|  |
| --- |
| **Callous and uncaring traits are associated with reductions in amygdala volume among youths with varying levels of conduct problems.** |
|  |
| **SUPPLEMENTARY MATERIAL** |
|  |

**Supplementary Text 1.**

Analyses examining the relationship between ICU scores and clinical symptomology were repeated following exclusion of participants who did not complete MRI scanning. For all analyses, gender, IQ, and age at screening were included as covariates. Results of a multiple linear regression analysis across only participants included in the neuroimaging analyses (n=84) predicting externalizing behaviors from ICU scores confirmed results observed in analyses across all participants (n=148); as total ICU scores increased, externalizing behaviors increased, =0.82, *t*(79)=13.08, *p*<.001, even after controlling for attentional difficulties and internalizing behaviors, =0.51, *t*(77)=6.33, *p*<.001. Again consistent with findings across all participants, a multiple regression with all three ICU subscales predicting externalizing behavior problems found that scores on the callous, =0.44, *t*(77)=4.17, *p*<.001, and uncaring, =0.44, *t*(77)=4.87, *p*<.001, subscales were independently associated with increased externalizing, whereas unemotional subscale scores were not, =0.01, *t*(77)=0.28, *p*=0.78. These findings again persisted after controlling for attentional difficulties and internalizing behaviors for the association between externalizing and the callous subscale, =0.26, *t*(75)=3.05, *p*=.003, and uncaring subscale, =0.35, *t*(75)=4.39, *p*<0.001, whereas the unemotional subscale scores remained non-significant, =-0.04, *t*(75)=-0.70, *p*=0.49.

**Supplementary Table 1.**

*Intercorrelations amongst experimental variables in the total sample (n=148)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1. Total ICU | --- |  |  |  |  |  |  |  |  |
| 2. Callous | 0.92\*\*\* | --- |  |  |  |  |  |  |  |
| 3. Uncaring | 0.84\*\*\* | 0.62\*\*\* | --- |  |  |  |  |  |  |
| 4. Unemotional | 0.67\*\*\* | 0.52\*\*\* | 0.40\*\*\* | --- |  |  |  |  |  |
| 5. Externalizing | 0.75\*\*\* | 0.72\*\*\* | 0.65\*\*\* | 0.36\*\*\* | --- |  |  |  |  |
| 6. Internalizing | 0.50\*\*\* | 0.54\*\*\* | 0.32\*\* | 0.34\*\* | 0.65\*\*\* | --- |  |  |  |
| 7. Attentional Difficulties | 0.68\*\*\* | 0.66\*\*\* | 0.60\*\*\* | 0.36\*\*\* | 0.82\*\*\* | 0.66\*\*\* | --- |  |  |
| 8. Left Amygdalaa | -0.31\*\* | -0.25\* | -0.40\*\*\* | -0.09 | -0.30\*\* | -0.13 | -0.36\*\*\* | --- |  |
| 9. Right Amygdalaa | -0.27\* | -0.22\* | -0.33\*\* | -0.11 | -0.26\* | -0.16 | -0.26\* | 0.78\*\*\* | --- |

aNeuroimaging measures were acquired in a subset of participants (n=84)

**Supplementary Table 2.**

*Descriptive statistics for subcortical volume (n=84)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Subcortical Region | | Mean | Stdev | Min-Max | Skew | Kurt |
| Accumbens | Left | 607.2 | 107.6 | 362.8 - 990.9 | 0.77 | 4.30 |
| Right | 653.7 | 98.1 | 400 - 964.5 | 0.31 | 3.68 |
| Amygdala | Left | 1686.2 | 221.4 | 1194.2 - 2163 | 0.21 | 2.53 |
| Right | 1705.3 | 232.8 | 1171.8 - 2272.7 | 0.11 | 2.81 |
| Caudate | Left | 3838.1 | 608.7 | 2502.7 - 5639.2 | 0.22 | 2.94 |
| Right | 3762.7 | 599.5 | 2394.3 - 5625.9 | 0.19 | 3.14 |
| Hippocampus | Left | 4404.4 | 516.1 | 2060.3 - 5565.6 | -0.86 | 6.86 |
| Right | 4553.0 | 464.4 | 3572.3 - 5562.9 | 0.02 | 2.08 |
| Pallidum | Left | 1574.4 | 227.5 | 983.1 - 2247.2 | 0.16 | 3.22 |
| Right | 1585.3 | 209.3 | 1001.1 - 2146.6 | 0.35 | 3.74 |
| Putamen | Left | 5946.4 | 733.4 | 4360.8 - 7417.7 | 0.06 | 2.33 |
| Right | 5695.5 | 628.1 | 4312.7 - 7016.6 | 0.13 | 2.37 |
| Thalamus | Left | 8390.1 | 800.2 | 6747.5 - 10510.8 | 0.41 | 2.38 |
| Right | 7595.9 | 712.0 | 6061.2 - 9685.7 | 0.27 | 2.97 |
| Ventral DC | Left | 3892.5 | 398.7 | 3034.7 - 4846.2 | 0.21 | 2.64 |
| Right | 3876.6 | 366.9 | 3183.1 - 4976.6 | 0.41 | 3.05 |



**Supplementary Figure 3.** CU traits mediate the relationship between externalizing behaviors and amygdala volume. Note: \*p<.05, \*\* p<.01, \*\*\*p<.001, Unstandardized regression coefficients are reported for each path.

**Supplementary Table 3.**

*Association between CU traits and subcortical volume (n = 84). All multiple regression models were run with robust standard errors and included Age at time of screen, age at time of scan, gender, IQ, headcoil, and total intercranial volume as covariates.* \**p* < .05 \*\**p* < .01

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Subcortical Region | | Standardized Beta | Standard Error | t-value | p-value |
| Accumbens | Left | -0.04 | 0.13 | -0.29 | 0.77 |
| Right | 0.05 | 0.12 | 0.42 | 0.68 |
| Amygdala | Left | -0.36 | 0.11 | -3.21 | 0.002\*\* |
| Right | -0.27 | 0.10 | -2.64 | 0.01\* |
| Caudate | Left | 0.005 | 0.09 | 0.05 | 0.96 |
| Right | -0.03 | 0.09 | -0.33 | 0.74 |
| Hippocampus | Left | -0.04 | 0.09 | -0.46 | 0.65 |
| Right | -0.02 | 0.10 | -0.21 | 0.84 |
| Pallidum | Left | -0.11 | 0.12 | -0.98 | 0.33 |
| Right | -0.13 | 0.12 | -1.16 | 0.25 |
| Putamen | Left | -0.08 | 0.11 | -0.73 | 0.47 |
| Right | -0.08 | 0.11 | -0.76 | 0.45 |
| Thalamus | Left | -0.81 | 0.07 | -1.17 | 0.25 |
| Right | -0.02 | 0.08 | -0.31 | 0.76 |
| Ventral DC | Left | -0.08 | 0.09 | -0.86 | 0.39 |
| Right | -0.12 | 0.09 | -1.43 | 0.16 |

**Supplementary Table 4.**

*Association between subscales of the ICU with subcortical volume (n = 84). All multiple regression models were run with robust standard errors and included Age at time of screen, age at time of scan, gender, IQ, headcoil, and total intercranial volume as covariates.* \**p* < .05 \*\**p* < .01 †*p = .05*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Subcortical Region | | Callous  *(SE)* | Uncaring  *(SE)* | Unemotional  *(SE)* | Callous-Uncaring  *(SE)* |
| Accumbens | Left | 0.06 (0.12) | -0.14 (0.14) | -0.01 (0.11) | -0.04 (0.13) |
| Right | 0.15 (0.11) | -0.05 (0.14) | 0.02 (0.10) | 0.06 (0.13) |
| Amygdala | Left | -0.32 (0.09)\*\* | -0.35 (0.11)\*\* | -0.18 (0.11) | -0.36 (0.11)\*\* |
| Right | -0.24 (0.10)\* | -0.24 (0.10)\* | -0.17 (0.09)† | -0.26 (0.10)\* |
| Caudate | Left | 0.02 (0.09) | 0.02 (0.09) | -0.07 (0.11) | 0.02 (0.09) |
| Right | 0.01 (0.08) | -0.03 (0.09) | -0.13 (0.11) | -0.01 (0.08) |
| Hippocampus | Left | -0.04 (0.09) | -0.02 (0.11) | -0.01 (0.10) | -0.03 (0.10) |
| Right | -0.01 (0.09) | -0.07 (0.11) | 0.07 (0.09) | -0.04 (0.10) |
| Pallidum | Left | -0.05 (0.11) | -0.08 (0.12) | -0.22 (0.13) | -0.07 (0.11) |
| Right | -0.07 (0.11) | -0.16 (0.12) | -0.12 (0.09) | -0.12 (0.12) |
| Putamen | Left | -0.02 (0.11) | -0.10 (0.11) | -0.13 (0.11) | -0.06 (0.11) |
| Right | -0.004 (0.10) | -0.12 (0.11) | -0.11 (0.11) | -0.07 (0.10) |
| Thalamus | Left | -0.04 (0.07) | -0.10 (0.07) | -0.09 (0.06) | -0.08 (0.07) |
| Right | -0.02 (0.08) | -0.02 (0.08) | -0.04 (0.07) | -0.02 (0.08) |
| Ventral DC | Left | -0.03 (0.10) | -0.11 (0.09) | -0.06 (0.08) | -0.07 (0.09) |
| Right | -0.06 (0.10) | -0.17 (0.08) \* | -0.05 (0.07) | -0.12 (0.08) |

**Supplementary Table 5.**

*Association between externalizing behaviors and subcortical volume (n = 84). All multiple regression models were run with robust standard errors and included Age at time of screen, age at time of scan, gender, IQ, headcoil, and total intercranial volume as covariates.* \**p* < .05

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Subcortical Region | | Standardized Beta | Standard Error | t-value | p-value |
| Accumbens | Left | -0.06 | 0.13 | -0.46 | 0.64 |
| Right | 0.004 | 0.13 | 0.03 | 0.98 |
| Amygdala | Left | -0.27 | 0.11 | -2.54 | 0.01\* |
| Right | -0.18 | 0.09 | -1.88 | 0.06 |
| Caudate | Left | -0.06 | 0.09 | -0.67 | 0.50 |
| Right | -0.09 | 0.09 | -0.98 | 0.33 |
| Hippocampus | Left | 0.02 | 0.10 | 0.22 | 0.83 |
| Right | -0.02 | 0.09 | -0.24 | 0.81 |
| Pallidum | Left | -0.06 | 0.12 | -0.52 | 0.60 |
| Right | -0.18 | 0.12 | -1.52 | 0.13 |
| Putamen | Left | -0.04 | 0.12 | -0.30 | 0.77 |
| Right | -0.07 | 0.12 | -0.58 | 0.56 |
| Thalamus | Left | -0.06 | 0.07 | -0.94 | 0.35 |
| Right | 0.001 | 0.09 | 0.02 | 0.99 |
| Ventral DC | Left | -0.12 | 0.09 | -1.33 | 0.19 |
| Right | -0.18 | 0.08 | -2.18 | 0.03\* |