606 | -0.30 | -0.870.27 | .304 |
| Site IP | 0.85 | 0.221.47 | **.009** | -0.07 | -0.750.62 | .853 | -0.30 | -0.960.36 | .377 | -0.60 | -1.370.17 | .129 | -0.58 | -1.340.18 | .135 |
| Site KKI | 0.44 | 0.120.77 | **.009** | 0.02 | -0.340.37 | .932 | 0.06 | -0.280.40 | .721 | 0.62 | 0.221.02 | **.003** | 0.13 | -0.260.53 | .504 |
| Site NYU2 | -0.37 | -0.950.21 | .215 | -0.60 | -1.240.04 | .066 | -0.63 | -1.24-0.02 | **.044** | -0.25 | -0.960.47 | .497 | -0.16 | -0.860.55 | .662 |
| Site OHSU | 0.43 | 0.120.74 | **.007** | 0.42 | 0.080.75 | **.017** | 0.20 | -0.130.52 | .238 | 0.02 | -0.360.40 | .902 | 0.35 | -0.030.72 | .069 |
| (TD vs ASDNo+ASDAnx)\*Hemi | 0.10 | -0.120.32 | .376 | 0.11 | -0.120.34 | .338 | 0.14 | -0.100.38 | .249 | -0.22 | -0.480.05 | .112 | -0.14 | -0.390.10 | .259 |
| (ASDNo vs ASDAnx)\*Hemi | 0.32 | -0.040.68 | .084 | 0.05 | -0.320.42 | .802 | 0.33 | -0.050.72 | .089 | -0.16 | -0.590.27 | .475 | -0.29 | -0.690.10 | .145 |
| (TD vs ASDNo+ASDAnx)\*Age | -2.13 | -5.691.42 | .241 | 0.19 | -3.714.09 | .924 | -2.50 | -6.231.24 | .192 | -2.10 | -6.482.27 | .347 | -2.38 | -6.681.93 | .281 |
| (ASDNo vs ASDAnx)\*Age | 3.14 | -2.148.43 | .245 | 2.70 | -3.098.49 | .361 | 0.28 | -5.275.84 | .921 | -4.71 | -11.211.80 | .157 | -0.29 | -6.706.11 | .928 |
| (TD vs ASDNo+ASDAnx)\*Age2 | 2.62 | -1.006.24 | .158 | 2.50 | -1.476.48 | .218 | 0.34 | -3.464.15 | .860 | 0.52 | -3.944.98 | .818 | 1.71 | -2.686.10 | .445 |
| (ASDNo vs ASDAnx)\*Age2 | -0.79 | -5.704.12 | .753 | 2.46 | -2.937.84 | .372 | -1.59 | -6.753.58 | .547 | -0.63 | -6.685.42 | .838 | 1.30 | -4.667.25 | .670 |
| **Random Effects** |
| σ2 | 0.31 | 0.33 | 0.35 | 0.44 | 0.37 |
| τ00 | 0.52 SUB | 0.65 SUB | 0.57 SUB | 0.81 SUB | 0.81 SUB |
| ICC | 0.63 | 0.67 | 0.62 | 0.65 | 0.68 |
| N | 232 SUB | 232 SUB | 232 SUB | 232 SUB | 232 SUB |
| Observations | 464 | 464 | 464 | 464 | 464 |
| Marginal R2 / Conditional R2 | 0.181 / 0.697 | 0.086 / 0.695 | 0.099 / 0.660 | 0.128 / 0.692 | 0.079 / 0.710 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), TD vs ASDNo+ASDAnx (TD -2/3, ASD-NoAnx+1/3, ASD+Anxiety +1/3), ASDNo vs ASDAnx (TD -1/3, ASD-NoAnx -1/3, ASD+Anxiety +2/3). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S5. Relationships between Amygdala – ACC/mPFC connectivity and clinical ratings in individuals with ASD.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **dACC** | **dmPFC** | **rACC** | **sgACC** | **vmPFC** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | -0.79 | -1.10-0.48 | **<.001** | -0.03 | -0.350.29 | .853 | 0.06 | -0.240.36 | .712 | 0.60 | 0.230.96 | **.002** | 0.64 | 0.221.06 | **.004** |
| ASDNo vs ASDAnx | -0.89 | -1.42-0.35 | **.002** | -0.15 | -0.700.39 | .589 | -0.79 | -1.30-0.28 | **.003** | -0.16 | -0.780.47 | .622 | 0.18 | -0.540.90 | .628 |
| Hemisphere | 0.00 | -0.180.19 | .988 | -0.04 | -0.230.15 | .707 | -0.07 | -0.260.13 | .497 | -0.43 | -0.66-0.19 | **.001** | -0.26 | -0.47-0.06 | **.013** |
| Age | -3.40 | -5.90-0.89 | **.009** | -1.21 | -3.761.33 | .353 | -4.01 | -6.41-1.60 | **.002** | -3.47 | -6.40-0.54 | **.023** | -2.27 | -5.631.09 | .189 |
| Age2 | 2.33 | -0.114.77 | .065 | -0.46 | -2.952.02 | .715 | 1.41 | -0.933.76 | .242 | 2.16 | -0.695.02 | .142 | 1.65 | -1.624.93 | .326 |
| Social | 0.11 | -0.230.45 | .522 | -0.34 | -0.680.00 | .054 | -0.26 | -0.580.06 | .119 | -0.03 | -0.420.37 | .889 | -0.07 | -0.520.38 | .764 |
| Comm. | -0.15 | -0.440.15 | .330 | 0.02 | -0.280.31 | .917 | 0.26 | -0.020.54 | .075 | 0.15 | -0.190.49 | .387 | 0.12 | -0.270.51 | .555 |
| RRB | 0.14 | -0.200.48 | .421 | -0.01 | -0.360.33 | .946 | 0.05 | -0.280.38 | .755 | -0.35 | -0.750.05 | .087 | -0.20 | -0.660.25 | .383 |
| Mean FD | 0.13 | -0.130.39 | .317 | -0.11 | -0.370.15 | .402 | -0.09 | -0.330.16 | .502 | -0.55 | -0.86-0.25 | **.001** | -0.29 | -0.630.06 | .105 |
| Site IP | -0.50 | -1.780.79 | .452 | -0.45 | -1.760.85 | .498 | -1.02 | -2.260.21 | .107 | -0.62 | -2.120.88 | .422 | -0.45 | -2.171.27 | .609 |
| Site KKI | 0.18 | -0.610.98 | .651 | 0.17 | -0.640.97 | .689 | 0.20 | -0.560.96 | .612 | 1.16 | 0.232.09 | **.017** | 0.43 | -0.631.49 | .430 |
| Site NYU2 | -0.84 | -1.48-0.19 | **.013** | -0.79 | -1.44-0.14 | **.020** | -0.93 | -1.55-0.31 | **.004** | -0.22 | -0.980.53 | .561 | -0.02 | -0.880.84 | .967 |
| Site OHSU | 0.66 | 0.181.14 | **.009** | 0.41 | -0.080.90 | .103 | 0.32 | -0.140.78 | .173 | 0.04 | -0.520.61 | .877 | 0.54 | -0.101.19 | .101 |
| (ASDNo vs ASDAnx)\*Hemi | 0.38 | 0.010.74 | **.050** | 0.06 | -0.320.44 | .754 | 0.38 | -0.010.76 | .057 | -0.09 | -0.550.38 | .720 | -0.22 | -0.620.19 | .294 |
| (ASDNo vs ASDAnx)\*Age | 3.45 | -1.818.70 | .202 | 4.72 | -0.6210.06 | .087 | 0.71 | -4.345.75 | .785 | 0.80 | -5.356.95 | .799 | 0.12 | -6.927.16 | .974 |
| (ASDNo vs ASDAnx)\*Age2 | -0.87 | -6.324.59 | .756 | 3.05 | -2.498.60 | .284 | 0.01 | -5.235.25 | .998 | 1.14 | -5.257.52 | .728 | 2.31 | -5.009.63 | .537 |
| (ASDNo vs ASDAnx)\*Social | -0.21 | -0.860.43 | .518 | -0.85 | -1.51-0.20 | **.013** | -0.56 | -1.180.06 | .080 | -0.75 | -1.500.01 | .055 | -0.29 | -1.150.58 | .515 |
| (ASDNo vs ASDAnx)\*Comm. | 0.35 | -0.210.91 | .221 | 0.17 | -0.400.74 | .554 | 0.68 | 0.151.22 | **.014** | 0.39 | -0.271.04 | .249 | 0.43 | -0.321.17 | .266 |
| (ASDNo vs ASDAnx)\*RRB | -0.21 | -0.810.40 | .503 | 0.03 | -0.580.65 | .922 | -0.34 | -0.920.24 | .258 | -0.17 | -0.880.54 | .640 | -0.08 | -0.890.73 | .847 |
| Age\*Social | -1.50 | -4.271.28 | .294 | 2.03 | -0.794.85 | .162 | -0.22 | -2.882.45 | .874 | 1.52 | -1.734.76 | .362 | -0.47 | -4.193.24 | .803 |
| Age2\*Social | 1.27 | -1.644.18 | .396 | -0.18 | -3.142.77 | .903 | 3.30 | 0.516.09 | **.023** | 3.48 | 0.086.89 | **.048** | 2.05 | -1.855.95 | .307 |
| Age\*Comm. | 1.70 | -1.364.76 | .279 | 1.04 | -2.074.15 | .513 | 0.40 | -2.543.33 | .791 | 0.04 | -3.533.62 | .982 | 0.76 | -3.334.86 | .716 |
| Age2\*Comm. | -0.39 | -3.372.58 | .796 | 1.65 | -1.384.68 | .289 | -1.62 | -4.481.23 | .269 | -0.29 | -3.773.19 | .871 | -0.82 | -4.813.17 | .690 |
| Age\*RRB | -2.09 | -6.021.85 | .302 | -4.67 | -8.67-0.66 | **.025** | -1.57 | -5.352.21 | .417 | -2.98 | -7.591.62 | .208 | -0.65 | -5.934.62 | .809 |
| Age2\*RRB | -0.91 | -5.333.51 | .688 | -1.77 | -6.262.73 | .444 | -0.57 | -4.813.68 | .794 | -1.79 | -6.963.38 | .499 | -0.44 | -6.375.48 | .883 |
| **Random Effects** |
| σ2 | 0.29 | 0.31 | 0.31 | 0.46 | 0.35 |
| τ00 | 0.47 SUB | 0.49 SUB | 0.41 SUB | 0.62 SUB | 0.94 SUB |
| ICC | 0.62 | 0.61 | 0.57 | 0.57 | 0.73 |
| N | 80 SUB | 80 SUB | 80 SUB | 80 SUB | 80 SUB |
| Observations | 160 | 160 | 160 | 160 | 160 |
| Marginal R2 / Conditional R2 | 0.399 / 0.771 | 0.291 / 0.727 | 0.341 / 0.716 | 0.318 / 0.708 | 0.138 / 0.766 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), ASDNo vs ASDAnx (ASD-NoAnx -.5, ASD+Anxiety +.5). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Social, Comm., and RRB are ADI Total scores for Social, Communication, and Restricted and Repetitive Behaviors (Diagnostic Algorithm); values were scaled by converting to Z-scores using sample mean and SD. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S6. Amygdala – Basal Ganglia connectivity**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Caudate (Head)** | **Nucleus Accumbens** | **Putamen** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 0.14 | -0.010.29 | .078 | 0.63 | 0.450.82 | **<.001** | 1.07 | 0.891.25 | **<.001** |
| TD vs ASDNo+ASDAnx | 0.08 | -0.150.31 | .511 | 0.01 | -0.270.30 | .928 | -0.17 | -0.450.11 | .237 |
| ASDNo vs ASDAnx | -0.24 | -0.580.09 | .151 | -0.46 | -0.87-0.05 | **.029** | 0.03 | -0.370.43 | .884 |
| Hemisphere | 0.02 | -0.090.12 | .719 | -0.04 | -0.150.06 | .394 | 0.24 | 0.140.34 | **<.001** |
| Crossing | -0.13 | -0.24-0.03 | **.012** | -0.05 | -0.150.05 | .323 | -0.20 | -0.30-0.10 | **<.001** |
| Age | -0.97 | -2.650.71 | .257 | -3.35 | -5.44-1.27 | **.002** | -1.08 | -3.120.96 | .301 |
| Age2 | -0.01 | -1.631.60 | .989 | 1.22 | -0.783.22 | .235 | -0.49 | -2.461.47 | .622 |
| Mean FD | -0.02 | -0.120.09 | .769 | -0.08 | -0.200.05 | .239 | 0.09 | -0.040.21 | .165 |
| Site EMC | -0.17 | -0.560.22 | .384 | 0.03 | -0.460.51 | .916 | -0.39 | -0.860.09 | .111 |
| Site IP | 0.05 | -0.480.57 | .864 | -0.07 | -0.710.58 | .844 | -0.62 | -1.250.02 | .058 |
| Site KKI | 0.04 | -0.240.31 | .799 | 0.79 | 0.461.13 | **<.001** | -0.54 | -0.87-0.21 | **.001** |
| Site NYU2 | -0.11 | -0.590.38 | .666 | -0.28 | -0.880.32 | .360 | -0.22 | -0.800.37 | .469 |
| Site OHSU | -0.09 | -0.340.17 | .503 | -0.51 | -0.83-0.19 | **.002** | 0.11 | -0.200.42 | .494 |
| (TD vs ASDNo+ASDAnx)\*Hemi | -0.03 | -0.210.15 | .732 | 0.12 | -0.060.30 | .199 | 0.04 | -0.130.21 | .629 |
| (ASDNo vs ASDAnx)\*Hemi | -0.06 | -0.360.23 | .677 | 0.01 | -0.280.30 | .934 | 0.02 | -0.260.30 | .908 |
| (TD vs ASDNo+ASDAnx)\*Crossing | -0.02 | -0.210.16 | .792 | -0.05 | -0.230.13 | .565 | -0.12 | -0.290.06 | .183 |
| (ASDNo vs ASDAnx)\*Crossing | -0.17 | -0.460.13 | .269 | -0.00 | -0.290.29 | .979 | -0.00 | -0.280.28 | .988 |
| (TD vs ASDNo+ASDAnx)\*Age | -0.08 | -3.042.89 | .960 | -1.51 | -5.182.15 | .419 | -0.74 | -4.332.86 | .688 |
| (ASDNo vs ASDAnx)\*Age | 1.94 | -2.466.34 | .388 | -0.67 | -6.124.79 | .811 | 1.81 | -3.547.15 | .508 |
| (TD vs ASDNo+ASDAnx)\*Age2 | 0.86 | -2.163.87 | .578 | 0.73 | -3.014.47 | .703 | -2.57 | -6.241.09 | .170 |
| (ASDNo vs ASDAnx)\*Age2 | -0.72 | -4.813.37 | .731 | -0.20 | -5.274.87 | .940 | -1.86 | -6.833.11 | .465 |
| **Random Effects** |
| σ2 | 0.41 | 0.40 | 0.37 |
| τ00 | 0.37 SUB | 0.62 SUB | 0.60 SUB |
| ICC | 0.47 | 0.61 | 0.62 |
| N | 232 SUB | 232 SUB | 232 SUB |
| Observations | 928 | 928 | 928 |
| Marginal R2 / Conditional R2 | 0.031 / 0.488 | 0.174 / 0.678 | 0.097 / 0.656 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), Crossing (Ipsilateral -.5, Contralateral +.5), TD vs ASDNo+ASDAnx (TD -2/3, ASD-NoAnx+1/3, ASD+Anxiety +1/3), ASDNo vs ASDAnx (TD -1/3, ASD-NoAnx -1/3, ASD+Anxiety +2/3). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S7. Relationships between Amygdala – Basal Ganglia connectivity and clinical ratings in individuals with ASD.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Caudate (Head)** | **Nucleus Accumbens** | **Putamen** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 0.18 | -0.060.42 | .155 | 0.68 | 0.390.96 | **<.001** | 1.25 | 0.991.51 | **<.001** |
| ASDNo vs ASDAnx | -0.43 | -0.84-0.01 | **.047** | -0.48 | -0.970.01 | .056 | -0.01 | -0.450.44 | .976 |
| Hemisphere | 0.01 | -0.150.16 | .946 | -0.03 | -0.180.12 | .731 | 0.23 | 0.080.37 | **.003** |
| Crossing | -0.13 | -0.290.02 | .095 | -0.08 | -0.230.07 | .287 | -0.21 | -0.36-0.06 | **.006** |
| Age | -1.16 | -3.110.78 | .244 | -3.12 | -5.41-0.83 | **.009** | -2.32 | -4.42-0.23 | **.033** |
| Age2 | -0.02 | -1.911.88 | .987 | 0.74 | -1.492.98 | .518 | 0.14 | -1.902.19 | .891 |
| Social | -0.08 | -0.340.18 | .530 | 0.14 | -0.160.45 | .366 | 0.21 | -0.070.49 | .140 |
| Comm. | -0.06 | -0.290.16 | .592 | 0.14 | -0.130.41 | .302 | -0.02 | -0.260.23 | .897 |
| RRB | 0.18 | -0.090.44 | .191 | -0.18 | -0.490.13 | .253 | 0.29 | 0.010.58 | **.046** |
| Mean FD | -0.00 | -0.200.20 | .969 | -0.29 | -0.52-0.05 | **.020** | 0.32 | 0.100.53 | **.005** |
| Site IP | -0.06 | -1.060.93 | .901 | -0.37 | -1.540.81 | .542 | -1.26 | -2.33-0.18 | **.025** |
| Site KKI | 0.57 | -0.051.19 | .073 | 1.37 | 0.642.09 | **<.001** | -1.14 | -1.81-0.48 | **.001** |
| Site NYU2 | -0.01 | -0.510.49 | .961 | -0.20 | -0.790.39 | .507 | -0.52 | -1.060.01 | .060 |
| Site OHSU | -0.13 | -0.500.24 | .494 | -0.58 | -1.02-0.14 | **.011** | 0.03 | -0.370.43 | .891 |
| (ASDNo vs ASDAnx)\*Hemi | -0.08 | -0.390.23 | .619 | 0.01 | -0.290.31 | .946 | 0.04 | -0.260.33 | .810 |
| (ASDNo vs ASDAnx)\*Cross | -0.11 | -0.420.20 | .496 | 0.02 | -0.280.31 | .919 | 0.03 | -0.270.33 | .833 |
| (ASDNo vs ASDAnx)\*Age | -0.81 | -4.893.26 | .698 | 1.52 | -3.286.33 | .537 | -2.16 | -6.552.24 | .339 |
| (ASDNo vs ASDAnx)\*Age2 | 0.13 | -4.114.36 | .954 | 3.43 | -1.578.42 | .182 | -0.76 | -5.333.80 | .745 |
| (ASDNo vs ASDAnx)\*Social | 0.15 | -0.350.65 | .567 | -0.03 | -0.620.56 | .914 | 0.47 | -0.071.01 | .093 |
| (ASDNo vs ASDAnx)\*Comm. | 0.13 | -0.300.56 | .559 | 0.39 | -0.120.90 | .135 | 0.10 | -0.360.57 | .670 |
| (ASDNo vs ASDAnx)\*RRB | -0.29 | -0.760.18 | .224 | -0.07 | -0.620.49 | .813 | -0.02 | -0.530.48 | .923 |
| Age\*Social | 1.11 | -1.043.26 | .316 | 1.23 | -1.313.76 | .346 | -0.04 | -2.352.28 | .976 |
| Age2\*Social | 1.48 | -0.773.74 | .201 | 3.94 | 1.286.60 | **.005** | -0.18 | -2.612.25 | .887 |
| Age\*Comm. | -2.78 | -5.15-0.41 | **.024** | -1.20 | -4.001.59 | .401 | -2.35 | -4.900.21 | .075 |
| Age2\*Comm. | -0.76 | -3.061.55 | .522 | -2.61 | -5.330.11 | .064 | -1.37 | -3.861.11 | .282 |
| Age\*RRB | 3.55 | 0.506.60 | **.025** | 1.02 | -2.584.61 | .581 | 3.84 | 0.557.13 | **.025** |
| Age2\*RRB | 1.07 | -2.364.50 | .542 | -1.58 | -5.622.46 | .446 | 1.27 | -2.424.97 | .501 |
| **Random Effects** |
| σ2 | 0.41 | 0.38 | 0.38 |
| τ00 | 0.27 SUB | 0.42 SUB | 0.34 SUB |
| ICC | 0.40 | 0.53 | 0.47 |
| N | 80 SUB | 80 SUB | 80 SUB |
| Observations | 320 | 320 | 320 |
| Marginal R2 / Conditional R2 | 0.187 / 0.509 | 0.388 / 0.711 | 0.281 / 0.622 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), Crossing (Ipsilateral -.5, Contralateral +.5), ASDNo vs ASDAnx (ASD-NoAnx -.5, ASD+Anxiety +.5). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Social, Comm., and RRB are ADI Total scores for Social, Communication, and Restricted and Repetitive Behaviors (Diagnostic Algorithm); values were scaled by converting to Z-scores using sample mean and SD. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Global Signal Regression**

Analyses in the main text include the global signal as a regressor during preprocessing in order to account for the effect of motion on connectivity measures (Byrge & Kennedy, 2018). Regressing the global signal can have undesirable effects, such as introducing strong negative correlations (Murphy & Fox, 2017). Here, we present a parallel analysis to the main text using data where the global signal was not regressed, to allow comparison of the different preprocessing pipelines on our results, which are not substantively changed between the two approaches.

**Amygdala – ACC and amygdala-mPFC connectivity**

 ASD+Anxiety individuals showed decreased connectivity between amygdala and dorsal ACC regions including dACC and rACC relative to both comparison groups, and between amygdala and dmPFC: ASD-NoAnx vs ASD+Anxiety *t*(232) = 3.084dACC, 2.328dmPFC, 2.600rACC, *p* = .002dACC, .021dmPFC, .010rACC, TD vs ASD+Anxiety *t*(232) = 3.114dACC, 2.407dmPFC, 2.937rACC, *p* = .002dACC, .017dmPFC, .004rACC, (Table S8). In contrast, ASD+Anxiety individuals did not show any differences in amygdala connectivity with ventral ACC/PFC (sgACC and vmPFC) relative to the ASD-NoAnx and TD control groups, ASD-NoAnx vs ASD+Anxiety *t*(232) = 0.957sgACC, 0.836vmPFC, *p* = .340sgACC, .404vmPFC, TD vs ASD+Anxiety *t*(232) = 1.184sgACC, 0.265vmPFC, *p* = .238sgACC, .791vmPFC. The ASD-NoAnx group did not show any differences in amygdala connectivity with dorsal or ventral ACC/PFC targets relative to the TD controls, *t*(232) = 0.003dACC, 0.082dmPFC, 0.462rACC, 0.323sgACC, 0.864vmPFC, *p* = .998dACC, .935dmPFC, .645rACC, .747sgACC, .389vmPFC. A laterality effect was observed where sgACC and vmPFC had higher connectivity to the left amygdala than the right (Cohen’s d effect sizes: 0.51sgACC, 0.35vmPFC) but there were no interactions between amygdala hemisphere and group.

**Amygdala – Basal Ganglia Connectivity**

ASD+Anxiety individuals showed decreased connectivity between the amygdala and the nucleus accumbens compared to ASD-NoAnx individuals: *t*(232) = 1.836NucAcc, *p* = .068NucAcc, but no differences were observed between groups in amygdala – caudate or amygdala – putamen connectivity (Table S10). Strong laterality effects were observed for amygdala – putamen connectivity, with greater connectivity from the right versus the left amygdala, and for ipsilateral versus contralateral amygdala – putamen connections. No group by side interactions were seen for amygdala connectivity with basal ganglia nuclei.

**Clinical and demographic associations.**

Age was associated with amygdala-sgACC connectivity across participants following a U-shaped pattern with higher connectivity in childhood and early adulthood compared to adolescence (effect size: 0.34linear\_age, 0.41quad\_age). Age-related linear decreases in amygdala-dACC (effect size: 0.04linear\_age) and amygdala-rACC connectivity (effect size: 0.19linear\_age) were observed in one processing pipeline, and were not significant for other PFC targets, and no diagnostic group differences were seen in the relationships between age and amygdala-PFC connectivity. In the basal ganglia, increased age was linearly associated with lower amygdala – nucleus accumbens connectivity, but no group by age interactions were observed for amygdala – nucleus accumbens connectivity, and age was not associated with amygdala-caudate or amygdala-putamen connectivity.

More severe ADI-rated social abnormalities were associated with decreased amygdala – dmPFC connectivity for individuals with ASD+Anxiety (Table S9; effect size: 0.35; Estimate = -0.85, SE = 0.30, *t*(80) = -2.78, *p* = .01). The relationship between social abnormalities and amygdala-dmPFC connectivity was not significant for the ASD-NoAnx group (Estimate = -0.22, SE = 0.17, *t*(80) = -1.26, *p* = .21). Social abnormalities were not associated with any other amygdala-PFC connections. More severe ADI-rated RRBs were associated with increases in amygdala – dACC/rACC connectivity in ASD-NoAnx individuals (Table S9, dACC Estimate = 0.43, SE = 0.19, *t*(80) = 2.24, *p* = .03; rACC Estimate = 0.35, SE = 0.17, *t*(80) = 2.11, *p* = .04), but this relationship was not significant for the ASD+Anxiety group (dACC Estimate = 0.58, SE = 0.36, *t*(80) = 1.62, p*p* = .11; rACC Estimate = 0.37, SE = 0.31, *t*(80) = 1.20, *p* = .23). RRB severity was not associated with any other amygdala-PFC connections, and Communication impairment was not associated with amygdala ACC/PFC connectivity in either group.

 More severe ADI-rated Social abnormalities were associated with decreased connectivity between the amygdala and the dorsal striatum in ASD-NoAnx individuals (Table S11, Caudate Estimate = -0.31, SE = 0.14, *t*(80) = 2.29, *p* = .02; Putamen Estimate = -0.36, SE = 0.18, *t*(80) = 2.02, *p* = .05), but these relationships were not significant in the ASD+Anxiety group (Caudate Estimate = 0.00, SE = 0.25, *t*(80) = 0.01, *p* = .99; Putamen Estimate = .52, SE = 0.32, *t*(80) = 1.66, *p* = .10). More severe RRB symptoms were associated with increased connectivity between the amygdala and the dorsal striatum in ASD-NoAnx individuals (Caudate Estimate = -0.39, SE = 0.13, *t*(80) = 3.08, *p* = .002; Putamen Estimate = 0.35, SE = 0.16, *t*(80) = 2.11, *p* = .04), and between the amygdala and the caudate in ASD+Anxiety individuals (Caudate Estimate = 0.53, SE = 0.24, *t*(80) = 2.24, *p* = .03; Putamen Estimate = 0.43, SE = 0.31, *t*(80) = 1.39, *p* = .17). No associations between ADI Communication scores and amygdala – basal ganglia connectivity were observed in either group.

**Table S8. Amygdala – ACC/mPFC connectivity (No Global Signal Regression)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **dACC** | **dmPFC** | **rACC** | **sgACC** | **vmPFC** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 0.39 | 0.180.60 | **<.001** | 1.10 | 0.901.30 | **<.001** | 1.19 | 0.981.39 | **<.001** | 1.25 | 1.041.47 | **<.001** | 1.62 | 1.411.83 | **<.001** |
| TD vs ASDNo+ASDAnx | -0.36 | -0.68-0.04 | **.031** | -0.27 | -0.580.04 | .084 | -0.39 | -0.70-0.08 | **.016** | -0.18 | -0.510.15 | .295 | -0.04 | -0.360.29 | .822 |
| ASDNo vs ASDAnx | -0.77 | -1.23-0.30 | **.001** | -0.53 | -0.97-0.09 | **.018** | -0.64 | -1.09-0.19 | **.006** | -0.23 | -0.710.24 | .335 | 0.21 | -0.260.67 | .387 |
| Hemisphere | 0.03 | -0.090.16 | .604 | -0.03 | -0.160.10 | .662 | -0.05 | -0.180.08 | .430 | -0.28 | -0.43-0.14 | **<.001** | -0.18 | -0.31-0.05 | **.008** |
| Age | -0.31 | -2.672.04 | .796 | -1.11 | -3.341.12 | .329 | -1.71 | -3.990.58 | .144 | -3.16 | -5.56-0.75 | **.011** | -1.62 | -3.980.74 | .180 |
| Age2 | 1.36 | -0.913.62 | .242 | -0.35 | -2.501.79 | .747 | 1.31 | -0.893.50 | .244 | 3.64 | 1.335.95 | **.002** | 1.33 | -0.943.60 | .251 |
| Mean FD | 0.35 | 0.210.49 | **<.001** | 0.17 | 0.030.30 | **.017** | 0.25 | 0.110.39 | **.001** | -0.05 | -0.200.09 | .475 | -0.07 | -0.220.07 | .322 |
| Site EMC | -0.35 | -0.900.19 | .206 | -0.29 | -0.810.23 | .270 | -0.65 | -1.18-0.12 | **.017** | -0.63 | -1.19-0.07 | **.029** | -0.34 | -0.890.21 | .225 |
| Site IP | 0.38 | -0.351.12 | .305 | -0.40 | -1.100.29 | .256 | -0.76 | -1.47-0.05 | **.037** | -0.69 | -1.440.05 | .071 | -0.99 | -1.72-0.25 | **.009** |
| Site KKI | -0.17 | -0.550.21 | .372 | -0.50 | -0.86-0.14 | **.008** | -0.48 | -0.85-0.11 | **.011** | 0.16 | -0.220.55 | .411 | -0.37 | -0.750.01 | .059 |
| Site NYU2 | -0.71 | -1.39-0.03 | **.041** | -0.78 | -1.42-0.14 | **.018** | -0.79 | -1.44-0.13 | **.020** | -0.19 | -0.890.50 | .583 | -0.18 | -0.860.50 | .597 |
| Site OHSU | 0.10 | -0.260.46 | .575 | 0.10 | -0.240.44 | .580 | -0.01 | -0.360.34 | .953 | -0.01 | -0.380.36 | .957 | 0.28 | -0.080.65 | .123 |
| (TD vs ASDNo+ASDAnx)\*Hemi | 0.13 | -0.080.35 | .219 | 0.14 | -0.080.37 | .212 | 0.12 | -0.100.35 | .288 | -0.15 | -0.400.10 | .232 | -0.11 | -0.340.12 | .355 |
| (ASDNo vs ASDAnx)\*Hemi | 0.24 | -0.110.58 | .182 | -0.01 | -0.380.35 | .944 | 0.24 | -0.130.60 | .207 | -0.25 | -0.660.15 | .218 | -0.32 | -0.690.05 | .090 |
| (TD vs ASDNo+ASDAnx)\*Age | -1.67 | -5.822.48 | .432 | -0.36 | -4.293.57 | .859 | -1.91 | -5.932.11 | .352 | -3.32 | -7.550.92 | .126 | -3.89 | -8.040.27 | .068 |
| (ASDNo vs ASDAnx)\*Age | 2.71 | -3.468.87 | .391 | 0.16 | -5.686.00 | .957 | 0.38 | -5.606.36 | .901 | -1.69 | -7.994.60 | .599 | 1.94 | -4.238.12 | .539 |
| (TD vs ASDNo+ASDAnx)\*Age2 | 1.82 | -2.416.05 | .400 | 1.10 | -2.915.10 | .593 | -1.77 | -5.872.32 | .397 | -0.80 | -5.113.52 | .718 | 0.11 | -4.134.34 | .960 |
| (ASDNo vs ASDAnx)\*Age2 | -2.94 | -8.672.80 | .317 | 0.13 | -5.305.56 | .963 | -4.31 | -9.861.25 | .130 | 0.41 | -5.456.26 | .891 | 0.41 | -5.336.15 | .889 |
| **Random Effects** |
| σ2 | 0.29 | 0.31 | 0.32 | 0.39 | 0.33 |
| τ00 | 0.78 SUB | 0.67 SUB | 0.71 SUB | 0.77 SUB | 0.76 SUB |
| ICC | 0.73 | 0.68 | 0.69 | 0.66 | 0.70 |
| N | 232 SUB | 232 SUB | 232 SUB | 232 SUB | 232 SUB |
| Observations | 464 | 464 | 464 | 464 | 464 |
| Marginal R2 / Conditional R2 | 0.153 / 0.772 | 0.095 / 0.711 | 0.145 / 0.735 | 0.111 / 0.701 | 0.117 / 0.736 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), TD vs ASDNo+ASDAnx (TD -2/3, ASD-NoAnx+1/3, ASD+Anxiety +1/3), ASDNo vs ASDAnx (TD -1/3, ASD-NoAnx -1/3, ASD+Anxiety +2/3). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S9. Relationships between Amygdala – ACC/mPFC connectivity and clinical ratings in individuals with ASD (No Global Signal Regression)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **dACC** | **dmPFC** | **rACC** | **sgACC** | **vmPFC** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 0.56 | 0.170.96 | **.007** | 1.01 | 0.691.33 | **<.001** | 1.29 | 0.951.63 | **<.001** | 1.27 | 0.921.61 | **<.001** | 1.46 | 1.081.83 | **<.001** |
| ASDNo vs ASDAnx | -1.22 | -1.90-0.54 | **.001** | -0.93 | -1.49-0.37 | **.002** | -1.08 | -1.66-0.50 | **<.001** | -0.44 | -1.040.15 | .145 | -0.20 | -0.840.45 | .558 |
| Hemisphere | 0.04 | -0.150.24 | .649 | 0.00 | -0.200.20 | .989 | -0.04 | -0.230.16 | .708 | -0.35 | -0.57-0.13 | **.003** | -0.21 | -0.40-0.03 | **.028** |
| Age | -3.44 | -6.62-0.26 | **.037** | -2.41 | -5.010.19 | .073 | -4.42 | -7.13-1.70 | **.002** | -3.90 | -6.67-1.13 | **.007** | -3.10 | -6.14-0.06 | **.049** |
| Age2 | 3.43 | 0.336.54 | **.033** | 0.43 | -2.112.96 | .743 | 1.83 | -0.834.48 | .181 | 1.07 | -1.633.78 | .438 | 1.30 | -1.664.27 | .391 |
| Social | -0.04 | -0.470.38 | .841 | -0.53 | -0.88-0.18 | **.004** | -0.27 | -0.640.09 | .150 | -0.11 | -0.480.26 | .555 | -0.26 | -0.670.15 | .218 |
| Comm. | -0.20 | -0.570.17 | .296 | 0.05 | -0.250.36 | .730 | 0.10 | -0.210.42 | .529 | 0.09 | -0.230.41 | .589 | 0.12 | -0.230.47 | .510 |
| RRB | 0.52 | 0.090.96 | **.020** | 0.30 | -0.050.65 | .102 | 0.38 | 0.010.75 | **.050** | -0.03 | -0.400.35 | .887 | 0.01 | -0.400.42 | .967 |
| Mean FD | 0.65 | 0.330.98 | **<.001** | 0.34 | 0.080.61 | **.014** | 0.45 | 0.170.73 | **.002** | -0.12 | -0.410.16 | .400 | 0.18 | -0.130.50 | .255 |
| Site IP | -0.92 | -2.550.72 | .274 | -0.32 | -1.651.02 | .642 | -1.71 | -3.11-0.32 | **.018** | -0.88 | -2.300.54 | .228 | -0.31 | -1.871.25 | .697 |
| Site KKI | -0.49 | -1.490.52 | .347 | -0.04 | -0.860.79 | .928 | -0.32 | -1.180.54 | .472 | 0.36 | -0.511.24 | .419 | 0.15 | -0.811.11 | .760 |
| Site NYU2 | -1.17 | -1.99-0.35 | **.006** | -0.92 | -1.59-0.26 | **.008** | -1.08 | -1.78-0.38 | **.003** | -0.21 | -0.920.50 | .563 | 0.10 | -0.680.88 | .807 |
| Site OHSU | 0.35 | -0.260.96 | .265 | 0.21 | -0.280.71 | .402 | 0.18 | -0.340.70 | .508 | -0.06 | -0.600.47 | .811 | 0.52 | -0.061.10 | .083 |
| (ASDNo vs ASDAnx)\*Hemi | 0.32 | -0.060.71 | .102 | 0.01 | -0.390.41 | .954 | 0.30 | -0.090.68 | .136 | -0.17 | -0.610.27 | .455 | -0.27 | -0.640.10 | .161 |
| (ASDNo vs ASDAnx)\*Age | -1.99 | -8.664.69 | .561 | -2.42 | -7.883.04 | .387 | -3.26 | -8.952.44 | .266 | 0.92 | -4.896.73 | .758 | -2.41 | -8.793.96 | .460 |
| (ASDNo vs ASDAnx)\*Age2 | -2.73 | -9.664.20 | .442 | -0.09 | -5.755.58 | .976 | -1.61 | -7.534.31 | .596 | -0.20 | -6.245.83 | .947 | -1.00 | -7.625.62 | .769 |
| (ASDNo vs ASDAnx)\*Social | -0.06 | -0.880.76 | .893 | -0.63 | -1.300.04 | .069 | -0.13 | -0.820.57 | .727 | -0.60 | -1.310.12 | .106 | -0.12 | -0.900.67 | .773 |
| (ASDNo vs ASDAnx)\*Comm. | 0.11 | -0.590.82 | .751 | 0.09 | -0.480.67 | .750 | 0.16 | -0.440.77 | .595 | 0.11 | -0.500.73 | .718 | 0.03 | -0.650.70 | .937 |
| (ASDNo vs ASDAnx)\*RRB | 0.15 | -0.620.92 | .702 | 0.13 | -0.490.76 | .676 | 0.02 | -0.640.68 | .956 | 0.11 | -0.560.78 | .747 | 0.19 | -0.540.93 | .608 |
| Age\*Social | -3.26 | -6.790.26 | .073 | -1.21 | -4.101.67 | .411 | -1.29 | -4.301.72 | .402 | 2.01 | -1.065.08 | .202 | -2.37 | -5.731.00 | .172 |
| Age2\*Social | 2.09 | -1.605.79 | .270 | 0.05 | -2.973.08 | .973 | 4.21 | 1.057.37 | **.011** | 3.04 | -0.186.26 | .068 | -0.05 | -3.583.48 | .977 |
| Age\*Comm. | -0.56 | -4.443.33 | .779 | 0.67 | -2.513.84 | .680 | -1.87 | -5.191.44 | .272 | -1.50 | -4.881.88 | .388 | 0.14 | -3.573.85 | .940 |
| Age2\*Comm. | -2.22 | -6.011.56 | .253 | -0.02 | -3.113.07 | .990 | -3.67 | -6.90-0.44 | **.029** | -1.77 | -5.061.53 | .296 | -0.66 | -4.272.95 | .722 |
| Age\*RRB | 2.98 | -2.027.98 | .246 | -0.22 | -4.313.87 | .917 | 2.83 | -1.447.10 | .198 | 0.10 | -4.254.46 | .963 | 3.04 | -1.747.81 | .216 |
| Age2\*RRB | 2.33 | -3.287.95 | .418 | 2.02 | -2.576.62 | .391 | 2.77 | -2.027.57 | .260 | 2.23 | -2.667.12 | .374 | 3.26 | -2.108.63 | .237 |
| **Random Effects** |
| σ2 | 0.31 | 0.34 | 0.32 | 0.42 | 0.30 |
| τ00 | 0.84 SUB | 0.50 SUB | 0.57 SUB | 0.55 SUB | 0.76 SUB |
| ICC | 0.73 | 0.59 | 0.64 | 0.57 | 0.72 |
| N | 80 SUB | 80 SUB | 80 SUB | 80 SUB | 80 SUB |
| Observations | 160 | 160 | 160 | 160 | 160 |
| Marginal R2 / Conditional R2 | 0.382 / 0.832 | 0.330 / 0.728 | 0.377 / 0.778 | 0.240 / 0.673 | 0.192 / 0.773 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), ASDNo vs ASDAnx (ASD-NoAnx -.5, ASD+Anxiety +.5). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Social, Comm., and RRB are ADI Total scores for Social, Communication, and Restricted and Repetitive Behaviors (Diagnostic Algorithm); values were scaled by converting to Z-scores using sample mean and SD. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S10. Amygdala – Basal Ganglia connectivity (No Global Signal Regression)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Caudate (Head)** | **Nucleus Accumbens** | **Putamen** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 1.05 | 0.881.22 | **<.001** | 1.68 | 1.491.87 | **<.001** | 1.96 | 1.762.17 | **<.001** |
| TD vs ASDNo+ASDAnx | -0.04 | -0.300.22 | .765 | -0.10 | -0.400.19 | .487 | -0.20 | -0.510.12 | .224 |
| ASDNo vs ASDAnx | -0.24 | -0.610.13 | .211 | -0.42 | -0.840.00 | .053 | 0.04 | -0.410.50 | .850 |
| Hemisphere | 0.03 | -0.080.13 | .604 | -0.01 | -0.110.09 | .862 | 0.24 | 0.140.34 | **<.001** |
| Crossing | -0.12 | -0.22-0.01 | **.034** | -0.04 | -0.140.06 | .393 | -0.17 | -0.27-0.07 | **.001** |
| Age | 0.04 | -1.851.93 | .968 | -2.62 | -4.76-0.48 | **.017** | 0.08 | -2.222.37 | .948 |
| Age2 | -0.57 | -2.391.24 | .536 | 0.40 | -1.662.45 | .706 | -0.81 | -3.021.39 | .472 |
| Mean FD | 0.15 | 0.030.26 | **.012** | 0.06 | -0.070.19 | .399 | 0.24 | 0.100.38 | **.001** |
| Site EMC | -0.52 | -0.96-0.08 | **.022** | -0.23 | -0.730.27 | .362 | -0.65 | -1.18-0.12 | **.018** |
| Site IP | -0.57 | -1.160.02 | .058 | -0.42 | -1.090.24 | .212 | -0.95 | -1.67-0.24 | **.010** |
| Site KKI | -0.61 | -0.92-0.30 | **<.001** | 0.10 | -0.250.44 | .583 | -0.98 | -1.35-0.61 | **<.001** |
| Site NYU2 | -0.32 | -0.870.22 | .247 | -0.42 | -1.040.19 | .182 | -0.33 | -0.990.33 | .333 |
| Site OHSU | -0.28 | -0.570.01 | .059 | -0.60 | -0.93-0.28 | **<.001** | -0.28 | -0.630.07 | .114 |
| (TD vs ASDNo+ASDAnx)\*Hemi | 0.00 | -0.180.19 | .988 | 0.16 | -0.010.33 | .074 | 0.09 | -0.080.27 | .300 |
| (ASDNo vs ASDAnx)\*Hemi | -0.12 | -0.420.18 | .443 | -0.08 | -0.360.20 | .577 | -0.02 | -0.300.26 | .896 |
| (TD vs ASDNo+ASDAnx)\*Crossing | -0.02 | -0.210.16 | .814 | -0.04 | -0.220.13 | .637 | -0.09 | -0.270.08 | .287 |
| (ASDNo vs ASDAnx)\*Crossing | -0.16 | -0.460.13 | .281 | -0.03 | -0.310.25 | .856 | 0.04 | -0.250.32 | .807 |
| (TD vs ASDNo+ASDAnx)\*Age | 0.09 | -3.253.42 | .960 | -1.60 | -5.372.16 | .405 | -0.72 | -4.763.32 | .728 |
| (ASDNo vs ASDAnx)\*Age | 3.39 | -1.578.35 | .181 | 1.95 | -3.647.55 | .495 | 3.37 | -2.649.37 | .273 |
| (TD vs ASDNo+ASDAnx)\*Age2 | 0.19 | -3.213.59 | .911 | -0.83 | -4.663.01 | .673 | -3.17 | -7.290.95 | .133 |
| (ASDNo vs ASDAnx)\*Age2 | -2.65 | -7.261.96 | .261 | -2.02 | -7.223.18 | .447 | -2.90 | -8.492.68 | .310 |
| **Random Effects** |
| σ2 | 0.43 | 0.37 | 0.38 |
| τ00 | 0.49 SUB | 0.67 SUB | 0.78 SUB |
| ICC | 0.53 | 0.64 | 0.67 |
| N | 232 SUB | 232 SUB | 232 SUB |
| Observations | 928 | 928 | 928 |
| Marginal R2 / Conditional R2 | 0.084 / 0.573 | 0.103 / 0.677 | 0.154 / 0.724 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), Crossing (Ipsilateral -.5, Contralateral +.5), TD vs ASDNo+ASDAnx (TD -2/3, ASD-NoAnx+1/3, ASD+Anxiety +1/3), ASDNo vs ASDAnx (TD -1/3, ASD-NoAnx -1/3, ASD+Anxiety +2/3). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

**Table S11. Relationships between Amygdala – Basal Ganglia connectivity and clinical ratings in individuals with ASD (No Global Signal Regression)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Caudate (Head)** | **Nucleus Accumbens** | **Putamen** |
| *Predictors* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* | *Estimates* | *CI* | *p* |
| (Intercept) | 1.10 | 0.841.36 | **<.001** | 1.67 | 1.381.96 | **<.001** | 2.17 | 1.842.51 | **<.001** |
| ASDNo vs ASDAnx | -0.74 | -1.19-0.29 | **.002** | -0.79 | -1.29-0.30 | **.002** | -0.16 | -0.730.42 | .599 |
| Hemisphere | 0.01 | -0.140.17 | .854 | 0.02 | -0.130.16 | .813 | 0.24 | 0.090.39 | **.002** |
| Crossing | -0.11 | -0.270.04 | .162 | -0.07 | -0.210.08 | .357 | -0.18 | -0.33-0.03 | **.021** |
| Age | -1.49 | -3.590.62 | .170 | -3.79 | -6.09-1.49 | **.002** | -2.36 | -5.060.34 | .091 |
| Age2 | 0.26 | -1.792.31 | .803 | -0.38 | -2.631.87 | .742 | 0.28 | -2.362.91 | .837 |
| Social | -0.15 | -0.440.13 | .287 | -0.06 | -0.360.25 | .725 | 0.08 | -0.280.45 | .652 |
| Comm. | -0.11 | -0.350.14 | .383 | 0.10 | -0.170.37 | .475 | -0.03 | -0.340.29 | .862 |
| RRB | 0.49 | 0.210.78 | **.001** | 0.16 | -0.150.47 | .317 | 0.40 | 0.030.77 | **.035** |
| Mean FD | 0.49 | 0.280.71 | **<.001** | 0.16 | -0.080.39 | .197 | 0.66 | 0.380.93 | **<.001** |
| Site IP | -0.86 | -1.940.22 | .122 | -0.64 | -1.820.54 | .293 | -1.51 | -2.89-0.12 | **.036** |
| Site KKI | -0.30 | -0.970.37 | .379 | 0.53 | -0.201.26 | .161 | -1.37 | -2.22-0.51 | **.002** |
| Site NYU2 | -0.35 | -0.890.19 | .202 | -0.35 | -0.940.24 | .250 | -0.62 | -1.310.08 | .085 |
| Site OHSU | -0.24 | -0.640.17 | .253 | -0.66 | -1.10-0.22 | **.004** | -0.19 | -0.710.33 | .469 |
| (ASDNo vs ASDAnx)\*Hemi | -0.12 | -0.430.19 | .460 | -0.06 | -0.350.23 | .680 | 0.03 | -0.270.33 | .836 |
| (ASDNo vs ASDAnx)\*Cross | -0.12 | -0.430.19 | .462 | -0.02 | -0.310.27 | .896 | 0.06 | -0.240.36 | .711 |
| (ASDNo vs ASDAnx)\*Age | -3.08 | -7.491.33 | .175 | 0.61 | -4.225.44 | .805 | -2.27 | -7.933.40 | .435 |
| (ASDNo vs ASDAnx)\*Age2 | -2.80 | -7.381.78 | .234 | 0.56 | -4.465.58 | .827 | 0.12 | -5.776.00 | .969 |
| (ASDNo vs ASDAnx)\*Social | 0.32 | -0.220.86 | .256 | 0.01 | -0.580.60 | .977 | 0.88 | 0.191.58 | **.015** |
| (ASDNo vs ASDAnx)\*Comm. | -0.27 | -0.740.19 | .256 | 0.02 | -0.490.54 | .924 | -0.40 | -1.000.21 | .201 |
| (ASDNo vs ASDAnx)\*RRB | 0.14 | -0.370.65 | .595 | 0.26 | -0.300.81 | .367 | 0.08 | -0.570.73 | .815 |
| Age\*Social | -0.00 | -2.332.32 | .998 | 0.44 | -2.112.98 | .738 | -0.74 | -3.732.25 | .628 |
| Age2\*Social | 0.66 | -1.783.09 | .600 | 3.92 | 1.246.59 | **.005** | 0.45 | -2.683.59 | .779 |
| Age\*Comm. | -3.97 | -6.53-1.40 | **.003** | -2.51 | -5.320.30 | .083 | -2.65 | -5.940.65 | .119 |
| Age2\*Comm. | -1.65 | -4.140.85 | .200 | -4.23 | -6.96-1.50 | **.003** | -1.65 | -4.861.56 | .317 |
| Age\*RRB | 5.94 | 2.649.23 | **.001** | 4.35 | 0.737.96 | **.021** | 4.71 | 0.478.95 | **.032** |
| Age2\*RRB | 4.69 | 0.988.40 | **.015** | 2.93 | -1.136.99 | .161 | 1.66 | -3.106.42 | .497 |
| **Random Effects** |
| σ2 | 0.42 | 0.36 | 0.39 |
| τ00 | 0.33 SUB | 0.43 SUB | 0.63 SUB |
| ICC | 0.44 | 0.55 | 0.62 |
| N | 80 SUB | 80 SUB | 80 SUB |
| Observations | 320 | 320 | 320 |
| Marginal R2 / Conditional R2 | 0.256 / 0.587 | 0.328 / 0.698 | 0.309 / 0.737 |

Note: Predictors are contrast coded: Hemisphere (Left -.5, Right +.5), Crossing (Ipsilateral -.5, Contralateral +.5), ASDNo vs ASDAnx (ASD-NoAnx -.5, ASD+Anxiety +.5). Age and Age2 are orthogonal polynomials centered in the range 5-18 years. Subjects’ mean framewise displacement (FD) is Z-transformed. Social, Comm., and RRB are ADI Total scores for Social, Communication, and Restricted and Repetitive Behaviors (Diagnostic Algorithm); values were scaled by converting to Z-scores using sample mean and SD. Table includes fixed effect estimates, 95% Confidence Intervals, and parameter *p*-values (based on the Kenwood-Rogers approximation for degrees of freedom).

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