Data Supplement for Alegria et al., Meta-Analysis of fMRI Studies of Disruptive Behavior Disorders. Am J Psychiatry (doi: 10.1176/appi.ajp.2016.15081089)

Supplementary Methods: Estimation of the mean of the effect-sizes of the different functional tasks, and its variance accounting for the number of tasks and the correlation among them

Note: the following formulas would be separately applied to each voxel of the brain map.

In previous meta-analyses(47) we had calculated the effect size of the "mean brain response to the different functional tasks". However, it may be shown that the variance associated to this mean brain response is lower than the variance associated to one task (see demonstration below). And this increase in precision implies an increase of the effect size, which could be a source of meta-analytic heterogeneity. To overcome this artificial, methodological heterogeneity, this study has adopted a new approach, consisting in simply calculating the arithmetic mean of the effect size of the different functional tasks, but then adjusting its variance accounting for the number of tasks and the correlation among them in order that the combined study has the same statistical significance (z-value) as when using the effect size of the mean response. In other words, the effect size reflects the response of an individual to a task, and the fact that the combined study includes several tasks reduces the variance in a similar way than large samples do. This was applied when there was 50% or more sample overlap. This new simple approach will be included in the next version of SDM software to allow other researchers conduct repeated-measures meta-analyses. Please find steps below.

Sample mean and variance of the mean brain response to different functional tasks in one group

The mean brain response of the i^{th} participant to the different functional tasks is:

$$m_i = \frac{1}{N}\sum_{j=1}^{N} x_{ij}$$

where N is the number of functional tasks, and x_{ij} is the brain response of the i^{th} participant to the j^{th} functional task.

The sample mean of the mean brain response to the different functional tasks is:

$$\overline{m} = \frac{1}{n}\sum_{i=1}^{n} m_i = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{1}{N}\sum_{j=1}^{N} x_{ij}\right) = \frac{1}{N}\sum_{j=1}^{N}\left(\frac{1}{n}\sum_{i=1}^{n} x_{ij}\right) = \frac{1}{N}\sum_{j=1}^{N}\overline{x}_j$$

where n is the number of participants, and $\overline{x}_j$ is the sample mean of the brain response to the j^{th} functional task.

The sample variance of the mean brain response to the different functional tasks is:

$$
\begin{aligned}
s_m^2 &= \frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n} m_i^2 - \overline{m}^2\right) \\
&= \frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n}\left(\frac{1}{N}\sum_{j=1}^{N} x_{ij}\right)^2 - \left(\frac{1}{N}\sum_{j=1}^{N}\overline{x}_j\right)^2\right) \\
&= \frac{1}{N^2}\frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n}\left(\sum_{j=1}^{N} x_{ij}^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} x_{ij_1}x_{ij_2}\right) - \left(\sum_{j=1}^{N}\overline{x}_j^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N}\overline{x}_{j_1}\overline{x}_{j_2}\right)\right) \\
&= \frac{1}{N^2}\frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{N} x_{ij}^2 + 2\frac{1}{n}\sum_{i=1}^{n}\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} x_{ij_1}x_{ij_2} - \sum_{j=1}^{N}\overline{x}_j^2 - 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N}\overline{x}_{j_1}\overline{x}_{j_2}\right) \\
&= \frac{1}{N^2}\frac{n}{n-1}\left(\sum_{j=1}^{N}\left(\frac{1}{n}\sum_{i=1}^{n} x_{ij}^2 - \overline{x}_j^2\right) + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N}\left(\frac{1}{n}\sum_{i=1}^{n} x_{ij_1}x_{ij_2} - \overline{x}_{j_1}\overline{x}_{j_2}\right)\right) \\
&= \frac{1}{N^2}\left(\sum_{j=1}^{N}\frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n} x_{ij}^2 - \overline{x}_j^2\right) + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N}\frac{n}{n-1}\left(\frac{1}{n}\sum_{i=1}^{n} x_{ij_1}x_{ij_2} - \overline{x}_{j_1}\overline{x}_{j_2}\right)\right) \\
&= \frac{1}{N^2}\left(\sum_{j=1}^{N} s_j^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} s_{j_1,j_2}\right) \\
&= \frac{1}{N^2}\left(\sum_{j=1}^{N} s_j^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} s_{j_1}s_{j_2}r_{j_1,j_2}\right)
\end{aligned}
$$

where s_j^2 is the sample variance of the brain response to the j^{th} functional task, s_{j_1,j_2} is the sample covariance between the brain responses to the j_1^{th} and j_2^{nd} functional tasks, and r_{j_1,j_2} is the sample correlation between the brain responses to the j_1^{th} and j_2^{nd} functional tasks. The specific s_j and r_{j_1,j_2} are usually unknown, but the expression may be greatly simplified under the general assumption that sample variances and correlations are similar across the different functional tasks and groups:

$$
\begin{aligned}
s_m^2 &= \frac{1}{N^2}\left(\sum_{j=1}^{N} s_j^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} s_{j_1}s_{j_2}r_{j_1,j_2}\right) \\
&\approx \frac{1}{N^2}\left(\sum_{j=1}^{N} s^2 + 2\sum_{j_1=1}^{N-1}\sum_{j_2=j_1+1}^{N} s^2 r\right) \\
&= \frac{1}{N^2}\left(N\cdot s^2 + 2\cdot\frac{N(N-1)}{2}\cdot s^2 r\right) \\
&= \frac{1+(N-1)\cdot r}{N}\cdot s^2 \\
&= VR_{N,r}\cdot s^2
\end{aligned}
$$

where $VR_{N,r}$ is the variance reduction associated to the specific N and r. Note that if $r < 1$ (i.e. the brain response is not identical between tasks), then $VR_{N,r} < 1$, i.e. the variance associated to the mean brain response is lower than the variance associated to the response to one task.

Sample effect size of the difference in brain response to different functional tasks

The sample effect size of the difference in the mean brain response to the different functional tasks is:

$$
\begin{aligned}
d_m^* = \frac{\overline{m_p} - \overline{m_c}}{s_m} &= \frac{\frac{1}{N}\sum_{j=1}^{N}\overline{x}_{j,p} - \frac{1}{N}\sum_{j=1}^{N_0}\overline{x}_{j,c}}{\sqrt{\frac{(n_p - 1)\cdot s_{m,p}^2 + (n_c - 1)\cdot s_{m,c}^2}{n_p + n_c - 2}}} \\
&= \frac{\frac{1}{N}\sum_{j=1}^{N}\left(\overline{x}_{j,p} - \overline{x}_{j,c}\right)}{\sqrt{\frac{(n_p - 1)\cdot VR_{N,r}\cdot s_p^2 + (n_c - 1)\cdot VR_{N,r}\cdot s_c^2}{n_p + n_c - 2}}} \\
&= \frac{\frac{1}{N}\sum_{j=1}^{N} d_j^* \cdot s_j}{\sqrt{VR_{N,r}\cdot \frac{(n_p - 1)\cdot s_p^2 + (n_c - 1)\cdot s_c^2}{n_p + n_c - 2}}} \\
&\approx \frac{\frac{1}{N}\sum_{j=1}^{N} d_j^* \cdot s}{\sqrt{VR_{N,r}\cdot s^2}} \\
&= \frac{1}{\sqrt{VR_{N,r}}}\cdot \frac{1}{N}\sum_{j=1}^{N} d_j^* \\
&= \frac{1}{\sqrt{VR_{N,r}}}\cdot \overline{d^*}
\end{aligned}
$$

where d_j^* is the sample effect size of the difference in brain response to the j^{th} functional task, subindexes "p" and "c" refer to patients and controls, and sample variances have been assumed to be similar.

The z-value for this effect size is:

$$
\begin{aligned}
z(d_m) &= \frac{d_m}{\sqrt{\sigma^2\left(d_m\right)}} \\
&= \frac{J_{df}\cdot d_m^*}{\sqrt{\sigma^2\left(J_{df}\cdot d_m^*\right)}} \\
&= \frac{J_{df}\cdot d_m^*}{\sqrt{\left(\frac{1}{n_1}+\frac{1}{n_2}\right)+\left(1-\frac{df-2}{df\cdot J_{df}^2}\right)\cdot\left(J_{df}\cdot d_m^*\right)^2}} \\
&= \frac{J_{df}\cdot\frac{1}{\sqrt{VR_{N,r}}}\cdot\overline{d^*}}{\sqrt{\left(\frac{1}{n_1}+\frac{1}{n_2}\right)+\left(1-\frac{df-2}{df\cdot J_{df}^2}\right)\cdot\left(J_{df}\cdot\frac{1}{\sqrt{VR_{N,r}}}\cdot\overline{d^*}\right)^2}} \\
&= \frac{J_{df}\cdot\overline{d^*}}{\sqrt{VR_{N,r}\cdot\left(\frac{1}{n_1}+\frac{1}{n_2}\right)+\left(1-\frac{df-2}{df\cdot J_{df}^2}\right)\cdot\left(J_{df}\cdot\overline{d^*}\right)^2}} \\
&= \frac{\overline{d}}{\sqrt{VR_{N,r}\cdot\left(\frac{1}{n_1}+\frac{1}{n_2}\right)+\left(1-\frac{df-2}{df\cdot J_{df}^2}\right)\cdot\overline{d}^2}} \\
&= \frac{\overline{d}}{\sqrt{\sigma_{modified}^2\left(\overline{d}\right)}}
\end{aligned}
$$

where d_m is the effect size of the difference in the mean brain response to the different functional tasks, J_{df} is the bias correction, $\sigma^2\left(d\right)$ is the estimated variance of d, and $\overline{d}$ is the simple arithmetic mean of the effect sizes.

Thus if, in order to keep the effect size in the range of the effect size of the remaining studies, we calculate the simple arithmetic mean of the effect sizes, the same z-value may be obtained using the modified variance:

$$
\sigma_{modified}^2\left(d\right)=VR_{N,r}\cdot\left(\frac{1}{n_1}+\frac{1}{n_2}\right)+\left(1-\frac{df-2}{df\cdot J_{df}^2}\right)\cdot d^2
$$

SUPPLEMENTARY TABLE S1. Whole-brain fMRI studies of DBD/CP included in the main-analyses by type of task[a]

Paper	DBD/CP group							HC group				Task and contrasts	Reduced activation (relative to HC)	Enhanced activation
	N	Mean age	SD	Males (%)	Diagnosis (assessment tool)	ADHD (%)	Med (%)	N	Mean age	SD	Males (%)			
1a) Studies using hot EF tasks														
Rubia (16)	14	12.8	2	100	CD (MDSI)	0	0	16	13.1	3	100	Rewarded> non-rewarded CPT targets	R OFC/vMOFC	-
Crowley (18)	20[b]	16.5	1	100	CD & non-nicotine Substance abuse (DISC)	N/A	30	20	16.5	1.6	100	Colorado Balloon Game: Risky decision making> instructed response	B r/vMPFC, L OFc, B r/dACC, B insula, B precentral, L postcentral g, R pre-SMA, L claustrum, R caudate/putamen, R amygdala, R MTG/STG, L hippocampus, L precuneus, L PCC, , R IPL, R lingual g, L & R Cb	-
												Risky win> no outcome	B rACC, B STG/R MTG/ITG, R precuneus, R fusiform g, B Cb	
												Risky loss > no outcome	-	B dMPFC, L OFC, B MTG;L ITG, L brainstem/ pons, L culmen, R paracentral g., R PCC , B MTG, L prec.
Kalnin (43)[c]	22	14.64	0.28	59	DBD with aggressive features (K-SADS, aggressive symptoms>1)	N/A	27	22	14.86	0.34	59	Emot. Stroop: Violent > nonviolent words	-	-
Cohn (39)[d]	22[e]	17.1	1.4	73	DBD (DISC-IV)	68	N/A	236	17.9	1.1	87	MID task: Reward anticipation > neutral anticipation	-	-

												Loss anticipation > neutral anticipation	-	-
												Reward hit > reward miss	-	-
												Loss miss> hit	-	-
White (19)[c]	15	14.4	2	73.3	DBD (K-SADS)	46.6	20	15	14	2.3	66.7	Fear conditioning task: Choose not to open > choose to open door	L MPFC, L SFG	-
												Appetitive choice> physical threat choice during cue phase	L DLPFC, R IFG/precentral g	-
												Appetitive > contamination threat choice	R MPFC	-
												Physical threat > appetitive stimuli feedback	R MTG	-
												Appetitive stimuli> contamination threat feedback	L Middle Occipital g	-
Marsh(40)[f]	14	14.4	1.9	57	DBD + High CU (K-SADS + APSD-YV; PCL-YV)	64	42.8	14	13.5	1.7	79	Moral judgement: categorizing legal > illegal words	amygdala	-
Finger (20)[f]	14	13.8	1.3	64	DBD + PT (K-SADS + APSD; PCL-YV)	71	21.4	14	13.6	2.2	64	Reversal learning: Punished reversal errors > rewarded correct responses	-	B MFC, R caudate
Finger (17)[f]	15	14.1	1.8	60	DBD + PT (K-SADS + APSD; PCL-YV	66.6	46.7	15	13.2	1.1	60	Passive avoidance task: Early > late trials	R OFC, L MFC, L SFC, B IFG, L IPL, B MTG, L caudate, L Cb	-
												Rewarded correct hits > punished commission errors	OFC	-
												Punished commission errors > rewarded correct hits	L DLPFC, R parahippocampal g	-
White et al. (41)[f]	17	15.5	2.3	76.5	DBD + PT (K-SADS +	52.9	11.8	19	15.2	2.3	47	Eye gaze task: Fearful congruent > fearful	B SPL, B IPL, L cuneus	-

					APSD; PCL-YV)							incongruent		
White et al. (41) [f]	17	15.5	2.3	76.5	DBD + PT (K-SADS + APSD; PCL-YV)	52.9	11.8	19	15.2	2.3	47	Eye gaze task: Angry congruent > angry incongruent	-	-
White et al. (35) [f]	15	15.7	2.5	80	DBD + PT (K-SADS + APSD; PCL-YV)	53.3	26.7	17	14.5	2.1	52.9	Emotion-attention bars task: Fear> neutral expression	L MTG	-
1b) Studies using Cool EF tasks														
Rubia et al. (22)	13	13	1	100	CD (MDSI)	0	0	20	14	2	100	Stop task: Failed Stop > Go	R PCC/precuneus, L IPL, R postcentral/STG/IPL	-
												Successful stop > failed stop	-	-
Rubia et al. (16)	14	12.8	2	100	CD (MDSI)	0	0	16	13.1	3	100	Rewarded CPT: Non-rewarded targets > non-targets	R insula/hippoc./premotor, L dACC, B Cb/TL/ thalamus/occipital/ hippocampus/ L PCC/precuneus	-
Rubia et al. (21)	13	12.9	2.2	100	CD (MDSI)	0	0	20	14	1.9	100	Simon task: incongruent > oddball	R STG/MTG, R precuneus	-
												oddball trial > congruent trial	R DLPFC	-
Rubia (23)	14	12. 6	2.3	100	CD (MDSI)	0	0	20	13 5	1.9	100	Switch: Switch > repeat	R IPL/ precentral g, L STL/IPL, L precuneus, cuneus	-
Marsh et al. (40) [f]	14	14.4	1.9	57	DBD + High CU (K-SADS + APSD-YV; PCL-YV)	64	42.8	14	13.5	1.7	79	IAT task: incongruent > congruent	-	-
White et al. (41) [f]	17	15.5	2.3	76.5	DBD + PT (K-SADS + APSD)	52.9	11.8	19	15.2	2.3	47	Eye gaze task: fear versus neutral: Incongruent > congruent		-
White et al. (41) [f]	17	15.5	2.3	76.5	DBD + PT (K-SADS + APSD)	52.9	11.8	19	15.2	2.3	47	Eye gaze task: angry versus neutral: Incongruent > congruent	R MTG, R thalamus	-
White et al.	15	15.7	2.5	80	DBD + PT	53.3	26.7	17	14.5	2.1	52.9	Emotion-attention	-	-

(35) [f]					(K-SADS + APSD)							bars task: High > low attention load		
1c) Studies using emotion processing tasks														
Herpertz et al. (31)	22	14.7	1.42	100	CD (K-SADS)	73	N/A	22	14.7	1.36	100	Passive viewing Negative > Neutral valence	-	-
												Positive > Neutral valence	-	-
Passamonti et al. (30) [c]	40	17.7; 17.1	1.2; 1.0 [d]	100	CD (K-SADS)	27.2	N/A	20	17.8	0.9	100	Incidental gender judgment: Angry > neutral expression	R DLPFC, L MTG, L ant insula	-
												Sad > neutral expression	-	-
Fairchild et al. (29)	20	16.97	1.52	0	CD (K-SADS)	15	N/A	20	17.62	0.64	0	Incidental gender judgment: Angry > neutral expression	-	-
												Sad > neutral expression	-	-
Sebastian et al. (32)	17	14.54	1.58	100	Conduct Problems + Low CU (CASI-4R + ICU)	N/A	11.8	17	13.51	1.6	100	Dot allocation: (feareyes>calmeyes) > (fearface>calmface)	-	rACC/OFC
Sebastian et al. (44)	31	14.35	1.75	100	Conduct Problems (CASI-4R)	N/A	0	16	13.51	1.65	100	Affective ToM > Cognitive ToM	-	-
												Affective ToM > Physical causation	-	-
Cohn et al. (38)	25 [e]	17.3	1.4	72	DBD (DISC-IV)	64	N/A	26	17.8	1.2	89	Fear conditioning task: conditioned> unconditioned	-	-
O'Nions et al. (26) [f]	16	14.2	1.9	100	Conduct Problems + High CU (CASI-4R + ICU)	N/A	0	16	13.5	1.7	100	ToM: ToM> Physical causation	R r/vMPFC	-
Marsh et al. (28) [c,f]	12	14.5	1.5	58.3	DBD + High CU (K-SADS + APSD-YV;PCL-YV)	58.3	41.6	12	14.2	1.6	50	Incidental gender judgment: Fearful> neutral expression	R STG	-
												Angry> neutral expression	-	-
Marsh et al.	14	14.4	1.9	57	DBD + High CU	64	42.8	14	13.5	1.7	79	IAT task: Positive >	R STG, R PCC, Precuneus	-

(40)[f]					(K-SADS + APSD-YV;PCL-YV)							negative valenced objects		
Jones et al. (27)[f]	17	11.9	0.69	100	Conduct Problems + High CU (SDQ + CU scale APSD)	N/A	N/A	13	11.3	0.92	100	Incidental gender judgment: Fearful> neutral expression	-	-
White et al. (41)[f]	17	15.51	2.33	76	DBD + PT (K-SADS +APSD)	52.9	11.8	19	15.22	2.3	47	Eye gaze task: Fear> Neutral expression	-	-
												Neutral> Angry expression	-	L SFC,R MFC
1d) Studies using empathic pain tasks														
Lockwood et al. (37)	37	14.05	1.7	100	Conduct problems (CASI-4R conduct disorder scale)	N/A	0	18	13.7	1.7	100	Images of hand/foot in painful situation: Pain > No pain	L STG/post insula, R Cb, R MTG, R caudate, GP, subst nigra, L thalamus, L SMA, L & R IFC/insula, L DLPFC/IFC, R Cb, R SFC, L ACC, L precuneus	L Parahippocampal g., L Cb
Marsh et al. (36)[f]	14	15.4	2.3	57	DBD + PT (K-SADS + PCL-YV; APSD)	57.14	14.3	21	14.3	1.8	71	Rating the level of pain in painful situation images: Other’s > Own pain	L SFC, R insula, L amygdala/uncus	-

[a] Only whole-brain results are reported for the studies. In addition, the results of the studies are summarized in this table for the benefit of the reader; the metaanalysis
is not based on these labels but on numerical voxel data.
[b] Nineteen of 20 subjects met DSM-IV conduct disorder diagnostic criteria, and all met diagnostic criteria of substance use disorder.
[c] Results reported here were obtained through a personal communication with the author or through a data supplement.
[d] Results reported in the article were not statistically significant at the whole-brain level and thus were excluded from the meta-analysis.
[e] Sample recruited from a cohort of adolescents who were first arrested by the police before age 12.
[f] Study included only youths showing a high score for psychopathic traits or callous unemotional traits; hence, this was included in the subgroup meta-analysis of youths with DBD/CP with psychopathic traits.
ACC= anterior cingulate cortex; ADHD= attention deficit and hyperactivity disorder; ant= anterior; APSD-YV= antisocial process screening device young version; B= bilateral; CASI-4R= child and adolescent symptom inventory; Cb= cerebellum; CD= conduct disorder; CP= conduct problems; CPT= continuous performance task; CU= callous unemotional traits; dACC= dorsal anterior cingulate cortex; DBD= disruptive behaviour disorder; DISC= diagnostic Interview schedule for children; DLPFC= dorsolateral prefrontal cortex; dMPFC= dorsomedial prefrontal cortex; EF= Executive functions; Emot = emotional; Ext= extending; g= gyrus; GP= globus pallidus; HC= Healthy controls; IAT= Implicit association test; IFG= Inferior frontal gyrus; IPL= inferior parietal lobe; ITG= inferior temporal gyrus; K-SADS= Kiddie scheduled for affective disorders and schizophrenia; L= left; MID= Monetary incentive delay; MDSI= Maudsley Diagnostic Structural Interview; MFC= middle frontal cortex; MTG= middle temporal gyrus; OFC= orbitofrontal cortex; PCC= posterior cingulate cortex; PCL-YV= psychopathy checklist–youth version; Post= posterior; Prec = precuneus; PT= psychopathic traits; R= right; rACC= rostral anterior cingulate cortex; rMPFC= rostral medial prefrontal cortex; SD= standard deviation; SDQ= strengths and difficulties questionnaire; SFC= superior frontal cortex; SMA= supplementary motor area; Sup= superior; STG= superior temporal gyrus; SPL= superior parietal lobe; ToM= theory of mind; TL= temporal lobe; vMOFC=ventromedial orbitofrontal cortex; vMPFC=ventromedial prefrontal cortex YPI= youth psychopathic traits inventory

SUPPLEMENTARY TABLE S2. Jacknife analysis of the sub-domain meta-analysis of fMRI studies of Hot EF based on 22 different task contrast results from 10 independent samples.

	Studies and contrasts included in brain map	**Reduced r/dACC/ r/dMPFC/ SMA (0, 12, 38)[a]**	**Increased right caudate (18, 0, 26)[a]**
1	Cohn et al. (39): Monetary incentive delay task: Reward trial anticipation > neutral trial anticipation; Loss trial anticipation > neutral trial anticipation; Reward trail hit > reward trail miss; Loss trail miss> loss trail hit	Yes	Yes
2	Crowley et al. (18): Colorado balloon game: risky decision making > following instructions; Winnings > no outcome; Losing > no outcome	No	Yes
3	Finger et al .(17): Passive avoidance task: Early trials > non early trials; Rewarded correct hits > punished commission errors; Punished commission errors >rewarded correct hits	No	No
4	Finger et al. (20): Reversal learning: Punished reversal errors >rewarded correct responses	Yes	No
5	Kalnin et al. (43): Emotional Stroop: Violent word> nonviolent word	Yes	Yes
6	Marsh et al. (40): Categorizing illegal words > categorizing legal words	Yes	Yes
7	Rubia et al. (16): Rewarded CPT: Rewarded > non-rewarded target trials	Yes	Yes
8	White et al. (41): Eye gaze task: Fear vs neutral: congruent > incongruent trials; Angry vs neutral: congruent> incongruent trials	Yes	Yes
9	White et al. (35) Emotion-attention bars task: Fear > neutral expressions	Yes	Yes
10	White et al. (19): Choose not open > Choose to open appetitive door; Appetitive choice> physical threat choice; Appetitive choice> contamination choice; Physical threat > appetitive stimuli feedback; Appetitive stimuli>	Yes	Yes

contamination threat feedback			
	Total	8/10	8/10

[a] Yes = brain region remains significantly reduced/increased in the jacknife analyses; No = brain region is no longer significantly reduced/increased in jacknife analyses.
r/d = rostral/dorsal; ACC= anterior cingulate cortex; MPFC= medial prefrontal cortex; EF= executive functions; SMA= supplementary motor area

SUPPLEMENTARY TABLE S3. Jacknife analysis of the sub-domain meta-analysis of fMRI studies of Cool EF based on 10 different task contrast results from 4 independent samples

	Studies and contrasts included in brain map	**Reduced R STG/MTG/ insula/putamen (40, -12, -8)[a]**
1	Marsh et al. (40): Incongruent > congruent trials.	Yes
2	Rubia et al. (16): Rewarded CPT: Non-rewarded target > non-target trials. Rubia et al. (22): Stop task: Failed Stop > Go trials; successful stop > failed stop. Rubia et al. (23): Visual–spatial Switching task: Switch > repeat trials Rubia et al. (21): Simon task: Successful incongruent trial > successful oddball trials; Successful oddball trial > successful congruent trial.	Yes
3	White et al. (41) : Eye gaze task Fear vs neutral: Incongruent > congruent trials (interference effect); Eye gaze task Angry vs neutral: Incongruent > congruent trials (interference effect)	Yes
4	White et al. (35) : Emotion-attention bars task: High attentional load > low attentional load	No
	Total	3/4

[a] Yes = brain region remains significantly reduced in the jacknife analyses; No= brain region is no longer significantly decreased in jacknife analyses.
EF= executive functions; MTG= middle temporal gyrus; R= right; STG= superior temporal gyrus

SUPPLEMENTARY TABLE S4. Jacknife analysis of the sub-domain meta-analysis of fMRI studies of emotion processing based on 17 different task contrast results from 8 independent samples.

	Studies and contrasts included in brain map	Reduced L MTG/ITG (-48, -8, -26)[a]	Reduced R DLPFC (48, 26, 34)[a]
1	Cohn et al. (38): Fear Conditioning task: Conditioned > unconditioned stimuli	Yes	Yes
2	Fairchild et al. (29): Angry > neutral expression; Sad > neutral expression	Yes	Yes
3	Herpertz et al.(31): Negative > neutral valence images; Positive > neutral valence images	Yes	Yes
4	Jones et al. (27): Fearful > neutral expression	Yes	Yes
5	Marsh et al. (28): Fearful > neutral expression; Angry > neutral expression Marsh et al. (41): Positive valenced objects > negative valenced objects	Yes	Yes
6	Sebastian et al. (32): (Fearful eyes: (fear/eyes > calm/eyes) > (fear/face> calm/face) Sebastian et al. (44): Affective ToM > cognitive ToM; Affective ToM > physical causation O'Nions et al. (26): Tom > physical causation	Yes	Yes
7	Passamonti et al. (30) : Angry > neutral expression; Sad > neutral expression	No	No
8	White et al. (41) : Eye gaze task: Neutral > anger expression; Fear > neutral expression	Yes	Yes
	Total	7/8	7/8

[a] Yes = brain region remains significantly decreased in the jacknife analyses. No = brain region is no longer significantly decreased in jacknife analyses.

DLPFC= Dorsolateral prefrontal cortex; ITG= inferior temporal gyrus; L= Left; MFG= middle frontal gyrus; R= right; ToM= theory of mind.

SUPPLEMENTARY TABLE S5. Jacknife analysis of the subgroup meta-analysis of DBD/CP+PT in all tasks based on 19 different task contrast results from 7 independent samples

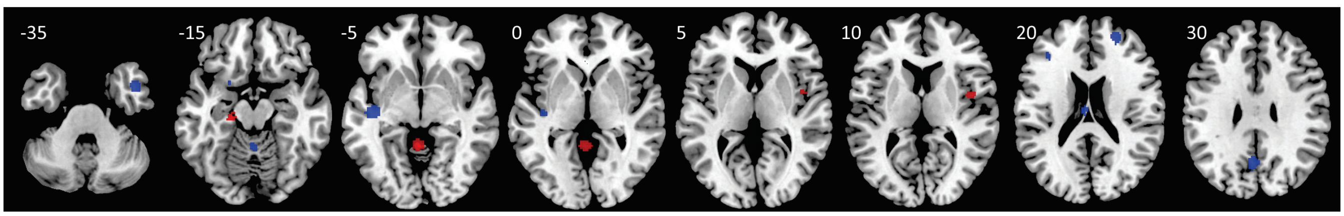
	Studies and contrasts included in brain map	**Reduced (hypo) thalamus/ vMPFC/VS (0, 0, 0)[a]**	**Increased rostral DLPFC (24, 48, 12)[a]**	**Increased dorsal caudate (18, 0, 26)[a]**
1	Finger et al. (20): Reversal learning: Punished reversal errors > rewarded correct responses	No	No	No
2	Finger et al. (17): Passive avoidance task: Early trials > non early trials; Rewarded correct hits > punished commission errors; Punished commission errors > rewarded correct hits	Yes	No	No
3	Jones et al.(27): Fearful > neutral expression	Yes	Yes	Yes
4	Marsh et al. (28): Fearful > neutral expression; Angry > neutral expression Marsh et al. (40): Positive valenced objects > negative valenced objects; categorizing illegal words > categorizing legal words; Incongruent > congruent trials. Marsh et al. (36): One's > Other's pain; Other's > One's pain	Yes	Yes	Yes
5	O'Nions et al. (26): Tom > physical causation	Yes	Yes	Yes
6	White et al. (41): Eye gaze task: Neutral > anger expression; Fear > neutral expression; Fear congruent > fear incongruent trials; Incongruent > congruent trials (interference effect)	Yes	Yes	Yes
7	White et al. (35): Emotion-attention bars task: Fear > neutral expressions; High attentional load > low attentional load	No	Yes	Yes
	Total	5/7	5/7	5/7

[a] Yes = brain region remains significantly increased/reduced in the jacknife analyses; No = brain region is no longer significantly increased/reduced in jacknife analyses.

DBD/CP= disruptive behaviour disorder/severe conduct problems; DLPFC= dorsolateral prefrontal cortex; HC= healthy controls; PT= psychopathic traits; vMPFC= ventral medial prefrontal cortex; VS = ventral striatum

Figure S1.

Effects of medication in DBD/CP: highly medicated DBD/CP compared to minimally medicated DBD/CP samples



Axial slices showing brain regions that are associated with medication. Red clusters indicate increased activity and Blue clusters indicate decreased activity in highly medicated DBD/CP compared to minimally/not medicated DBD/CP samples. The right side corresponds to the right side of the brain.