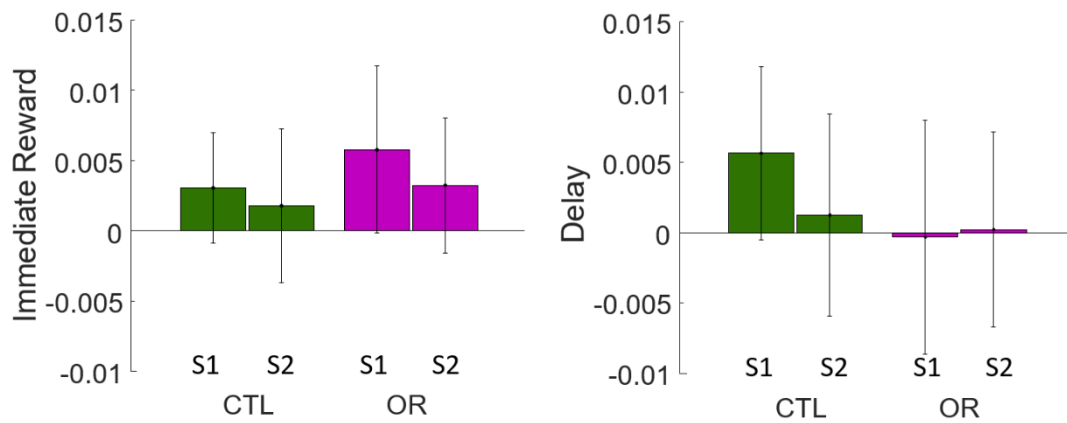


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2 **Fig. S1. Choice-related activity in control brain regions.**
3 Graphs show activity during choice (vs. baseline) extracted from the right middle frontal gyrus (MFG)
4 and from the left inferior parietal lobule (IPL) in the control (CTL, green) and overreaching group (OR,
5 purple) groups. Error bars represents intersubjects SEs. There was no significant difference between
6 sessions (S1 vs. S2) or between groups (see also Table S4).



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Fig. S2. Effects of choice-related variables on left MFG activity.

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Graphs show regression estimates (betas) obtained for parametric modulators, magnitude of

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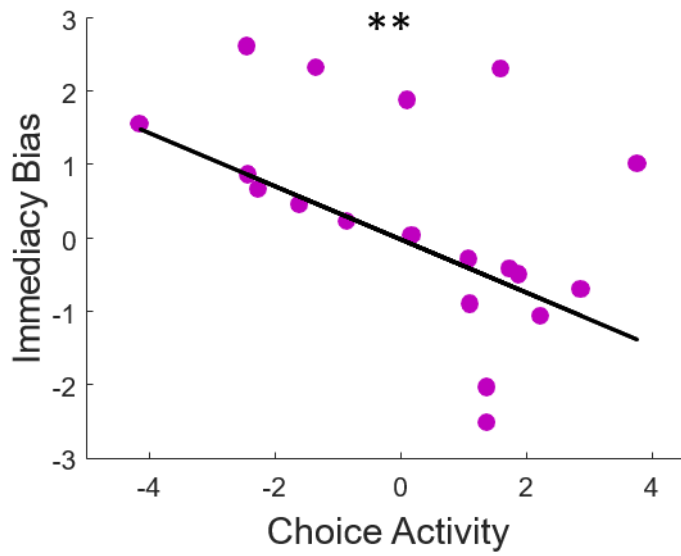
immediate reward (left) and delay of the alternative option (right) for the control (CTR, green) and

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overreaching (OR, purple) groups. Error bars represents intersubjects SE. There was no significant

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difference between sessions (S1 vs. S2) or between groups.



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14 **Fig. S3. Brain-behavior relationship.**

15 The graph shows the correlation between choice-related activity in the left MFG and the fitted immediacy bias,

16 across subjects in the overtrained group. Stars represent significance of the linear regression fit ($p < 0.01$)

17 **Supplementary tables**

Group effect	CTL	OR	Difference	F-value	df	p-value
Immediacy bias	-0.61±0.30	0.29±0.33	-0.90	3.99	1,35	0.054
Discount factor	0.040±0.0082	0.042±0.0080	-0.0021	0.0475	1,35	0.83
Choice stochasticity	8.1±0.70	8.3±0.86	-0.19	0.0286	1,35	0.87
Balanced accuracy	0.61±0.025	0.64±0.024	-0.028	0.656	1,35	0.42
Executive performance	0.93±0.060	0.95±0.081	-0.018	0.568	1,35	0.46
Session effect	Session 1	Session 2	Difference	F-value	df	p-value
Immediacy bias	-0.090±0.21	-0.21±0.27	0.12	0.985 0.00	1,35	0.33
Discount factor	0.040±0.0056	0.041±0.0057	-0.0013	1.08	1,35	0.31
Choice stochasticity	8.22±0.57	8.21±0.59	0.013	0.00112	1,35	0.97
Balanced accuracy	0.63±0.016	0.62±0.020	0.013	0.632	1,35	0.43
Executive performance	0.93±0.014	0.95±0.012	-0.016	3.10	1,35	0.09
Interaction	S1-S2 CTL	S1-S2 OR	Difference	F-value	df	p-value
Immediacy bias	0.35±0.19	-0.089±0.18	-0.44	2.79	1,35	0.10
Discount factor	-0.0035±0.0018	0.0082±0.0018	-0.0043	2.92	1,35	0.096
Choice stochasticity	-0.018±0.66	0.04±0.36	-0.615	0.00690	1,35	0.93
Balanced accuracy	0.0011±0.015	0.015±0.013	-0.014	0.466	1,35	0.50
Executive performance	0.019±0.012	0.013±0.014	0.006	0.103	1,35	0.75

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19 **Table S1. Comparison of model parameter estimates and executive performance for tasks**
20 **made during fMRI sessions.**

21 Models were fitted separately for the two fMRI sessions and for the CTL and OR groups. Parameters
22 from top to bottom are denoted *bias*, *k* and β in the models (see Table 1). Balanced accuracy is the
23 percentage of choices correctly predicted by the model, calculated separately for impulsive and patient
24 choices before averaging. Note that balanced accuracy is low because options were adjusted to
25 indifference points. Executive performance is the ratio of correct response rate between hard and easy
26 tasks. N-back and N-switch tasks were pooled together. Results are given as inter-subject means \pm
27 standard errors. Group, session and interaction effects were tested using two-way ANOVA. df is
28 degree of freedom.

Side	Anatomical label	Peak T	Peak P (unc.)	Cluster P (FWE)	Voxels	Peak MNI coordinates		
						X	Y	Z
Left	Inferior Parietal Lobule	10.21	0.000000000000011	0.000000073	2075	-44	-38	46
Left	Superior Parietal Lobule	8.33	0.0000000000023			-28	-60	48
Left	Superior Parietal Lobule	7.85	0.000000000017			-24	-64	42
Right	Precuneus	8.15	0.0000000000049	0.000000050	2141	32	-66	42
Right	Inferior Parietal Lobule	7.78	0.000000000024			42	-40	44
Right	Inferior Parietal Lobule	7.35	0.00000000014			36	-46	44
Right	Insula	7.08	0.00000000045	0.000085	995	32	22	0
Right	Middle Frontal Gyrus	5.37	0.00000048			48	32	32
Right	Middle Frontal Gyrus	4.61	0.0000089			42	36	22
Left	Clastrum	6.73	0.00000000	0.00046	777	-28	22	2
Left	Middle Frontal Gyrus	5.54	0.00000025			-40	28	26
Left	Sub-Gyral	6.17	0.00000002	0.015	392	-26	0	52
Right	Middle Frontal Gyrus	6.10	0.00000003	0.00000030	1838	30	-2	56
Right	Middle Frontal Gyrus	5.96	0.00000005			30	6	54
Right	Superior Frontal Gyrus	5.85	0.00000007			2	16	50
Left	Inferior Frontal Gyrus	5.48	0.00000031	0.00034	817	-42	6	22
Left	Precentral Gyrus	5.35	0.00000054			-40	2	32
Left	Precentral Gyrus	4.56	0.000011			-50	0	42

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30 **Table S2. Whole-brain statistics for the conjunction between task difficulty and choice-related**
31 **activity in the CTL group.**

32 This conjunction served to generate statistical maps shown in Fig. 5B. All clusters are shown that
33 survived a threshold of $p < 0.05$ after FWE correction for multiple comparisons. Lines correspond to
34 clusters and sub-clusters ranked by decreasing peak t-values, as provided by SPM software. Number
35 of voxels and corrected p-values are only shown at the cluster level. [X, Y, Z] coordinates refer to the
36 MNI space.

Group	CTL	OR	Difference	F-value	df	p-value
Choice	1.86±0.43	0.15±0.50	1.72	6.36	1,35	0.016
Performance	0.52±0.07	0.42±0.07	0.10	1.05	1,35	0.31

Session	CTL	OR	Difference	F-value	df	p
Choice	1.07±0.54	0.94±0.54	0.13	0.237	1, 35	0.63
Performance	0.45±0.09	0.48±0.10	-0.02	0.086	1,35	0.77

Interaction	CTL	OR	Difference	F-value	df	p
Choice	0.26±0.38	-0.52±0.36	0.78	2.22	35	0.14
Performance	0.12±0.16	-0.06±0.10	0.18	0.92	1,35	0.34

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Table S3. Comparison of choice- and performance-related activity in the left middle frontal gyrus (L MFG).

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Choice-related activity refers to implicit contrast against baseline, whereas performance-related activity refers to contrast between hard and easy versions of executive tasks (N-back and N-switch pooled together). L MFG corresponds to the red cluster shown in Fig. 5B, independently defined from previous study (see methods). Results are given as inter-subject means ± standard errors. Group, session and interaction effects were tested using two-way ANOVA. df is degree of freedom.

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Group	CTL	OR	Difference	F-value	df	p-value
R MFG	2.39±0.36	1.61±0.57	0.78	1.31	1,35	0.26
L IPL	2.45±0.38	2.06±0.32	0.39	0.62	1,35	0.44

Session	CTL	OR	Difference	F-value	df	p-value
R MFG	2.27±0.46	1.70±0.60	0.57	2.87	1,36	0.10
L IPL	2.37±0.40	2.14±0.38	0.24	0.91	1,36	0.35

Interaction	CTL	OR	Difference	F-value	df	p-value
R MFG	-0.32±0.35	-0.80±0.55	0.48	0.52	1,35	0.48
L IPL	-0.16±0.40	-0.30±0.29	0.14	0.080	1,35	0.78

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46 **Table S4. Comparison of choice-related activity in the right middle frontal gyrus (R MFG) and in**
47 **the left inferior parietal lobe (L IPL).**

48 Choice-related activity refers to implicit contrast against baseline. R MFG and L IPL correspond to
49 spheres placed on activation peaks obtained in the conjunction between choice- and performance-
50 related activity (Fig. 5B and Table S2). Results are given as inter-subject means ± standard errors.
51 Group, session and interaction effects were tested using two-way ANOVA. df is degree of freedom.