SUPPLEMENTAL INFORMATION

Meta-analytic clustering dissociates brain activity and behavior profiles across reward processing paradigms

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SUPPLEMENTAL CONTENT

Table S1. Published articles included in the current reward processing corpus. 176 studies contributed experimental contrasts (minimum = 1, maximum = 23) to the corpus.

	PubMed ID	Authors	Year	# of contrasts
1	17265148	Abler, Erk & Walter	2007	3
2	16487726	Abler et al.	2006	2
3	16675403	Adcock et al.	2006	12
4	12948722	Akitsuki et al.	2003	8
5	19961940	Alexander & Brown	2010	4
6	19071223	Ballard & Knutson	2009	3
7	22336565	Balodis et al.	2012	12
8	19560123	Beck et al.	2009	4
9	17676057	Behrens et al.	2007	2
10	19587291	Bickel et al.	2009	9
11	17140674	Bjork & Hommer	2007	9
12	14985419	Bjork et al.	2004	4
13	18851716	Bjork, Knutson & Hommer	2008	4
14	17079666	Blair et al.	2006	9
15	15907305	Bolla et al.	2005	1
16	15142963	Bolla et al.	2004	2
17	19524531	Boorman et al.	2009	2
18	18509047	Bray et al.	2008	1
19	11395019	Breiter et al.	2001	4
20	10706432	Brunia et al.	2000	2
21	17188518	Budhani et al.	2007	2
22	22338036	Burger & Stice	2012	2
23	20589242	Burke et al.	2010	3
24	19242558	Camara, Rodriguez-Fornells & Munte	2008	6
25	18042401	Chandrasekhar et al.	2008	4
26	19793990	Chib et al.	2009	4
27	19812332	Christopoulos et al.	2009	2
28	19217383	Clark et al.	2009	3
29	17997112	Cohen, Elger & Weber	2008	5
30	19843618	Cooper et al.	2009	9
31	17904386	Cooper & Knutson	2008	3
32	16116457	Coricelli et al.	2005	12
33	15758183	Cox, Andrade & Johnsrude	2005	1
34	11239442	Critchley, Mathias & Dolan	2001	3

35	18309087	D'Ardenne et al.	2008	1
36	16778890	Daw et al.	2006	4
37	11110834	Delgado et al.	2000	3
38	17850241	Dillon et al.	2008	7
39	16033924	Dreher, Kohn & Berman	2006	6
40	21612768	Duka et al.	2011	4
41	18445214	Elliott, Agnew & Deakin	2008	2
42	10934265	Elliott, Friston & Dolan	2000	5
43	9347486	Elliott, Frith & Dolan	1997	6
44	12514228	Elliott et al.	2003	3
45	15006665	Elliott et al.	2004	3
46	10215087	Elliott, Rees & Dolan	1999	4
47	9626713	Elliott et al.	1998	3
48	19640506	Elman et al.	2009	1
49	19308261	Engelmann et al.	2009	7
50	19576868	Engelmann & Tamir	2009	5
51	15850746	Ernst et al.	2005	10
52	15327927	Ernst et al.	2004	3
53	19047075	Ersner-Hershfield, Wimmer & Knutson	2009	7
54	18985124	Feinstein, Stein & Paulus	2006	2
55	18793731	Finger et al.	2008	8
56	20357071	Fleming et al.	2010	7
57	17656073	Frangou et al.	2008	1
58	19783412	Freyer et al.	2009	2
59	15588617	Fukui et al.	2005	1
60	16682235	Fukui et al.	2006	1
61	17286837	Galvan et al.	2007	2
62	18550593	Glascher, Hampton & O'Doherty	2009	7
63	17202543	Goldstein et al.	2007	1
64	20600994	Guitart-Masip, Talmi & Dolan	2010	1
65	17698008	Hampton et al.	2007	5
66	16899731	Hampton, Bossaerts & O'Doherty	2006	5
67	18427116	Hampton, Bossaerts & O'Doherty	2008	4
68	20357127	Han et al.	2010	1
69	20071521	Hare et al.	2010	5
70	19407204	Hare, Camerer & Rangel	2009	4

71	18509023	Hare et al.	2008	3
72	20105435	Hartstra et al.	2010	5
73	14973239	Haruno et al.	2004	4
74	16339445	Hsu et al.	2005	6
75	19228976	Hsu et al.	2009	2
76	17007234	Huettel	2006	4
77	16504951	Huettel et al.,	2006	1
78	18439412	Izuma, Saito & Sadato	2008	4
79	19515916	Jocham et al.	2009	4
80	16139525	Juckel et al.	2006	2
81	20510371	Kahnt et al.	2011	2
82	20231475	Kahnt et al.	2010	2
83	16802856	Kim, Shimojo & O'Doherty	2006	8
84	14568478	Kirsch et al.	2003	4
85	11459880	Knutson et al.	2001	5
86	17916330	Knutson et al.	2008	4
87	15260961	Knutson et al.	2004	4
88	11726774	Knutson et al.	2001	4
89	12595181	Knutson et al.	2003	3
90	17196537	Knutson et al.	2007	3
91	15888656	Knutson et al.	2005	8
92	10875899	Knutson et al.	2000	2
93	18388729	Knutson et al.	2008	3
94	18549791	Knutson et al.	2008	23
95	19032746	Koeneke et al.	2008	9
96	17765572	Kramer et al.	2007	7
97	16129404	Kuhnen & Knutson	2005	4
98	18320179	Labudda et al.	2008	2
99	18787233	Lawrence et al.	2009	5
100	19015090	Lee et al.	2008	2
101	19770058	Linke et al.	2010	5
102	16426719	Little et al.	2006	7
103	17460071	Liu et al.	2007	6
104	17712267	Marco-Pallares, Muller & Munte	2007	1
105	17292631	Marsh et al.	2007	2
106	11703464	Martin-Soelch et al.	2001	3
107	12911764	Martin-Soelch et al.	2003	1
108	11545466	Martin-Solch et al.	2001	3

109	15486494	Matthews et al.	2004	2
110	12718866	McClure, Berns & Montague	2003	2
111	15486304	McClure et al.	2004	2
112	20138482	Miedl et al.	2010	2
113	19726640	Mitchell et al.	2009	2
114	17950474	Mitchell et al.	2008	1
115	17717184	Mobbs et al.	2007	17
116	15945130	Nieuwenhuis et al.	2005	5
117	15978024	Nieuwenhuis et al.	2005	1
118	15087550	O'Doherty et al.	2004	5
119	11135651	O'Doherty et al.	2001	9
120	19864559	Palminteri et al.	2009	8
121	11133312	Paulus et al.	2001	4
122	12948701	Paulus et al.	2003	2
123	16929307	Pessiglione et al.	2006	5
124	20016088	Peters & Buchel	2009	12
125	20399735	Peters & Buchel	2010	7
126	17855612	Plassmann, O'Doherty & Rangel	2007	6
127	11960021	Pochon et al.	2002	2
128	16880132	Preuschoff, Bossaerts & Quartz	2006	7
129	18337404	Preuschoff, Quartz & Bossaerts	2008	3
130	15528079	Ramnani et al.	2004	2
131	12571121	Ramnani & Miall	2003	4
132	18582578	Rao et al.	2008	7
133	15907318	Remijnse et al.	2005	8
134	17088503	Remijnse et al.	2006	3
135	15538191	Rilling et al.	2004	1
136	10516320	Rogers et al.	1999	8
137	17698371	Sailer et al.	2007	5
138	17468751	Samanez-Larkin et al.	2007	8
139	18399882	Samanez-Larkin et al.	2008	1
140	12805551	Sanfey et al.	2003	1
141	17655834	Schaefer & Rotte	2007	1
142	16950228	Scheres et al.	2007	1
143	18097655	Schlagenhauf et al.	2008	4
144	18032658	Schonberg et al.	2007	4
145	17475790	Seymour et al.	2007	4

146	18947356	Shamosh et al.	2008	2
147	19718655	Simoes-Franklin et al.	2010	3
148	18804540	Smith et al.	2009	3
149	20164333	Smith et al.	2010	6
150	19174537	Spreckelmeyer et al.	2009	2
151	19521264	Sripada et al.	2009	1
152	17996464	Strohle et al.	2008	2
153	18579749	Tanaka, Balleine & O'Doherty	2008	2
154	9175118	Thut et al.	1997	1
155	18987206	Tobler et al.	2008	3
156	17122317	Tobler et al.	2007	3
157	19490086	Tricomi, Balleine & O'Doherty	2009	6
158	12764119	Ullsperger & von Cramon	2003	5
159	19793875	Valentin & O'Doherty	2009	4
160	16574168	van Leijenhorst, Crone & Bunge	2006	8
161	21389226	Venkatraman et al.	2011	5
162	19477159	Venkatraman et al.	2009	4
163	19349237	Volkow et al.	2009	1
164	12814578	Volz, Schubotz & von Cramon	2003	2
165	15006651	Volz, Schubotz & von Cramon	2004	3
166	19307555	Weber et al.	2009	3
167	18710652	Weber & Huettel	2008	5
168	17216152	Wittmann, Leland & Paulus	2007	2
169	17521924	Wrase et al.	2007	7
170	17291784	Wrase et al.	2007	2
171	19805082	Wunderlich, Rangel & O'Doherty	2009	6
172	19185567	Xu et al.	2009	5
173	18842669	Xue et al.	2009	6
174	16971537	Yacubian et al.	2006	11
175	20600178	Zheng, Wang & Zhu	2010	3
176	15134646	Zink et al.	2004	3

Table S2. **BrainMap paradigm class composition of the corpus.** Percentage of experiments in the corpus archived under each BrainMap paradigm class.

Paradigm Class	Percentage of experiments in corpus
Reward	94.9
Task Switching	6.4
Delay Discounting	5.6
Go-NoGo	2.9
Visuospatial	2.9
Gambling	2.7
Wisconsin Card Sorting Test	2.5
Reasoning Problem Solving	1.3
Tower of London	1.2
Finger Tapping Button Press	0.9
Saccades	0.8
Taste	0.8

Note. As studies included in the corpus could be archived under multiple paradigm classes, the percentages of corpus experiments in each paradigm class are not expected to sum to 100%.

Table S3. Convergent activity coordinates for each meta-analytic grouping (k = 7 model order)

Meta-Analytic Grouping	Peak	Region	Volume (mm^3)	x	y	z
1	1	Left ventral striatum	52944	-12	10	-6
		Right accumbens		12	10	-6
		Right claustrum		34	22	-8
		Right thalamus		2	-14	10
	2	Medial orbital frontal gyrus (BA 10)	3168	0	50	-10
		Left medial orbital frontal		-12	42	-14
	3	Anterior cingulate (BA 32)	4056	-4	38	16
		Right middle dorsal cingulate		2	28	34
		Right middle dorsal cingulate		4	18	36
	4	Posterior cingulate		-2	-32	32
2	1	Left caudate	39536	-10	4	6
		Right caudate		12	4	8
		Right pallidum		14	4	0
		Left putamen		-18	4	6
	2	Dorsal medial frontal gyrus (BA 32)	6248	0	10	46
		Right dorsal cingulate		6	22	30
		Dorsal medial frontal gyrus (BA 6)		0	0	56
		Left dorsal medial frontal gyrus (BA 24)		-4	-8	48
	3	Right posterior cingulate (BA 23)	1408	2	-24	34
3	1	Right amygdala	8848	26	-2	-14
		Right hippocampus		32	-22	-22
	2	Left amygdala	7712	-24	-2	-14
		Left Putamen		-28	-6	0
		Left culmen		-8	-30	-16
		Left parahippocampus		-20	-16	-18
	3	Right dorsal medial frontal gyrus (BA 6)	1984	6	-4	46
4	1	Right anterior insula (BA 13)	11208	36	20	-4
	2	Left anterior insula (BA 13)	9864	-30	22	-2
	3	Medial frontal gyrus (BA 8)	11008	6	22	46
		Left cingulate (BA 32)		-8	24	32
		Medial frontal gyrus (BA 6)		-8	8	46
	4	Left superior parietal gyrus (BA 7)	2160	-32	-54	46
	5	Right thalamus (medial dorsal nucleus)	5512	8	-12	10

		Left habenula		-4	-26	-2
		Right thalamus (anterior nucleus)		-8	-18	10
		Left thalamus (ventral posterior nucleus)		14	-30	-6
	6	Left dorsal middle frontal gyrus (BA 6)	1200	-26	0	52
	7	Left declive	1488	-40	-64	-20
	8	Right precentral gyrus (BA 9)	1544	44	14	30
		Right precentral gyrus (BA 9)		48	14	44
	9	Right inferior parietal gyrus (BA 40)	1608	46	-52	54
	10	Right posterior cingulate (BA 23)	1168	6	-24	28
	11	Left middle frontal gyrus (BA 9)	1136	-38	26	34
	12	Right middle frontal gyrus (BA 46)	1680	44	32	20
		Right middle frontal gyrus (BA 9)		38	30	34
		Right middle frontal gyrus (BA 9)		34	44	32
5	1	Dorsal medial frontal gyrus (BA 6)	6280	-2	32	32
		Right dorsal medial frontal gyrus (BA 6)		8	22	48
	2	Right superior frontal gyrus (BA 9)	7536	44	42	22
		Right superior frontal gyrus (BA 8)		42	32	40
		Right middle frontal gyrus (BA 46)		48	22	20
	3	Left precentral gyrus (BA 6)	4304	-40	2	32
		Left precentral gyrus (BA 9)		-46	22	32
		Left middle frontal gyrus (BA 9)		-56	6	34
	4	Right inferior parietal gyrus (BA 40)	4056	48	-42	52
		Right inferior parietal gyrus (BA 40)		44	-38	44
	5	Right superior parietal gyrus (BA 7)	2496	26	-62	44
		Right superior parietal gyrus (BA 7)		32	-60	52
	6	Right superior frontal gyrus (BA 10)	1824	30	52	0
	7	Left inferior parietal gyrus (BA 40)	1344	-42	-44	44
	8	Left middle frontal gyrus (BA 6)	1224	-28	2	52
	9	Left lateral middle frontal gyrus	1256	-40	32	24
	10	Right middle frontal gyrus (BA 6)	2864	32	8	54
	11	Left superior parietal gyrus (BA 7)	1208	-28	-58	44
6	1	Left anterior medial frontal gyrus (BA 9)	11128	-4	50	22
		Left anterior medial frontal gyrus (BA 10)		-4	56	10
		Right anterior cingulate (BA 24)		4	32	12
		Right medial frontal gyrus (BA 10)		12	48	0
	2	Left temporal parietal junction (39)	6328	-42	-76	34
		Left superior temporal gyrus (BA 39)		-48	-56	32
		Left supra-marginal gyrus (BA 39)		-58	-50	34

		Left supra-marginal gyrus (BA 39)		-54	-56	44
	3	Right inferior frontal gyrus (BA 47)	1752	48	36	-14
		Right inferior frontal gyrus (BA 45)		52	38	-4
	4	Right middle temporal gyrus (BA 21)	1472	66	-26	-8
		Right middle temporal gyrus (BA 21)		60	-36	-4
	5	Right temporal parietal junction (BA 40)	832	54	-42	26
	6	Left precuneus (BA 31)	1456	-4	-48	34
		Left precuneus (BA 31)		-6	-60	28
	7	Left inferior frontal gyrus (BA 47)	1104	-56	34	-6
7	1	Medial orbital frontal gyrus (BA 32)	27504	0	56	-8
		Subgenual anterior cingulate (BA 11)		0	34	-18
		Right frontal pole (BA 10)		6	68	0
	2	Left parahippocampus (amygdala)	2888	28	-6	-20
	3	Left posterior cingulate (BA 30)	1424	-6	-54	14
		Left posterior cingulate (BA 31)		-8	-56	24
	4	Left middle frontal gyrus (BA 47)	880	-30	38	-10

Note. Peak and sub-peak coordinates (LPI), spatial volume and anatomical labeling informed by Eickhoff-Zilles macro labels from N27 (MNI_ANAT space) and Talairach-Tournoux atlas labels for clusters comprising each MAG's thresholded ($p_{cluster\text{-}level} < 0.05$ [FWE-corrected]; $p_{voxel\text{-}level} < 0.001$) ALE image.

ADDITIONAL VIABLE CLUSTERING SOLUTIONS: *POST HOC* COMPARISON.

While the $k = 7$ model order was identified as a viable solution and selected for presentation in the main text, the hierarchy index and variation of information metrics indicated that the $k = 5$ model order was also a viable clustering solution (**main text Fig. 2**). Further, the $k = 4$ model order met criteria for the average silhouette metric (**main text Fig. 2**), also suggesting a viable solution. As such, in a *post hoc* assessment, we explored the organization of MAG activity patterns across the $k = 5$ (**Fig. S1**) and $k = 4$ (**Fig. S3**) MAG solutions and performed automated functional decoding (**Fig. S2 & Fig. S4**) using a NeuroSynth approach. Results are discussed in relation to the $k = 7$ outcomes found in the main text.

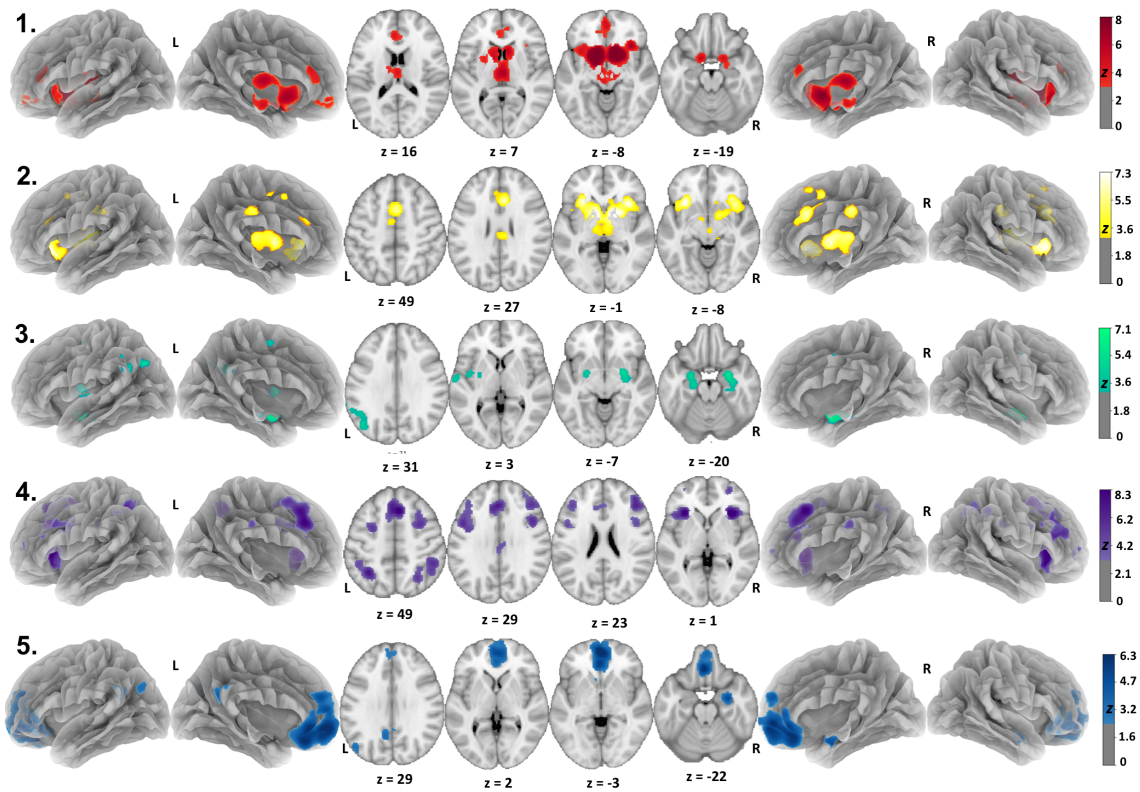
$k = 5$ model order in relation to $k = 7$ model order. We believe our examination of three viable clustering model orders provides additional information regarding the integration and segregation of functional brain activity and cognitive-behavioral constructs across varying levels of meta-analytic parcellation. We observed that two MAGs in the $k = 5$ solution (**MAG-4^{5}** and **MAG-5^{5}**) appeared to be decomposed into multiple separate MAGs in the $k = 7$ solution. Specifically, MAG-4^{5} was decomposed into MAG-4^{7} and MAG-5^{7} in the $k = 7$ solution and MAG-5^{5} was decomposed into MAG-6^{7} and MAG-7^{7} in the $k = 7$ solution. Details of these instances of further parsing of experiments into dissociable MAGS are provided below.

MAG-4^{5}. Convergent activity clusters observed in MAG-4 of the $k = 5$ model order (MAG-4^{5}) (**Fig. S1, purple**) noted in the lateral prefrontal cortex (LPFC), intraparietal sulcus (IPS) and pre-supplementary motor area (pre-SMA) were observed in both MAG-4^{7} (main text **Fig. 3, pink)** and MAG-5^{7} (main text **Fig. 3, purple).** However, certain clusters observed in MAG-4^{5} in the superior frontal cortex and parietal cortex were only observed in MAG-5^{7} and convergent activity in the bilateral anterior insula and posterior cingulate cortex (PCC) were only observed in MAG-

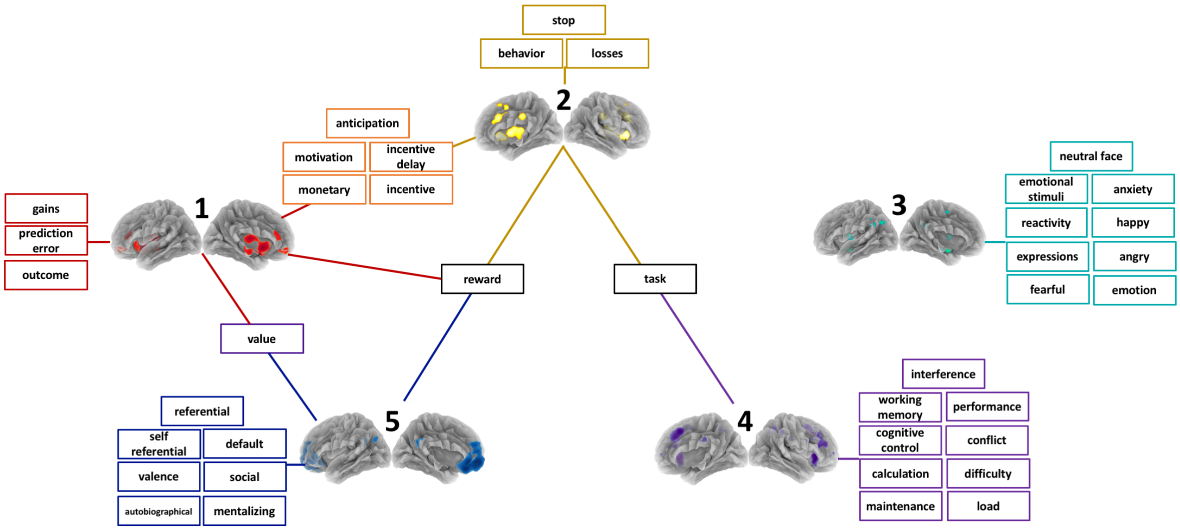
4^7. Functional decoding also suggested that MAG-4^5 was decomposed into MAG-4^7 and MAG-5^7 in the k = 7 solution, as MAG-4^5 included many of the same terms relating to working memory (*working memory*, *load, maintenance*), performance monitoring (*difficulty*, *performance*, *conflict*), calculating (*calculation*), and more general executive control (*cognitive control*, *task*; **Fig. S3, Table S4**), that were observed across both MAG-4^7 and MAG-5^7 in the k = 7 solution (main text **Fig. 4**).

MAG-5^5. Similarly, the convergent activity from MAG-5 in the k = 5 model order (MAG-5^5) was decomposed into two separate MAGs in the k = 7 solution. In the k = 5 solution, MAG-5^5 (**Fig. S1, blue**) displayed convergence in the ventral medial prefrontal cortex (vmPFC) and central medial prefrontal cortex (cmPFC), medial orbital frontal cortex (OFC), left angular gyrus, right amygdala, right hippocampus, PCC, temporal parietal junction (TPJ), and precuneus. However, in the k = 7 solution (main text **Fig. 3**), MAG-5^5 activity was represented in two MAGs, one with convergent activity in the anterior cmPFC, TPJ, PCC, and right middle temporal lobe (MAG-6^7) and one with convergent activity in the vmPFC, mOFC, right amygdala, and more ventral PCC (MAG-7^7). The functional decoding of MAG-5^5 included terms that suggested both interpersonal and intrapersonal reflection (*mentalizing, theory mind, self-referential, autobiographical, social*) as well as terms that suggested subjective valuation (*value, valence, emotional, reward*; **Fig. S2, Table S4**). While the functional decoding of MAG-6^7 and MAG-7^7 both included terms suggesting general internal processing (*default, social, referential, autobiographical*; **Fig. 4, Table 3**), MAG-6^7 separately included terms (*theory of mind, self-referential, mental states, mentalizing, beliefs, and moral*) indicative of interpersonal and intrapersonal reflection, whereas MAG-7^7 separately included terms (*value, valence, emotion, neutral and arousal*) indicative of subjective value judgments. These functional decoding results suggest that the further parsing of experiments in the

$k = 7$ solution decomposed MAG-5^{5} into two separate MAGs both with a potential role in internally focused attention yet one specializing in in abstract mentalizing (MAG-6^{7}) and the other in valuation (MAG-7^{7}). Stated from a different perspective, at a lower model order *(k* = 5) these two distinct yet related activity patterns and associated cognitive constructs were likely integrated in the same MAG (MAG-5$^{5)}$.



<u>Figure S1.</u> Brain activity profiles associated with each meta-analytic grouping (MAG) of reward processing experiments (*k* = 5 model order). ALE images identified significant ($p_{cluster\text{-}corrected} < 0.05$; $p_{voxel\text{-}level} < 0.001$) convergence in dissociable and distributed brain regions across each MAG. Unthresholded maps of each MAG are available on NeuroVault (https://neurovault.org/collections/5070/).



<u>**Figure S2.**</u> **Behavior profiles associated with each meta-analytic grouping (MAG) of reward processing experiments (*k* = 5 model order).** Behavior profiles consisted of NeuroSynth (NS) terms with the top 10 highest correlation values for each MAG representing the similarity between the MAG and activity patterns reported for terms in the NeuroSynth database (excluding anatomical terms). Lines connect MAGs to the terms making-up their unique behavior profile. Additionally, some terms or groups of terms are connected to multiple MAGs indicting that these terms had correlation values in multiple MAGs' top 10.

<u>Table S4.</u> NeuroSynth (NS) terms composing each MAG's behavior profile and their respective correlation values (*k* = 5 model order).

MAG-1		MAG-2		MAG-3		MAG-4		MAG-5	
NS term	***r***	**NS term**	***r***	**NS term**	***r***	**NS term**	***r***	**NS term**	***r***
monetary (2)[a]	0.780	anticipation (2)[g]	0.321	reactivity	0.302	task (2)[m]	0.582	default (2)[q]	0.372
reward (2)[b]	0.766	incentive (2)[h]	0.289	fearful (2)[k]	0.301	working memory (5)[n]	0.510	social	0.305
incentive (2)[c]	0.754	incentive delay	0.288	neutral	0.292	load (2)[o]	0.382	autobiographical (2)[r]	0.295
anticipation (2)[d]	0.735	monetary	0.286	emotion (3)[12]	0.279	difficulty (2)[p]	0.326	value	0.262
incentive delay	0.701	reward (3)[i]	0.285	happy	0.266	maintenance	0.253	referential	0.254
motivation (2)[e]	0.677	task	0.219	anxiety	0.266	cognitive control	0.253	valence	0.246
gains	0.631	motivation (2)[j]	0.206	expressions (2)[l]	0.261	performance	0.241	self referential	0.232
outcome (2)[f]	0.616	behavior	0.206	neutral faces	0.259	calculation	0.241	emotional	0.229
prediction error	0.596	stop	0.193	angry	0.256	interference	0.238	reward	0.194
value	0.554	losses	0.188	emotional stimuli	0.268	conflict	0.236	mentalizing	0.191

Near Duplicates

[a] monetary reward	[g] reward anticipation	[k] fear	[n] tasks	[r] default mode
[b] rewards	[h] monetary incentive	[l] emotional, affective	[o] working, memory-wm, wm, memory	[s] autobiographical memory
[c] monetary incentive	[i] rewards, monetary reward	[m] facial expressions	[p] demands	
[d] reward anticipation	[j] motivational		[q] task difficulty	
[e] motivational				
[f] outcomes				

<u>Note.</u> Terms with the top 10 highest correlation values for each MAG representing the similarity between the MAG and activation patterns reported for terms automatically extracted from abstracts across functional neuroimaging studies archived in the NeuroSynth database (anatomical terms excluded). The number of near duplicates for any given term in a MAG's top 10 list is indicated in "()" following the term and the superscript labels the list of near duplicate terms in the lower section of the table.

***k* = 4 model order in relation to *k* = 5 model order.** Again, in the k = 4 lowest model order, we observed further condensing of MAGs that functional decoding accordingly linked to broader cognitive-behavior constructs. Specifically, subsets of convergent activity in MAG-1 (**Fig. S3, red**) of the k = 4 solution (MAG-1^4) appeared to be decomposed into two separate MAGs in the k = 5 solution (MAGs 1^5 and 2^5), indicating that the additional MAG included in the k = 5 solution segregated MAG-1^4 of the k = 4 solution into ventral and dorsal striatal-medial prefrontal cortex networks (**Fig. S1, red & yellow).** Further, NS terms associated with MAG-1^4 (*reward*, *anticipation*, *incentive delay*, *motivation, gains*; **Fig. S4, Table S5**) were associated with both MAG-1^5 and MAG-2^5 (**Table S4**). Overall, we suggest these outcomes indicated that, the k = 5 solution provided a more meaningful segregation of brain activity patterns during reward processing tasks that better captured a previously reported dissociation between ventral and dorsal frontal-striatal networks (see discussion section main text).

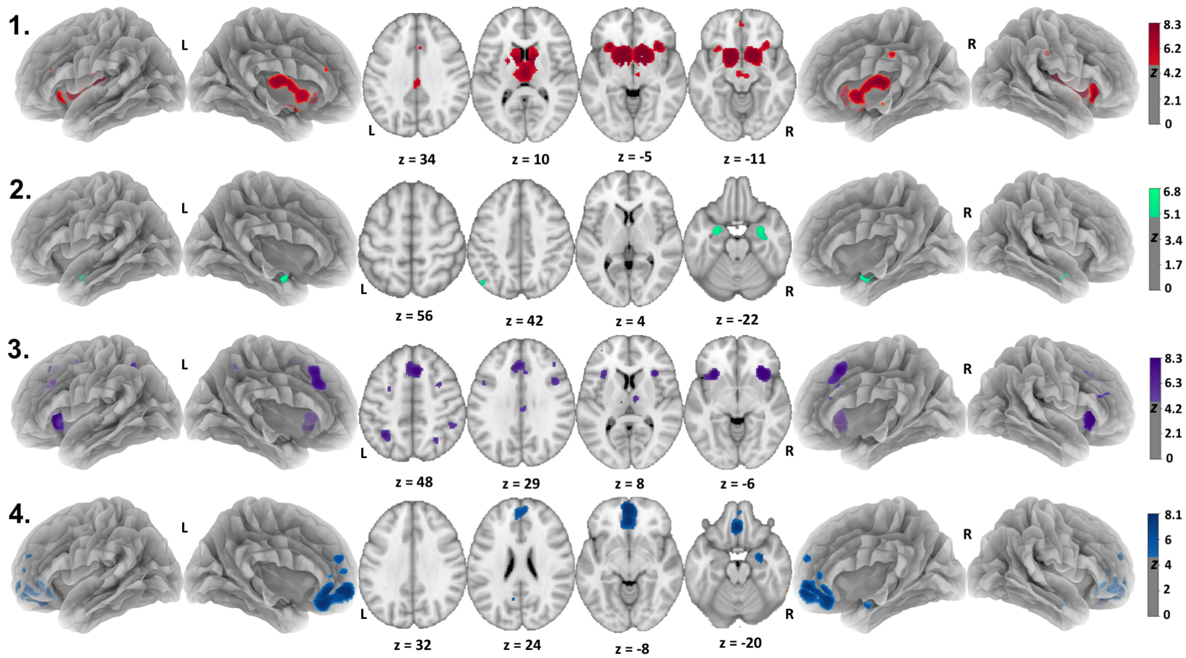


Figure S3. Brain activity profiles associated with each meta-analytic grouping (MAG) of reward processing experiments (k = 4 model order). The figure depicts ALE images identifying significant ($p_{cluster\text{-}corrected}$ < 0.05; $p_{voxel\text{-}level}$ < 0.001) activity convergence for each MAG in the k = 4 solution. Unthresholded maps of each MAG are available on NeuroVault (https://neurovault.org/collections/5070/).

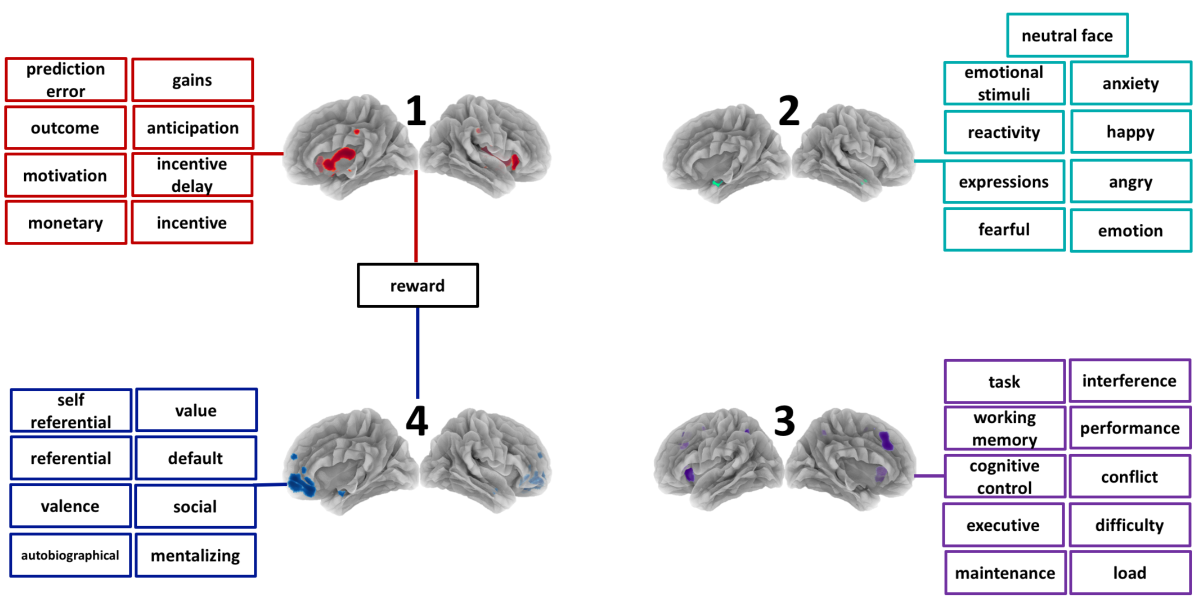
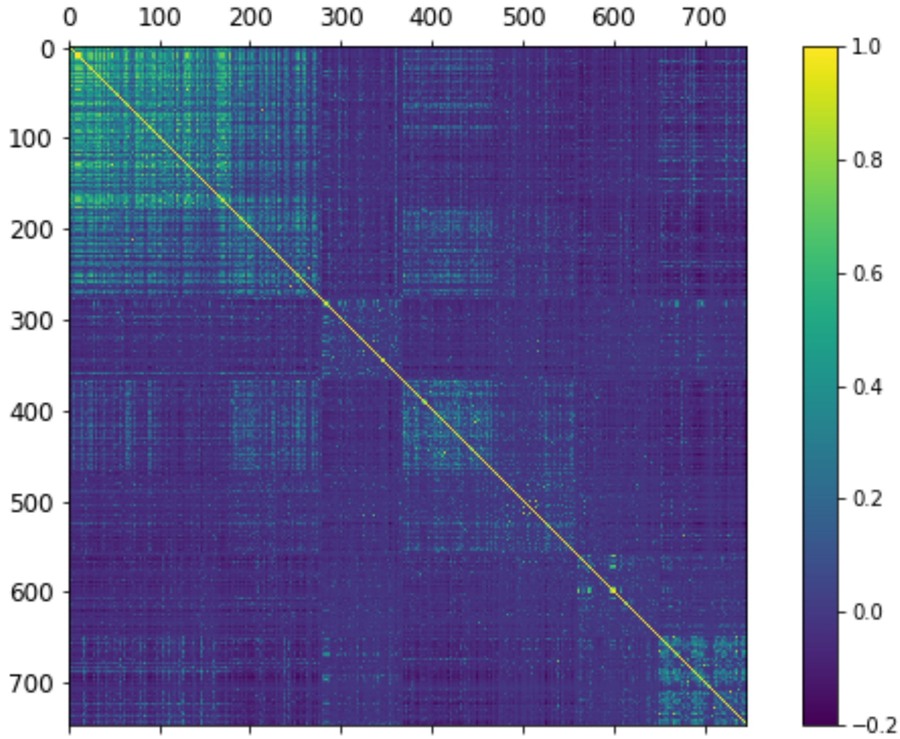


Figure S4. Behavior profiles associated with each meta-analytic grouping (MAG) of reward processing experiments (k = 4 model order). Behavior profiles consisted of NeuroSynth (NS) terms with the top 10 highest correlation values for each MAG representing the similarity between the MAG and activity patterns reported for terms in the NeuroSynth database (excluding anatomical terms). Lines connect MAGs to the terms making-up their unique behavior profile. Additionally, some terms or groups of terms are connected to multiple MAGs indicting that these terms had correlation values in multiple MAGs' top 10.

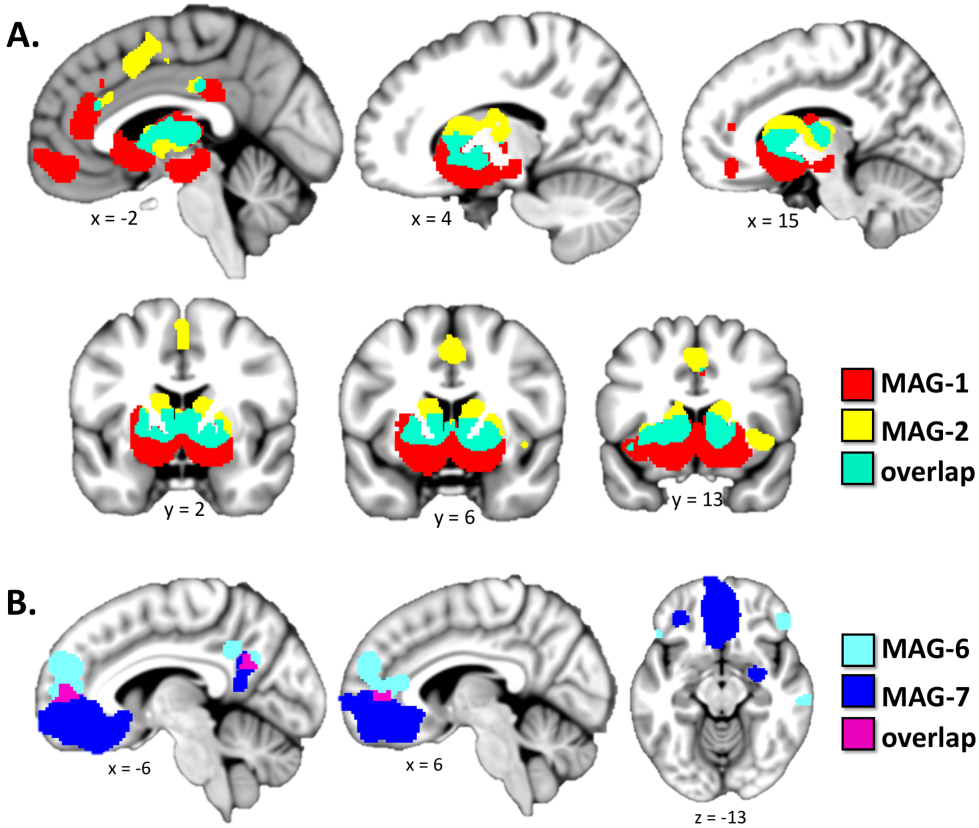
Table S5. NeuroSynth (NS) terms composing each MAG's behavior profile and their respective correlation values (*k* = 4 model order).

MAG-1		MAG-2		MAG-3		MAG-4	
NS term	***r***	**NS term**	***r***	**NS term**	***r***	**NS term**	***r***
monetary	0.731	reactivity	0.303	task (2)[i]	0.563	default (2)[m]	0.373
reward (3)[a]	0.717	fearful (2)[e]	0.301	working memory (4)[j]	0.467	social	0.307
incentive (2)[b]	0.712	neutral (2)[f]	0.292	load (2)[k]	0.353	autobiographical (2)[n]	0.291
anticipation (2)[c]	0.704	emotion (3)[g]	0.279	difficulty (2)[l]	0.317	value	0.264
incentive delay	0.669	happy	0.264	conflict	0.252	referential	0.249
motivation (2)[d]	0.617	emotional stimuli	0.264	cognitive control	0.246	valence	0.246
gains	0.572	anxiety	0.263	maintenance	0.242	self referential	0.228
outcome	0.538	expressions (2)[h]	0.257	interference	0.231	emotional	0.227
prediction error	0.513	angry	0.254	performance	0.230	mentalizing	0.196
losses	0.501	pictures	0.245	executive	0.221	reward	0.196
Near Duplicates							
[a] rewards, monetary reward		[e] fear		[i] tasks		[m] default mode	
[b] monetary incentive		[f] neutral faces		[j] working, memory wm, memory		[n] autobiographical memory	
[c] reward anticipation		[g] affective, emotional		[k] demands			
[d] motivational		[h] facial expressions		[l] task difficulty			

Note. Terms with the top 10 highest correlation values for each MAG. The number of near duplicates for any given term in a MAG's top 10 list is indicated in "()" following the term and the superscript labels the list of near duplicate terms in the lower section of the table.



<u>Figure S5.</u> ***K*-mean clustering cross-correlation matrix (*k* = 7 model order).** The experiment (*e*) x experiment (*e*) cross-correlation matrix ordered by the seven-MAG solution from the *k* = 7 model order indicated that between-group differences of experiment correlation distributions were maximized while within-group differences were minimized.



<u>Figure S6.</u> **Comparison of convergent activity for MAG-1 vs. -2 and for MAG-6 vs. -7.** (**A**) Whereas, both MAG-1 (red) and MAG-2 (yellow) displayed convergent activity that overlapped (cyan) in the striatum and medial frontal cortex, MAG-1's convergent activity was located more ventrally. Overlapping activity of these MAGs (cyan) was observed in the mid-striatum while activity unique to MAG-1 (red) was localized to the ventral striatum and ventromedial prefrontal cortex and the activity unique to MAG-2 (yellow) was localized to the dorsal striatum and dorsal medial frontal cortex. (**B**) MAG-6 (aqua) displayed convergent activity in the central medial prefrontal cortex and the precuneus, whereas MAG-7 (dark blue) displayed convergent activity located just ventral to that of MAG-6 in the ventral orbital frontal cortex and posterior cingulate. There was modest overlap of these MAGs in the medial prefrontal cortex and posterior cingulate (magenta). Additionally, MAG-6 displayed clusters of convergent activity in the lateral inferior prefrontal gyrus, middle temporal gyrus, and temporal parietal junction, whereas MAG-7 displayed convergent activity in the right amygdala.

MANUAL (vs. automated) ANNOTATION OF EXPERIMENTS FOR FUNCTIONAL DECODING

Corpus-specific manual annotation of experiments (*k* = 5 solution): Rationale. The manual annotation of our corpus was prompted by our observation that the existing annotation of experimental contrasts provided by the BrainMap taxonomy was too generalized and nonspecific to capture the nuanced, yet critical distinctions of the specific reward-related neuroimaging contrasts. Thus, our functional decoding required metadata terms that were capable of capturing the precise nature of each experimental contrast. To achieve this level of detail, we performed corpus-specific, manual annotations that relied on the generation of an experiment-specific glossary through an admittedly subjective process. We acknowledge that this technique could be improved and have thus decided to instead perform and present a more automated and objective (yet, also more general) functional decoding technique in the main text utilizing a NeuroSynth-based strategy. However, as our manual decoding approach provides an example of the initial steps taken towards developing corpus- and domain-specific (e.g., reward processing) annotation ontologies, we have included methodological details and results from the *k* = 5 solution below.

To more precisely and succinctly characterize mental operations associated with each experimental contrast, we coded each one with cognitive-behavioral terms through a blind, multi-rater procedure. Due to the nuanced, yet critical distinctions between specific neuroimaging contrasts included in our reward processing corpus of results, our functional decoding required metadata terms capable of capturing the precise nature of each experimental contrast. To achieve this level of detail, we performed corpus-specific, manual annotations using a newly generated glossary of terms reflecting a summative definition of commonly operationalized phenomena in the included reward processing papers. First, a glossary was created consisting of terms (**Table**

S6) commonly employed to describe cognitive-behavioral aspects of reward processing tasks in the corpus. To create this glossary, raters read each published article's method section and collapsed synonyms, used to describe similar task contexts, task events, and/or cognitive phenomena into a singular term that encompassed a summative meaning. This resulted in a glossary of 42 terms which served to reduce potential, unnecessary lexical variability while still providing needed specificity to more fully capture the multifaceted aspects of reward processing tasks. A brief definition of each glossary term can be found in **Table S6**. Then to annotate all experimental contrasts, these glossary terms were assigned to each experimental contrast based on a review of the original article and the associated BrainMap metadata. Discrepancies between raters were discussed until consensus was reached. The "experiment name" BrainMap metadata was taken into particular consideration during this annotation process as it often provided the most specific definition of the contrast. Each contrast could be coded with multiple terms if all the terms appropriately pertained to the contrast.

Table S6. **Corpus-specific manual annotations: Term glossary and frequency distribution across MAGs.**

Term	Definition	Total Frequency	Frequency for MAG-1	Frequency for MAG-2	Frequency for MAG-3	Frequency for MAG-4	Frequency for MAG-5
MID	contrast isolated part of a monetary incentive delay task	199	74	35	31	26	33
positive outcomes	contrast represented an instance in which a positive outcome was delivered	163	63	27	20	18	35
gambling choice	contrast represented an instance in which the participant chooses between two or more outcome contingencies that varied in either risky-ness, probability or another, similar parameter	132	36	19	27	37	13
value	contrast isolated the value of an outcome, for example: a contrast that subtracted situations in which the outcome was $5 from situations in which the outcome was $1	102	27	15	16	20	24
negative outcomes	contrast represented an instance in which a negative outcome was delivered	91	13	23	19	27	9
prediction uncertainty	contrast represented an instance in which participants had to choose between options that would lead to different outcomes without being completely sure which option led to which outcome	83	8	8	13	36	18
choice	contrast represented an instance in which a participant made a choice	79	18	14	10	20	17
anticipation	contrast isolated the period before an expected outcome was delivered	73	28	14	11	10	10
reward learning	contrast represented an algorithm that calculated how task performance changed over time	68	10	5	12	26	15
delay	contrast represented a wait period (real or hypothetical) before an outcome included in delay discounting tasks	62	10	8	15	22	7
reversal learning task	contrast isolated a part of any task in which outcome contingencies were periodically changed throughout the task	59	5	5	14	23	12
reward price	contrast represented either how much a participant would pay for an outcome or the delivery of information about the cost of an outcome	59	8	5	12	12	22
delay discounting	contrast represented part of a task that involved making decisions based on the delay until an outcome	57	10	7	15	17	8
rewarded performance	contrast represented an instance in which any positive outcome, that was contingent on a task response, was delivered	54	9	15	8	14	8
probability	contrast represented the probability of an outcome	53	12	7	12	17	5
reward omission	contrast represented instances in which an expected positive outcome was not delivered	52	26	9	2	11	4
risk	contrast represented the odds of an outcome contingency	51	10	12	3	18	8
social	contrast represented part of a task that involved interacting with another person (real or hypothetical)	42	9	10	9	7	7

wheel of fortune task	contrast isolated part of a task that involved a 'wheel of fortune.' Often the participant was instructed to choose a section of the wheel and that section would indicate the outcome delivered if the wheel landed on that section when spun.	42	12	5	11	10	4
negative outcomes escape	contrast represented an instance in which a negative outcome was avoided	37	8	4	5	10	10
food	contrast isolated part of a task that involved food (real or hypothetical)	35	10	8	9	2	6
picture of desired object	contrast isolated part of a task that involved a picture of a desired object	33	6	1	7	10	9
probabilistic conditioning	contrast isolated part of a task that involved a probabilistic stimuli-outcome contingency	31	9	3	5	4	10
classical conditioning	contrast isolated part of a task that involved stimuli-outcome associations	27	14	4	3	3	3
performance feedback	contrast isolated an instance in which feedback about task performance was provided	26	6	7	3	5	5
risk vs. amount	contrast isolated part of a task in which participants choose between outcomes varying in risk and value. In most cases, the choice was between a high-risk, high-value outcome, and a low-risk, low-value outcome	23	1	6	5	9	2
go/no-go	contrast isolated part of a go/no-go inhibitory control task	17	4	3	4	3	3
moving through virtual maze	contrast isolated part of a task in which participants had to navigate through a virtual space	17	2	4	1	1	9
predator and prey paradigm	contrast isolated part of the predator and prey paradigm in which participants had to navigate a virtual space to escape a 'predator.'	17	2	4	1	1	9
unexpected outcomes	contrast isolated the delivery of unexpected outcomes	15	6	4	3	2	0
pattern recognition	contrast isolated part of a task that required participants to learn associations between outcomes and complex patterns of stimuli or cues	14	0	8	3	3	0
purchasing	contrast isolated part of a task that involved paying a cost of some sort, to receive an outcome	14	2	0	6	2	4
slot machine	contrast represented part of a task involving a simulated slot machine	13	3	3	0	5	2
stock market	contrast represented part of a task involving the monetary decisions and outcomes of a simulated stock market	12	1	3	4	3	1
tower of London task	contrast represented part of a Tower of London task. These tasks involve cognitive control, planning and problem solving	9	1	3	0	1	4
valence	contrast isolated the difference between positive and negative outcomes	7	3	0	2	1	1
altruistic donation	contrast represented part of a task that involved making decisions about voluntarily giving valuable capital to others	6	3	0	1	1	1
face attractiveness	contrast represented part of a task instructing participants to make	6	1	0	0	1	4

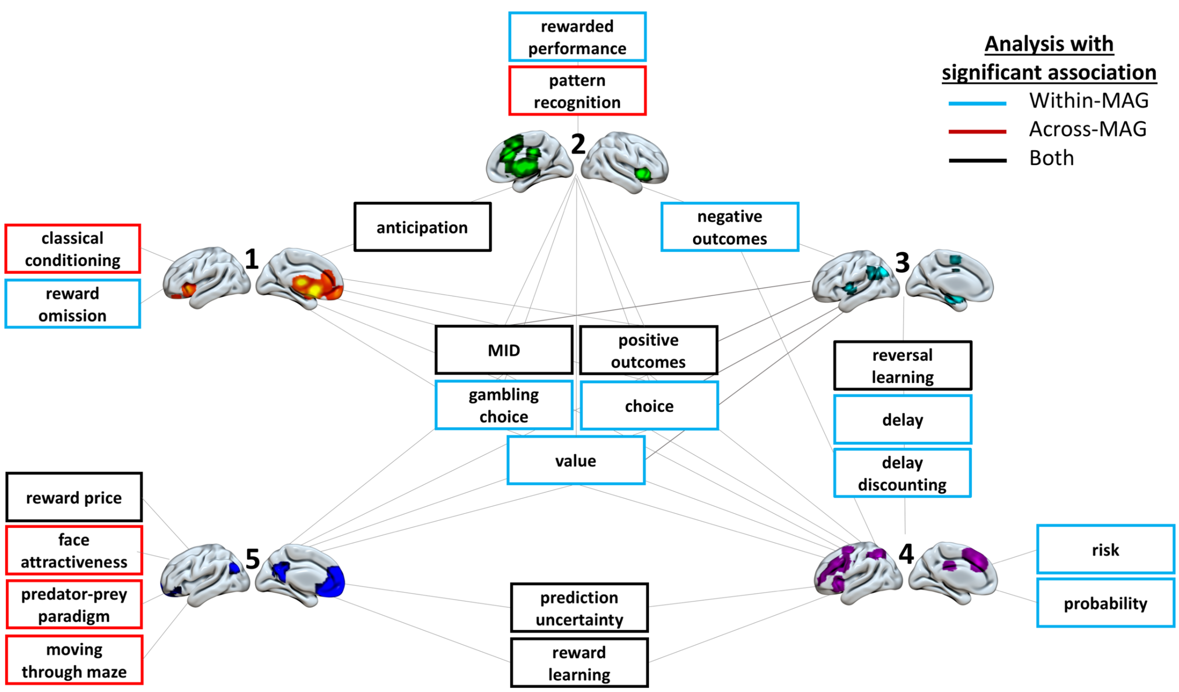
	judgments and indicate preferences about human faces						
advice	contrast represented part of a task in which a participant had to make a choice and were given advice from an outside source (usually an 'expert') on which choice to make.	3	2	0	0	1	0
reward delivery	contrast isolated an instance in which a positive outcome was delivered	3	1	0	0	2	0
blackjack	contrast represented part of a task in which participants played a type of blackjack game	2	1	1	0	0	0
verbal reward	contrast isolated an instance in which positive verbal (auditory or written) feedback was provided	2	1	1	0	0	0

Note. Terms used to code all experimental contrasts in corpus with a brief definition describing rational for assigning it to a contrast. Each term's frequency across the corpus and frequency for each MAG are provided.

Corpus-specific manual annotations for functional decoding of meta-analytic groupings (*k* = 5 solution): Methods. To generate cognitive-behavior profiles for each MAG, we performed exploratory functional decoding analyses using the terms coding each experimental contrast. We characterized term frequency distributions within and across MAGs using an adapted implementation of the forward and reverse inference analyses employed by NeuroSynth to calculate term frequency distributions within and across voxels from a large pool of studies (Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011). Forward inference analyses have been used to characterize the likelihood of activation given a mental phenomenon, and reverse inference analyses have been used to characterize the likelihood of a mental phenomenon given activation (Cieslik et al., 2013; Nickl-Jockschat et al., 2015; Poldrack, 2006; Yarkoni et al., 2011). In our adaptation of these analyses, multiple comparisons across terms were corrected for using the Benjamini-Hochberg procedure, which restricts the false discovery rate (FDR) to a given level (0.05; (Benjamini & Hochberg, 1995).

We first performed a within-MAG consistency analysis which calculated the probability of a term given assignment to a particular MAG, P(term | MAG). This analysis identified terms with a higher representation in a certain MAG than would be expected given a baseline level, which was defined as that MAG's average term frequency. Significance was assessed with one-way Chi-square tests of independence (FDR-corrected for the number of terms [$p_{FDR\text{-}corrected}<0.05$]). A significant, positive association between a term and a MAG indicated that the term was coded for experiments in that particular MAG at a higher frequency than would be expected given the average frequency of all terms coded for that MAG. An across-MAG selectivity analysis was then performed which calculated the probability of experiment MAG assignment given a term, P(MAG | term). This analysis assessed whether a term had a higher frequency within a certain MAG than would be expected given the frequency of that term across all other MAGs. Significance was assessed with two-way Chi-square tests ($p_{FDR\text{-}corrected}$<0.05) with a significant, positive association between a term and a MAG indicating that the term was coded for experiments in that particular MAG at a higher frequency than would be expected given the frequency in all other MAGs. Whereas the within-MAG analysis was influenced by each term's overall frequency in the corpus but not by cluster size (i.e., number of experimental contrasts in a MAG), the across-MAG analysis was less influenced by term frequency but more influenced by cluster size. Consequently, both the within-MAG and across-MAG analyses provided complementary information about term-MAG associations and were both utilized to create behavior profiles for each MAG. The posterior probability of each association was calculated (assuming a uniform prior of 0.5) as a measure of effect size (Poldrack, 2006), and plotted for significant terms from each MAG (**Fig. S8**).

Corpus-specific manual annotations for functional decoding of meta-analytic groupings (*k* = 5 solution): Results. We calculated the frequency at which each term was coded across the entire corpus, in addition to the frequency it was coded in each MAG (**Table S6**). We then employed within-MAG consistency and across-MAG selectivity analyses that utilized these term frequency distributions to determine statistically significant term-MAG associations. We use the phrase 'behavior profile' to refer to the collection of meta-analytic terms/labels showing a significant, positive association with a MAG from either the within-MAG consistency or across-MAG selectivity analyses ($p < 0.05$). If a term was significantly associated with at least four of the five MAGs, it was assigned to a 'common reward processing behavior profile'. This common behavior profile (**Fig. S7**) was composed of five terms: *Monetary Incentive Delay task* (MID) and *positive outcomes* (associated with all 5 MAGs) as well as *choice*, *value,* and *gambling choice* (associated with 4 out of the 5 MAGs). All other terms (not included in the common behavior profile) that displayed a significant association with a MAG ($p < 0.05$) were included in that MAG's unique behavior profile. We found that results from this corpus-specific, manual-annotation decoding procedure largely supported functional decoding results for the $k = 5$ solution that were derived using a NeuroSynth strategy (**Fig. S2**).



<u>Figure S7.</u> Behavior profiles associated with each meta-analytic grouping (MAG) of reward processing experiments utilizing corpus-specific manual annotations ($k = 5$ solution). Behavior profiles for each MAG consisted of terms demonstrating significant positive associations in either the within-MAG consistency analysis (blue outline), the between-MAG selectivity analysis (red), or both analyses (black) ($p_{FDR\text{-}corrected} < 0.05$). Terms significantly associated with at least four of the five MAGs were assigned to the 'common reward processing behavior profile'. Terms significantly and positively associated with only one MAG were included in that MAG's unique behavior profile.

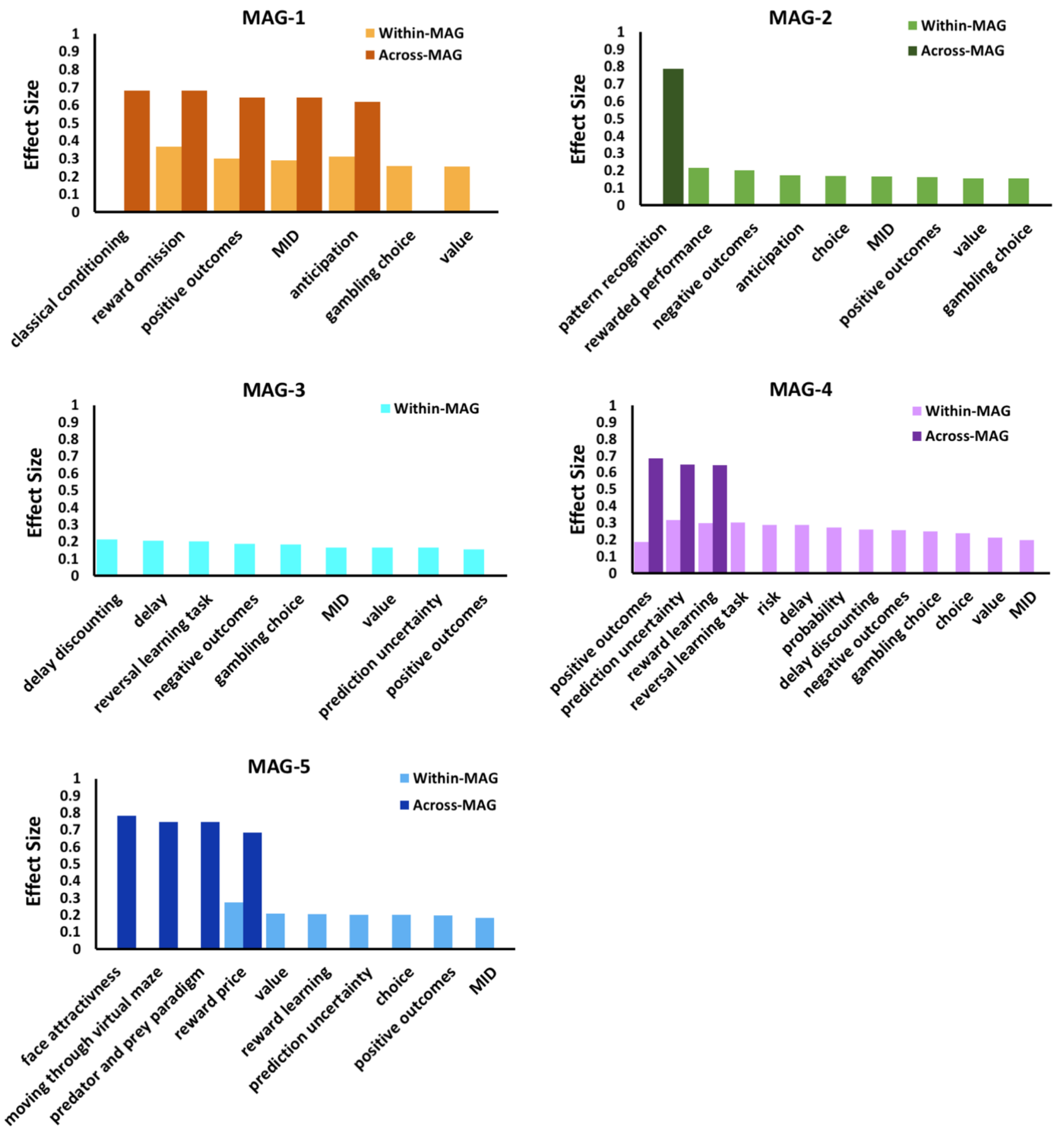


Figure S8. Effect size of each significant term-MAG association identified using corpus-specific manual annotations (*k* = 5 solution). Posterior probabilities were calculated and used as a measure of effect size for terms (out of a possible 42 terms) that were identified as significant in the within-MAG (lighter colors) or across-MAG functional decoding analysis (darker colors). The within-MAG analysis effect size indicates the probability of term, given a MAG (P[term | MAG]), while the across-MAG analysis effect size indicates the probably of a MAG, given a term (P[MAG | term]). The posterior probability of each association was calculated (assuming a uniform prior of 0.5), used as a measure of effect size (Poldrack, 2006), and plotted for significant terms from each MAG. The uniform prior was employed primarily to prevent estimates of posterior probabilities from being overwhelmed by differences in terms' base frequencies across the reward processing literature. In all instances the term-MAG associations reaching significance in the across-MAG analysis had higher effect sizes than term-MAG associations reaching significance in the within-MAG analysis. Additionally, terms uniquely associated with a certain MAG usually had higher effect sizes than terms significantly associated with multiple MAGs. Examining the effect sizes of significant terms increases the transparency of the functional decoding analysis.

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